DRAFT Sustainability and Heat Report

Western Sydney Aerotropolis

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MOSAIC insights

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alluvium

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Executive Summary

Alluvium Consulting Australia Pty Ltd (Alluvium) in partnership with Mosaic Insights and the Institute for Sustainable Futures (UTS) have been engaged by the Department of Planning, Infrastructure and Environment to complete a **Sustainability and Heat** study for the priority precincts in Western Sydney Aerotropolis. The brief was to provide advice on sustainability and heat mitigation measures as part of the planning for the Western Sydney Aerotropolis (Aerotropolis). The brief explicitly asked for advice that reimagined traditional methods and extended beyond the Business as Usual (Business as Usual) approach using innovative and flexible planning solutions that respond to emerging issues such as urban heat, water management and circular economies. The report approaches sustainability from the four current thought leadership positions of:

- Water sensitive cities
- Low carbon communities
- Circular economy
- Cool suburbs

While this report looks specifically at water, waste, carbon and heat it is important to acknowledge that ecological sustainability across the Aerotropolis e.g. maintaining and enhancing natural ecological functions, protecting and improving natural biodiverse corridors and connectivity and connection to Country through inclusive and integrated management of the landscape with First Nations people is crucial.

The definition of sustainability (with respect to water, waste, carbon, and heat) recommended will support an immediate response and will assist in the development and transition to a sustainable Aerotropolis over next 30 – 40 years. The recommended definition for sustainability for Aerotropolis:

The planning, design, delivery, and operation of the Aerotropolis precincts supports ***cyclical resource flows*** *and strives for a* ***net positive outcome*** *on all scales and by all parties across ecological, cultural, social, and economic sectors.*

This definition is used as one of three scenarios – the Sustainable Regenerative scenario – for each of the areas of water, carbon/energy, waste, and heat. The two other scenarios explored are Baseline: Business as Usual and Leading Industry Practice. The data used to outline potential outcomes was drawn from multiple sources and most extrapolated from other studies and applied to the Aerotropolis based on predicted population and job numbers. The sustainable regenerative scenario assessed delivers the best outcomes for the Aerotropolis from all aspects – water, waste, energy, and heat – and it is strongly recommended that an approach aligned with this model is adopted as a priority.

To achieve a sustainable, regenerative, and resilient Aerotropolis will require significant commitment from the agencies and organisations who will be managing and operating within the Aerotropolis. The high-end, high-tech Agribusiness, location of the Sydney Science Park in the Northern Gateway, the development of a global airport city in the Aerotropolis core and the significant infrastructure investment to occur in the Aerotropolis all support the vision for a leading global city in the Western Parkland City.

The results of the high-level assessment of sustainability and heat (from the available predicted data) shows that adoption of a sustainability approach could see, by 2036:

- Up to a 30% reduction in the consumption of potable water
- A 75% reduction in polluted stormwater entering South Creek
- Close to elimination of waste to landfill

- Up to 100% recovery of organics for compost and energy generation
- 100% local renewable energy generation (net positive carbon and energy exported to the grid)
- A more flexible and liveable built form that can respond to changes in needs through adoption of adaptable infrastructure and a share economy
- A greener more resilient Western Sydney area with up to 7°C of cooling on extreme heat days provided by better design, greening and irrigation
- A reduction in **extreme** and **very strong** heat stress days per summer from 47 to 19 days
- A world leading circular city that works across jurisdictions and industries in its transition to become sustainable, regenerative, and resilient

The report gives an overview of land use opportunities and constraints with respect to the land capabilities with evidence provided by other consultants engaged on this project. It is clear from this high-level analysis that adjustments to the planning definitions e.g. permitted or prohibited uses, for certain land uses will need to be reviewed to achieve the innovative and flexible planning solutions desired.

The major recommendations from the report are centred around two key focus areas:

1. Management of the Aerotropolis now and into the future
2. Principles and Performance Outcomes for the Precincts
3. Benchmark solutions to be considered for the Aerotropolis Development Control Plan

The main general recommendations are to:

1. Appoint a coordinating body (with statutory powers and operating licence) to provide the governance and integrated decision-making to deliver the vision
2. Commit to a guiding sustainability / resilience framework
3. Develop Aerotropolis specific strategies to set targets (based on detailed modelling of resource demands), guide the Aerotropolis to a sustainable or net positive outcome and influence other NSW policy (BASIX):
    a. waste management – circular economy strategy
    b. integrated water management plan
    c. carbon neutral / positive plan
4. Create partnerships for multifunctional outcomes and joint delivery and management of services and infrastructure
5. Review resourcing policy and regulations to support the delivery and maintenance of the blue green landscape vision by local government
6. Coordinate delivery of essential / temporary infrastructure e.g. water recycling plants, flexible material sorting spaces, temporary parking infrastructure
7. Develop Aerotropolis specific plans / guides for developers and land managers:
    a. soils (salinity)
    b. urban cooling
    c. share-economy
    d. tree management (urban forest)
    e. 100% renewables

8. Engage with and upskill development industry about the Aerotropolis beyond Business as Usual approach
9. Codesign with relevant stakeholders – including Aboriginal community – innovative, commercial solutions to achieve the circular economy
10. Review permitted / prohibited land use categories and definitions to support development of a sustainable regenerative Aerotropolis
11. Improve capacity of agencies and individuals for sustainability and resilience management to deliver on the Premier's priority for a world class public service.

The recommended principles in addition to the principles listed in the WSAP 2020 are:

WATER	Fit for purpose water is supplied from within the catchment as the priority (rain and stormwater to be used first then recycled water then potable)
	Co-governance / compliance arrangements are place to share water across property boundaries
	Protection natural soils, protecting and enhancing the existing areas of remanent native vegetation and biodiversity.
	Green infrastructure to provides water treatment, urban cooling, ecosystem services and amenity is integrated into built, landscaped and natural environments
	Aerotropolis is designed as a sponge to increase perviousness
	Landscapes potentially adversely impacted by contaminated soils and salinity are actively managed and restored
	Rainwater is captured at a range of scales – lot, neighbourhood, regional
	Vegetation/trees in the public and private domain is supported by soil volumes and passive irrigation
	Tree canopy targets are met at the neighbourhood scale
	Incorporate development that protects, maintains, or restores waterway health and the community's environmental values and uses of waterways through a risk-based approach to manage the cumulative impacts of development.
	Stormwater run-off targets (infiltration and harvesting) are applied at the lot and neighborhood scale
	Retreat - Adapt – Defend options for flood management are integrated and coordinated
	Incorporate development that protects, maintains, or restores waterway health and the community's environmental values and uses of waterways through a risk-based approach to managing the cumulative impacts of development.

WASTE	Adopt principles of AVOID first, the REDUCE, REUSE, RECYCLE in material choices and construction methods Educate and embed behaviours, practices, and systems through adoption of Sustainability / Resilience Framework and planning controls, services and information and education – individuals and businesses Design out waste in supply chain and manufacturing and eliminate single use items: • by using design guides for buildings with prefabricated/modular, long life and loose fit, flexible and adaptable solutions • adaptable and reusable infrastructure - temporary facilities that can be remodelled as the Aerotropolis grows/changes • eliminate construction waste with programs with volume builders to encourage waste minimisation in building design • design for end-of-life disassembly and recovery • use of recycled and renewable materials Establish Circular Economy Hubs for innovation and including Resources Recovery Processing infrastructure • plan now to process materials locally establishing local economies and circular systems within the Aerotropolis and on the boundary with Western Sydney councils • match suppliers with the local markets • testing innovative construction approaches - link with new CRC Source separate for Circular Economy • design infrastructure, collection, processing, policy, procurement, pricing, and behaviours to produce high quality outputs for high quality inputs to other processes • consider combining services for transport efficiency (commercial industrial and residential) around materials rather than land use e.g. organics, plastics, residual waste • provide processing and treatment facilities at a range of scales - lot, neighbourhood, regional – basement processing, micro-factories, large scale processing where possible • establish network based drop off points in preference of door to door collection. • think of adopting PAYT to encourage waste separation Design for share economy - encouraging collaborative housing models that reduce waste/encourage sharing Adopt Product Stewardship approaches - policy and regulations already in place (CDS, Computers and TVs) and consider the schemes in the development phase (batteries, solar, e-waste) including Extended Producer Responsibility Joint procurement for new commercial markets – councils, State and Local government with revised serving contracts – bundle for efficiencies and economies –education, customer services, collection, servicing, processing, reporting

ENERGY	• Plan for greater than 100% renewable energy supply to make Aerotropolis a net exporter of clean energy to the NSW grid. • Include diversity of renewable energy supply including solar, wind, green hydrogen, and bioenergy (anaerobic digestion of organic waste) • Provide decentralised local generation and supply • Develop integrated systems for energy generation – waste and water • Develop multi modal transport system that prioritises walking and cycling in the 30-minute city • Promote pedestrian and cycling network • Design and regulate for greening Infrastructure in public realm and private spaces for cooling, shade, amenity • Implement in the Street Design Guidelines the transition from individual use of infrastructure such as on and off road to shared adaptive infrastructure • Adaptable infrastructure for Charging stations – public facilities transition to private charging • Design roof space for energy generation, open space and amenity, gardens, food production, water harvesting, urban cooling • Provide space for local food production and distribution / retail / sharing – via markets, community gardens on public land and private spaces - lot, neighbourhood, and regional scale • Create equity of access to solar or renewables - removal of barriers to solar or renewables - Cost, rentals, heritage, solar access • Establish circular economy markets to reduce waste and transport emissions • Distributed and diverse share economy facilities and libraries - cars, books, tools, equipment, toys, parking spaces and infrastructure, bikes, kitchens, living and dining rooms - at a range of scales

HEAT	Green infrastructure • Vegetation – larger natural areas offer multiple benefits in terms of cooling and biodiversity providing (evapotranspiration, shade from large trees) • Water providing (evaporative cooling through misting and irrigation breezes over water bodies, healthy vegetation, green roofs, walls, and facades providing shade, insulation, and evapotranspiration • Design of places providing air flow, green open space, and appropriate building morphology so that the cooling from green space can be harnessed and spread throughout the city, e.g. having green open space upwind of the area of interest. Built environment • High albedo building materials to reflect light and heat • Shade through eaves and overhangs, awnings • Permeable pavements • Street tree pits redesigned for deep soils and passive irrigation • Dimples not pimples in the landscape (make dips and concave spaces to trap water and reduce run off) • Passive irrigation of vegetation to increase evapotranspiration • Adequate vegetation around the buildings • Natural ventilation

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1 Introduction

1.1 The Brief

Alluvium Consulting Australia Pty Ltd (Alluvium) in partnership with Mosaic Insights and the Institute for Sustainable Futures (UTS) have been engaged by the Department of Planning, Infrastructure and Environment to perform a **Sustainability and Heat** report for the Western Sydney Parkland City (Aerotropolis).

Alluvium was engaged to provide advice on and identify sustainability and heat mitigation measures as part of the planning for the Western Sydney Aerotropolis (Aerotropolis) to help implement the vision of the Western Parkland City.

The brief explicitly identified that

- traditional methods will need to be reimagined to formulate planning controls that are innovative and reflect best practice
- the intention was to extend beyond the Business as Usual (Business as Usual) approach to deliver on the Western Parkland vision for the Aerotropolis
- innovative and flexible planning solutions will be paramount and that the precinct plans, which will be informed by the Sustainability Report, respond to emerging issues such as urban heat, water management and circular economies.

The objectives of the sustainability and heat scope include:

- measures to support productive, connected, liveable and sustainable places as set out in the Greater Sydney Region Plan (GSRP) and Western City District Plan (WCDP).
- creating a 30-minute compact city with pedestrian orientated development around key destinations.
- creating a unique city character with outstanding architectural and landscape design outcomes.
- establish public and private domains which mitigate urban island effect and support water sensitive urban design.
- facilitate development of vibrant, accessible and exemplary green places with a strong sense of place and custodianship, and recognition and celebration of Aboriginal and European heritage places.
- provide for an effective multi-functional green corridor which performs social, environmental, water management and recreational functions for the local community; and
- allow for the successful implementation and integration of the blue and green grid for the Aerotropolis.

1.2 The Aerotropolis

The Aerotropolis is framed to be a global gateway for Sydney, providing a once in-a-lifetime opportunity to drive transformational change in the emerging Western Parkland City that will improve opportunity, amenity, and sustainability. Its overarching vision is to ‘respect and connect Country’. The development is to be sensitive to the landscape of Western Sydney, its traditional owners, ecology, and community. This ***landscape-led*** approach underpins planning and development: the environmental planning vision of the Western Parkland City is for a “city in its landscape” that is restorative and regenerative, restoring ecological and hydrological systems. Building resilience and adaptability in the face of a changing climate is also a central consideration, planning for solutions to manage urban heat and water issues. There are clear aspirations for a ‘beyond business as usual’ approach: the Aerotropolis incorporates goals for a low carbon, water sensitive, cool development based on circular economy principles.

1.3 This Report

The vision for the Aerotropolis is to be commended, it lays the foundation for a transition to a new way of working and aligns with the principles of regenerative development. Accordingly, this report examines the resource demands for the Aerotropolis and its initial precincts; Aerotropolis Core, Badgerys Creek, Northern Gateway, Agribusiness and Wianamatta-South Creek across three scenarios for 2036. It sets out principles, recommendations, and a planning approach that is geared towards achieving sustainable regenerative development.

This report provides a definition of sustainability in the sense of regenerative development and draws on information from:

- the Sustainability and Heat Background Analysis Report (Alluvium, 2020),
- current targets of the Australian Government, the NSW Government and local government
- a range of academic and published literature,
- data and information sourced from state agencies and Penrith and Liverpool councils, the Western Sydney Planning Partnership, Greater Sydney Commission, and technical consultants
- feedback from various agencies involved in the development of Precinct Plans and other planning documents for the Aerotropolis.

This report was structured around the assessment of the current thought leadership in sustainability themes including:

1. Water sensitive cities - integrated water management – both the design of water sensitive buildings and public domain to protect receiving waters of the Wianamatta-South Creek catchment and the design of sustainable water supply options,
2. Low carbon communities – reducing emissions through a range of means and generating renewable energy
3. Circular Economy – new systems, services, and behaviours to realise a circular economy in households, businesses, and public spaces
4. Cool suburbs (resilience) - urban heat and cooling in a changing climate recommending green infrastructure for mitigation of heat and creation of a comfortable Western Sydney to support connectivity, walkability and human health and comfort,

These key sustainability themes were applied to the Aerotropolis and three key scenarios for 2026 have been investigated for each of the precincts:

1. Baseline – business as usual
2. Leading Industry Practice
3. Sustainable Regenerative

1.4 What is Sustainability for the Western Sydney Aerotropolis?

The report provides a definition of sustainability in the sense of sustainable - regenerative development.

Sustainable - regenerative development (sometimes called 'regenerative sustainability') is the new frontier for city and precinct design, supporting cyclical resource flows (circular economy) and striving to achieve a net positive ecological, social, and economic impact. This concept has grown out of the original sustainability movement which had its origins in the latter part of the last century.

In 1987, the Bruntland Commission published Our Common Future which provided the oft-cited definition of sustainable development as "***development that meets the needs of the present without compromising the ability of future generations to meet their own needs***" this concept of sustainable development aims to maintain economic advancement and progress while protecting the long-term value of the environment, however for the past 20 – 30 years it has been argued that a trade-off between environmental sustainability and economic development is not helpful. (Emas, 2015)

Sustainability as it has been applied in the past is not adequate to describe the progress needed. The word sustainability itself does not outline what it is we are trying to sustain when for the past 30 years we have been focussed on merely minimising harm.

In this report we argue that a sustainable regenerative model where the human culture (healthy, resilient and adaptable) cares for the planet and life in the awareness that this is the most effective way to create a thriving future for all of humanity. When we aim for a regenerative form of sustainability we are focussed on the whole system, one that deals with resources and culture in an interconnected cyclic way where actions in one part positively impact on the outcomes of another. Urban heat has been identified as a particular challenge for Western Sydney, especially as the climate changes so integrating heat and culture with the landscape and built form is crucial. Regenerative Sustainability is first and foremost about systemic health and resilience at different scales, from local, to regional and global. We are suggesting that to really move beyond the business as usual scenario we should be aiming to design the Aerotropolis for systemic health – this may not stop unexpected side-effects and uncertainty, but it offers the Western Sydney Parkland city an opportunity to trial and learn towards a regenerative culture. (Whal, 2018)

We propose that the Aerotropolis consider the following definition of sustainability:

> *The planning, design, delivery, and operation of the Aerotropolis precincts supports* ***cyclical resource flows*** *and strives for a* ***net positive outcome*** *on all scales and by all parties across ecological, cultural, social, and economic sectors.*

While it may seem ambitious today, it is the only appropriate vision for a city-shaping development of such strategic significance and scale as Aerotropolis. A fundamental principle of regenerative development is that it is based on an understanding of, and response to, local place and ecosystem. This resonates strongly with the Aerotropolis vision to 'respect and connect Country' and the landscape-led approach. The Aerotropolis can be an exemplar, showcasing how urban developments can build in long-term resilience to the effects of climate change.

2 Planning for Sustainability in the Western Sydney Aerotropolis

In this chapter we outline, in brief, the strategic context, the planning framework and guiding documents that inform the Aerotropolis.

2.1 Broader Planning Context

The Aerotropolis is governed by a series of government priorities, strategic documents, and statutory planning instruments. This report reviewed a range of strategic plans, policies, schemes, and action plans to provide context and inform the direction. The Statutory plans that will be influenced by this report include the Aerotropolis precinct planning and Development Control Plan.

2.1.1 Premier's Priorities

The NSW Government has proposed a list of priorities that represent a commitment to enhancing the quality of life of the people of NSW. They have been listed as the *Premier's Priorities* and have been set with the purpose of delivering on this government's key policy priorities:

- a strong economy
- highest quality education
- well-connected communities with quality local environments
- putting customer at the centre of everything we do
- breaking the cycle of disadvantage.

The three priorities (and their targets) relevant to the sustainability outcomes for the Aerotropolis are outlined in **Table 1**.

Table 1 - Premier's priorities relevant to the sustainability outcomes for Aerotropolis (https://www.nsw.gov.au/premiers-priorities)

Priority	Targets
Greener public spaces	Increase the proportion of homes in urban areas within 10 minutes' walk of quality green, open and public space by 10 per cent by 2023.
Greening our city	Increase the tree canopy and green cover across Greater Sydney by planting one million trees by 2022.
World-class public service	Implement best-practice productivity and digital capability in the NSW public sector and drive public sector diversity by 2025.

2.1.2 Relevant Planning Hierarchy for Western Sydney Aerotropolis

There are several adopted strategies, plans, policies, and targets that will influence the activity and land use planning in the Aerotropolis. The documents listed in **Table 2** are a summary of the most relevant to the vision of the landscape led Parkland City and the ambition to go beyond business as usual for this project. They have been reviewed in relation to the project and to identify those quantifiable commitments (targets) which need to be included in the sustainability and heat recommendations. The targets are outlined in **Table 5**.

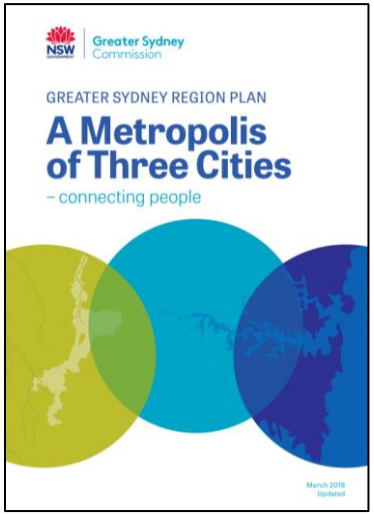
Table 2 – Strategies, plans and policies relevant to the Aerotropolis sustainability and heat agenda

	Strategy	Schemes	Policy	Plan
National 	Smart Cities Plan (A, 2016), Australian Infrastructure Plan (Australia, 2016), Bioenergy Roadmap (ARENA, in development)	National Television and Computer Recycling Scheme (Stewardship, n.d.) Sustainable Packaging Guidelines (APCO, Sustinable Packaging Guidelines, 2020)	National Waste Policy: less waste more resources (National Waste Policy: less waste more resources, 2018) Hazardous Waste (Regulation of Exports and Imports) Act 1989 **Invalid source specified.**	National Waste Policy Action Plan (National Waste Policy Action Plan, 2019)
State 	20- Year Waste Strategy for NSW (20-Year Waste Strategy for NSW, in development) NSW Waste Avoidance and Resource Recovery Strategy 2014-21 (EPA, 2014) NSW Electricity Strategy (DPIE, 2019) NSW Future Transport Strategy 2056 (NSW T. f., 2018) Western City and Aerotropolis Authority Strategy (WCAA, 2019) Decisions (OEH, 2017) State Infrastructure Strategy 2018-2038 (NSW I. , 2018), Greater Sydney Water Strategy (DPIE, Greater Sydney Water Strategy, in development)	Return and Earn (EPA, Return and Earn, n.d.) Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions (Dela-Cruz J, 2017), NSW Biodiversity Offset Policy (OEH N. , NSW Biodiversity Offsets Policy for Major Projects, 2014)	NSW Energy from Waste Policy Statement (NSW Energy from Waste Policy Statment, 2015) NSW Circular Economy Policy Statement (EPA, 2019) NSW Climate Change Policy Framework (OEH, NSW Climate Change Policy Framewrok, 2016) Technical Guidelines for Urban Green Cover in NSW (OEH N. , Urban Green Cover in NSW, Technical guidelines, 2015) Minimising the impact of extreme heat: A guide for local government (OEH N. , 2016)	NSW Plastics Plan (NSW Plastics Plan, in develoment) Greener Places Design Guide (NSW G. A., 2020) NSW Net Zero Plan – Stage 1 2020-2030 (DPIE, 2020)
Region 	Western Sydney Regional Waste Avoidance and Resource Recovery Strategy 2017-2021 (WSROC, 2017) Turn Down the Heat Strategy (WSROC, Turn down the heat strategy and action plan, 2018) Resilient Sydney Strategy (Resiliant Sydney, 2018) Vision and Transition Strategy for a Water Sensitive Greater Sydney (CRC, 2018) Greater Sydney Regional Plan - Metropolis of Three Cities (2016)	Western Parkland City Liveability Program (WSCD, n.d.)		

	Strategy	Schemes	Policy	Plan
District 	Western City District Plan (GSC, 2018)			Draft Cumberland Plain Conservation Plan (Planning, 2020)
Local Government Area 	Waste Strategy 2017-2026 (Penrith, 2017) Cooling the City Strategy (Penrith, 2015)			
Areas of Interest 	Western Parkland City – Urban Typologies (Hoban, 2020)	Sydney Water Strategy 2019 (Water, 2019)		Western Sydney Aerotropolis Plan (Western Sydney Aerotropolis Plan, 2019)

2.1.3 Greater Sydney Regional Plan

A **Metropolis of Three Cities** is the region plan for Greater Sydney. It is built on a vision of three cities where most residents live within 30 minutes of their jobs, education and health facilities, services, and great places.



This vision seeks to rebalance the economic and social opportunities and deliver a more equitable Greater Sydney.

The Greater Sydney Region Plan sets a 40-year vision for the three cities of Greater Sydney. It sets out a 20-year plan considering the social, economic, and environmental issues related to growth and change for Greater Sydney. It:

- informs district and local plans and the assessment of planning proposals
- assists infrastructure agencies to plan and deliver for growth and change and to align their infrastructure plans to place-based outcomes
- informs the private sector and the wider community of the growth management and infrastructure investment intentions of government.

The GSRP sets out 10 Directions, objectives and planning priorities under the four themes of (**Table 3**):

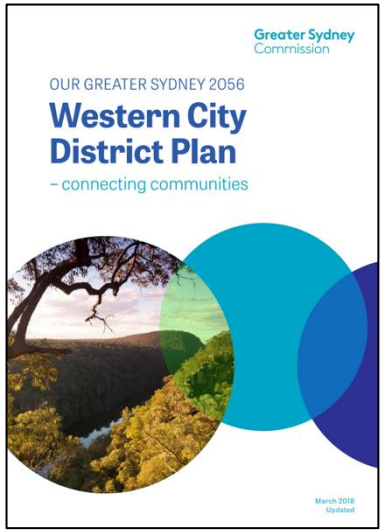
1. Infrastructure
2. Liveability
3. Productivity
4. Sustainability

Photo - (Western Sydney Planning Partnership , 2020)

Table 3 - Directions, objectives, and planning priorities for Western Sydney under the Greater Sydney Region Plan

Infrastructure		Liveability			Productivity		Sustainability		
A city supported by infrastructure	A collaborative city	A city for people	Housing the city	A city of great places	A well-connected city	Jobs and skills for the city	A city in its landscape	An efficient city	A resilient city
									
Infrastructure supports the three cities Infrastructure aligns with forecast growth – growth infrastructure compact Infrastructure adapts to meet future needs Infrastructure use is optimised	Benefits of growth realised by collaboration of governments, community & business	Services & infrastructure meet communities' changing needs Communities are healthy, resilient & socially connected Greater Sydney's communities are culturally rich with diverse neighbourhoods Greater Sydney celebrates the arts & supports creative industries & innovation	Greater housing supply Housing is more diverse & affordable	Great places that bring people together Environmental heritage is identified, conserved & enhanced	A Metropolis of Three Cities – integrated land use & transport creates walkable & 30-min cities The Eastern, GPOP & Western Economic Corridors are better connected & more competitive Freight & logistics network is competitive & efficient Regional connectivity is enhanced	Harbour CBD is stronger & more competitive Greater Parramatta is stronger & better connected Western Sydney Airport & Badgerys Creek Aerotropolis are economic catalysts for Western Parkland City Internationally competitive health, education, research & innovation precincts Investment & business activity in centres Industrial & urban services land is planned, retained & managed Economic sectors are targeted for success	The coast & waterways are protected & healthier A cool & green parkland city in the South Creek corridor Biodiversity is protected, urban bushland & remnant vegetation is enhanced Scenic & cultural landscapes are protected Environmental, social & economic values in rural areas are protected & enhanced Urban tree canopy cover is increased Public open space is accessible, protected & enhanced The Green Grid links parks, open spaces, bushland & walking & cycling paths	A low-carbon city contributes to net-zero emissions by 2050 & mitigates climate change Energy & water flows are captured, used, and re-used More waste is re-used and recycled to support the development of a circular economy	People & places adapt to climate change & future shocks & stresses Exposure to natural & urban hazards is reduced Heatwaves & extreme heat are managed
Increased 30-minute access to a metropolitan centre/cluster	Increased use of public resources such as open space and community facilities	Increased walkable access to local centres	Increased housing completions (by type); Number of councils that implement Affordable Rental Housing Target Schemes	Increased access to open space	% of dwellings located within 30 min by public transport of a metropolitan centre/ cluster or strategic centre	Increased jobs in metropolitan and strategic centres	Increased urban tree canopy; Expanded Greater Sydney Green Grid	Reduced transport-related greenhouse gas emissions; Reduced energy use per capita	Number of councils with standardised state-wide natural hazard information

2.1.4 Western City District Plan



The Parkland City

This Western City District Plan (WSDP) is a 20-year plan to manage growth in the context of economic, social, and environmental matters to achieve the 40-year vision for Greater Sydney.

It is a guide for implementing the Greater Sydney Region Plan, *A Metropolis of Three Cities*, at a district level and is a bridge between regional and local planning The Western Sydney District Plan informs local strategic planning statements and local environmental plans, the assessment of planning proposals as well as community strategic plans and policies.

The WSDP responds to the 10 Directions and themes of the Greater Sydney Region Plan.

The document sets a clear direction for improved sustainability from the landscape perspective. While there is reference to efficient management of resources and recycling (see Sequential development – construction materials example below) there is less detail of how this will be actioned, measured, and reported.

Sequential development – construction materials

Mineral resources of sand, clay and aggregate are used for construction materials that supply housing and infrastructure across the Greater Sydney Region. Retaining access to those construction material resources in the metropolitan rural areas and some urban areas of the Greater Sydney Region minimises transport requirements. It also reduces the cost, environmental footprint and social impact of construction, supporting continued growth and affordability of development, infrastructure and housing.

Land use planning can respond to the lifecycle of mineral resources through a multiple or sequential use of land. For instance, under a multiple use-of-land approach compatible activities such as brickworks or landfills may be located on or near land also used for mineral resource operations. Alternatively, the successful rehabilitation of land after a resource has been extracted can enable the sequential use of land, such as the Penrith Lakes area, where redeveloped sand and aggregate quarries are now a series of recreational lakes, including the Sydney International Regatta Centre. These approaches aim to achieve a balanced approach to land use that maximises environmental, social and economic benefits for the community.

A city in its landscape

- Protecting and improving the health and enjoyment of the District's waterways
- Creating a Parkland City urban structure and identity, with South Creek as a defining spatial element
- Protecting and enhancing bushland and biodiversity
- Increasing urban tree canopy cover and delivering Green Grid connections
- Protecting and enhancing scenic and cultural landscapes
- Better managing rural areas
- Delivering high quality open space

An efficient city

- Reducing carbon emissions and managing energy, water, and waste efficiently

A resilient city

- Adapting to the impacts of urban and natural hazards and climate change

2.2 Western Sydney Aerotropolis Planning

Acknowledgement of Country

Planning for the Western Sydney Aerotropolis acknowledges more than 60,000 years of continuous Aboriginal connection to the land that makes up NSW

Starting with Country:

Traditional understandings of Country will shape the Aerotropolis, influencing planning, urban design, and landscape management. Aboriginal peoples understand that they originated from Country; it is at the centre of their ways of knowing and being. An appreciation of Country ensures Country is cared for throughout the process of design and development.

Aerotropolis VISION

The Aerotropolis is Australia's newest global gateway, built around the world-class Western Sydney International (Nancy-Bird Walton) Airport. Its evolution has driven transformational change in the Western Parkland City. Development is framed around Wianamatta–South Creek and an expansive network of parklands and green and blue corridors to realise the cool and connected Western Parkland City. Above all, it respects and connects Country. It creates opportunity, amenity and sustainability for workers and residents in Western Sydney.

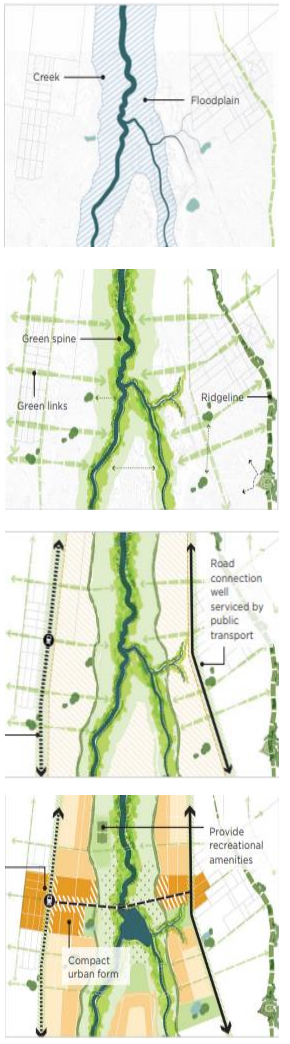
The Aerotropolis is low carbon, featuring next-generation energy, waste, and water infrastructure.

Circular economy principles minimise waste and pollution, retain water in the environment, reuse energy and regenerate natural systems to increase the tree canopy and urban cooling.

Sustainable food production in the Agribusiness Precinct minimises food miles and reduces food wastage.

Sustainable urban connections include efficient and accessible public transport links, walking and cycling facilities, smart technologies, and an efficient road network.

Efficient freight movements are mainly by rail. People and business can access key centres in the Western Parkland City Metropolitan Cluster.



Vision of a landscape led Aerotropolis (Western Sydney Planning Partnership , 2020)

2.2.1 Western Sydney Aerotropolis Plan objectives

A single overarching objective of recognising country underpins the Aerotropolis (below):

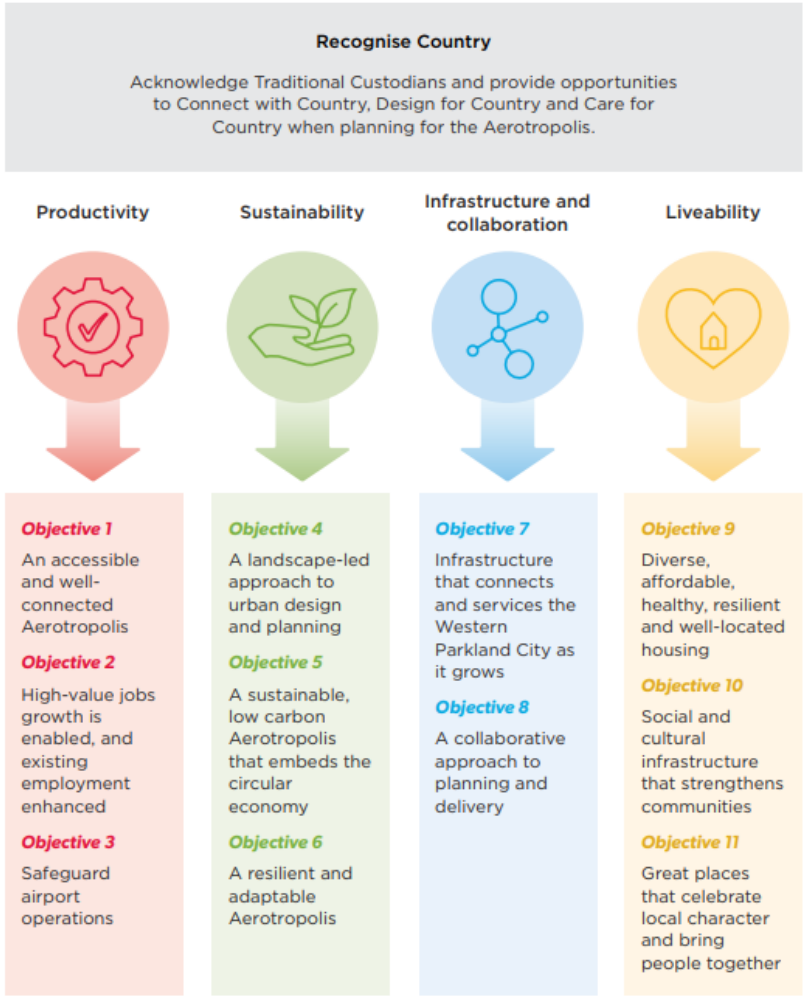


Figure 1 - Overarching and specific objectives for the Western Sydney Aerotropolis *(Western Sydney Planning Partnership , 2020)*

2.2.2 Western Sydney Aerotropolis Plan – Sustainability objectives

The following pages list the sustainability related objectives from the Western Sydney Aerotropolis Plan. These are provided for context and reference in relation to the beyond business as usual recommendations for the Aerotropolis.

Objective 4 A landscape-led approach to urban design and planning (Western Sydney Planning Partnership , 2020)

- Retain and enhance natural features such as waterways, vegetation, landform, and culturally significant landscapes.
- Integrate Blue Green Infrastructure links with public open spaces and the Green Grid, maximising opportunities for connections, an urban tree canopy and active use of the floodplain.
- Retain water in the landscape by maximising appropriate permeable surfaces, reusing water, and developing appropriate urban typologies.
- Orient urban development towards creeks and integrate into the landscape through quality open space, a high degree of solar access and tree canopy.
- Develop a connected parkland network linking with the Wianamatta–South Creek corridor that shapes the Aerotropolis and provides amenity and ecological value and create a high quality ridgeline and linear parks adjacent to, and integrated with, riparian corridors that retain water. 92 Western Sydney Aerotropolis Plan
- Retain and increase the urban tree canopy and green cover across the Aerotropolis consistent with the Region Plan target of 40% and the Premier's Priority for Greening our city.
- Retain, enhance, and co-locate vegetation on ridgelines with active open space and use it to guide building heights.
- Identify and protect scenic and cultural landscapes and develop a street grid based on landforms, with long north– south blocks in urban areas to attain good solar performance, and east–west streets to capture long views to the Blue Mountains.
- Meet the requirements of the biodiversity conservation program in the Cumberland Plain Conservation Plan and approved strategic biodiversity certification and strategic assessment protecting land with biodiversity value and provide a sensitive urban interface that supports and enhances corridors and reserves.
- Avoid, minimise, and mitigate impacts on threatened species and endangered ecological communities, habitat corridors, and riparian and aquatic habitats to

prioritise length, connectivity, and representativeness to maintain ecological function. Protect the integrity and continuity of wildlife by protecting priority habitat corridors to support migrating species, birds, and arboreal mammals; using public land for biodiversity conservation with an appropriate management regime; and expanding vegetation corridors if impacted by utility installations.

- Retain and protect wetland environments to support plant animal communities and to mitigate wildlife attraction or wildlife strike.
- Provide open space buffers and asset protection zones to conservation areas wholly within urban capable footprints.
- Plan stormwater and wastewater in the Wianamatta–South Creek Catchment to minimise potential hydrologic and hydraulic impacts on ecology, creek structure, infrastructure, water quality and the natural water cycle. Integrate water sensitive urban design and use stormwater or recycled water to irrigate streets and public open space to support public amenity and urban cooling. Co-locate industrial water users, where appropriate.

Objective 5 A sustainable, low carbon Aerotropolis that embeds the circular economy (Western Sydney Planning Partnership , 2020)

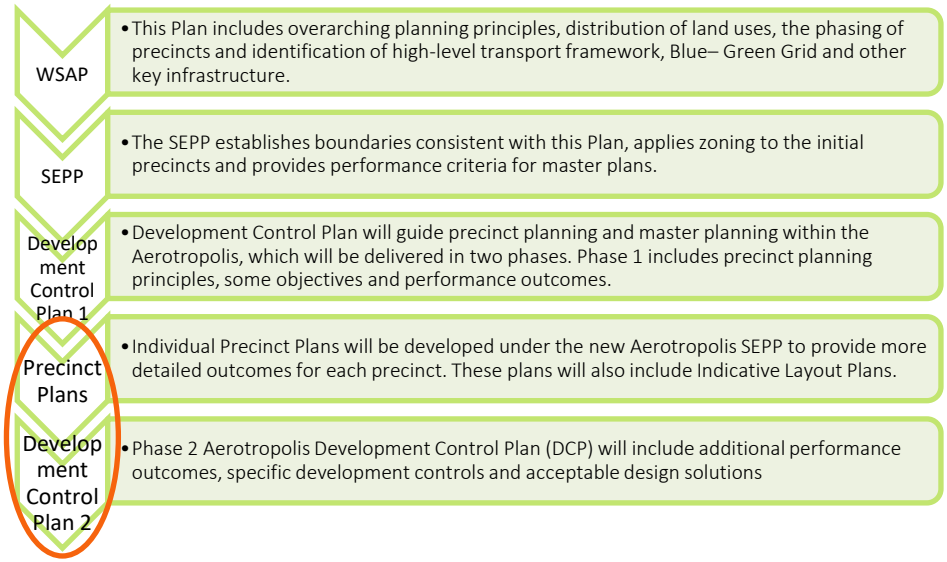
- Use low carbon, high efficiency strategies to reduce emissions and energy use in line with NSW net zero emissions target and mitigate urban heat through urban development and building design. Use innovative and integrated approaches to achieve higher standards of resource recovery, waste management, water management and renewable energy.

Objective 6 A resilient and adaptable Aerotropolis (Western Sydney Planning Partnership , 2020)

- Plan for compatible land uses within the floodplain, provide safe evacuation, and egress from flood events and consider climate change, culvert blockage and floodplain revegetation.
- Prohibit cut and fill to alter the 1% AEP flood extent.
- Design, build and manage flood mitigation assets to provide where feasible native habitat, aesthetics, public recreation, and amenity, whilst not impacting on flood behaviour.
- Protect, maintain, and improve the water quality and flow to meet the NSW Government waterway health targets.
- Protect high value terrestrial and aquatic ecosystems to enhance biodiversity and protect environmental values.

2.2.3 Western Sydney Aerotropolis Planning the Precincts

The activities that have taken place to develop the planning controls for the priority sites in the Aerotropolis priority precincts are outlined below, this report is providing advice to the Precinct Plans and the development of Development Control Plan for Sustainability and Heat. The five priority precincts are outlined in the **Table 4.**



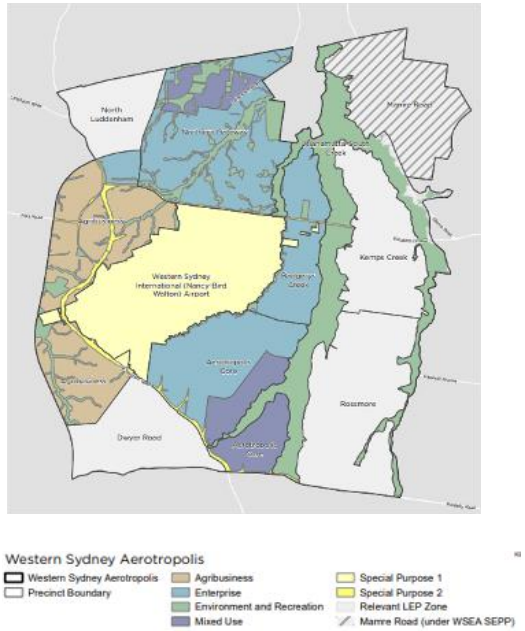


Table 4 – Priority Precincts for Sustainability and Heat report

1. Aerotropolis Core	Facilitate investment and jobs that will benefit from the Airport.
2. Northern Gateway	Facilitate investment and jobs that will benefit from investments in transport infrastructure such as the proposed Sydney Metro Greater West Stage 1.
3. Wianamatta – South Creek	This central green spine is crucial to the Aerotropolis' amenity, liveability and environment.
4. Agribusiness Precinct	To stimulate planning and investment in new industries close to the Airport.
5. Badgerys Creek Precinct	As this precinct adjoins the Airport and Aerotropolis Core, it will facilitate the detailed planning of necessary road infrastructure to support the Airport. Additionally, it is acknowledged that the amenity of the area has been impacted by its already occurring transition to industrial uses.

2.3 Relevant sustainability targets applicable for Western Sydney Aerotropolis

The Aerotropolis area covers multiple jurisdictions – it will have a federally managed airport, State Government agencies will have responsibility for significant infrastructure across transport, energy and water and waste policy, recreation and open space, public facilities (schools and health) and local councils will have reasonability for services, infrastructure, open space, compliance and community services. There are many adopted targets and directions relating to the sustainability elements of water, carbon, energy, waste and heat, these are outlined in **Table 5**. We are also aware of policies and strategies currently under development e.g. NSW 20 Year Waste Strategy that will have a significant impact on the development of the Aerotropolis.

Table 5 – Relevant adopted targets and directions relating to sustainability and heat

	WATER	WASTE	ENERGY	HEAT
National 		• Ban export of waste: plastic, paper, glass, and tyres from second half of 2020 • Reduce total waste generated per person in Australia by 10% by 2030 • 80% average resource recovery rate from all waste streams following the waste hierarchy by 2030 • Significantly increase use of recycled content by governments and industry • Phase out problematic and unnecessary plastic by 2025 • Halve the amount of organic waste sent to landfill by 2030 • Make comprehensive, economy-wide, and timely data publicly available to support better consumer, investment, and policy decisions • Phase out problematic and unnecessary single-use plastic through redesign, innovation, or alternative delivery methods • 100% of packaging to be reusable recyclable or compostable • 70% of plastic packaging recycled or composted • 30% average recycled content across all packaging	• Emissions are 5% below 2000 levels by 2020 • Emissions are 26-28% below 2005 levels by 2030	• Limit warming to 1.5 – 2 °°C as part of the ratified Paris climate agreement
State 	Minimum pervious targets • 50% residential • 40% employment uses Minimum dedicated open space targets - <u>Residential:</u> • Low density – 10% • High density – 25% <u>Employment:</u>	• 80% of all material used in packaging products must be recovered • 100% of new and existing packaging must be reviewed using the Sustainable Packaging Guidelines by June 2020 • By 2021–22 increase recycling rates for: • MSW from 52% to 70% • C&I from 57% to 70% • C&D from 75% to 80%	• Achieve zero net emissions by 2050 (emissions savings objective) • Reduce emissions by 35% by 2030 (interim target) • NSW is more resilient to a changing climate (impacts and adaptation objective) • 10% hydrogen in the gas network by 2030 • Increasing solar from 55,000 to 125,000MWh by 2024	• People and places adapt to climate change and future shocks and stresses • Exposure to natural and urban hazards is reduced • Heatwaves and extreme heat are managed • Increase the tree canopy and green cover across Greater Sydney by planting one million trees by 2022.

	WATER	WASTE	ENERGY	HEAT
	• 5-10% The NSW government is currently updating water quality objectives for the South Creek Catchment – there will be a range of objectives and thresholds to meet for the blue grid (waterways, riparian corridors, wetlands etc).	• Increase the waste diverted from landfill from 63% to 75% by 2021–22 • Establish or upgrade 86 drop-off facilities or services for managing household problem wastes state-wide by 2021–22 • By 2016–17, reduce the number of litter items by 40% and then continue to reduce litter items to 2021–22 • phase out key single-use plastics • triple the proportion of plastic recycled in NSW across all sectors and streams by 2030 • reduce plastic litter items by 25% by 2025 • make NSW a leader in national and international research on plastics.	• Increasing #electric/hybrid passenger vehicles by 30% by 2023 (10% fully electric) • Switching to electric busses • Rolling out hybrid diesel-electric regional passenger trains from 2023	• 40% tree canopy cover by planting 1 million trees by 2022 and 5 million trees by 2030. • Increase the proportion of homes in urban areas within 10 minutes' walk of quality green, open and public space by 10 per cent by 2023.
Region 	• 40% tree canopy cover – 1 million trees by 2022 and 5 million trees by 2030 • Govt Architects – Greener Places Design Framework to: o protect, conserve, and enhance NSW's network of green and open natural spaces o deliver a network of high-quality, high performing and well-designed green space, establishing a crucial component of urban infrastructure to address the environmental challenges of the 21st Century o protect and enhance local habitat including both native flora and fauna o promote healthy living, encouraging physical activity, social cohesion, and enhancing wellbeing by providing liveable places for the NSW community o create a more strategic approach to planning for green infrastructure, encouraging early and integrated investment through statutory planning o deliver better tools for the delivery of green infrastructure across NSW			• Increase multi-sectoral collaborations and investment to deliver more projects to address the impact of urban heat in WS by 2023 • Reduce the average peak ambient temperature in WS by 1.5OC through water, greening and cool materials strategy by 2023 • Zero net increase in economic impacts of heatwaves by 2023 • Zero net increase in morbidity and mortality impacts of heatwaves in WS by 2023
District 	• A landscape led approach	• A sustainable low carbon Aerotropolis that embed the circular economy	• A sustainable low carbon Aerotropolis that embed the circular economy	

	WATER	WASTE	ENERGY	HEAT
Local Government Area 		• Reduce waste generation to 7.5 kg/capita/week by 2021 • Achieve 70% diversion of waste from landfill by 2021		• Maximise community awareness and understanding of the effects of heat and the importance of cooling in Penrith LGA • Encourage greater appreciation of green infrastructure and green spaces in the LGA and their cooling benefits • Implement the identified actions with the Strategy giving priority to heat vulnerable areas • Identify ways to adapt existing projects and activities that will work towards cooling the Penrith LGA and identify new projects.
Site 	• The Western Sydney Planning Partnership with Sydney Water and NSW Government is currently working on an appropriate run-off target for the Aerotropolis • Allocate minimum pervious area – 50% for residential and 40% for employment uses			

2.3.1 Conclusions

There is considerable support from adopted plans and strategies and current leaders in government and in elected representatives for the development of a beyond business as usual Aerotropolis. There is a strong and clear focus on a *landscape-led* Western Sydney. The change from a rural landscape to a new urban aerotropolis is being influenced by its connection to Country and visions for landscape and a parkland city are outlined and repeated in the Greater Sydney Regional Plan, the Western Sydney District Plan and in the Wester Sydney Aerotropolis Plan. This combined with a clear target for tree canopy (40% canopy cover) and emissions reduction (35% reduction by 2030) provides direction for the future for the Aerotropolis. However, there is less focus or agreement on how water (specifically stormwater) will be managed and integrated to deliver the landscape vision and resilience needed in the Western Sydney and how a Circular Economy – the valuing, servicing, recovery and circulation of materials and resources as inputs and outputs from homes, industry and businesses will be realised. The NSW Government is currently working on a Draft 20-year Waste Strategy and based on the Issues paper released for consultation in May 2020 the focus is on waste as a resource in a circular economy approach. In addition, the COAG commitments on waste export ban, the WSP not only has an opportunity to progress in the circular economy transition but it will be strategically supported on state and national levels.

Our approach – expanded upon in Section 3 has been therefore to outline the resource demands - energy, water, materials – and resource outputs (waste in the form of wastewater, waste, emissions, heat) for each of the precincts for the year 2036. We have provided these resource outputs for the three scenarios for each of water, energy, waste and heat using either data that is currently available or data based on assumptions from known resource use to demonstrate the impact of adopting a beyond business as usual approach to our urban areas.

3 Opportunities for the Precincts

3.1 Sustainability Scenarios for the Precinct

In this section we have examined the resource needs – inputs (demand) and outputs (waste products and emissions) for each of the three adopted scenarios:

1. Baseline
2. Leading Industry Practice
3. Sustainable Regenerative

Each resource category - water, energy, and waste – have been included as well as the future heat expectations for the Aerotropolis. We have used data that is currently available from agencies or data based on assumptions from known resource use to demonstrate the impact of adopting a beyond business as usual approach to our urban areas.

3.1.1 Scenarios

For the purposes of demonstrating the possibilities for Aerotropolis, we have outlined three scenarios:

1. **Baseline** – this is the 'business as usual' scenario, based on the minimum regulatory standards and policies that currently apply to Aerotropolis. We understand that the aspirations for Aerotropolis are to exceed this default or 'business as usual' level of performance. Business as usual is therefore the baseline scenario from which improvements can be modelled.
2. **Leading industry practice** – this scenario represents current leading local industry practice in sustainable development. While this is a reasonable scenario in today's context, the strategic scale and nature of the Aerotropolis, its long development time frame, and the rapidly changing urban context (e.g. climate change and other challenges for cities, technological change) warrants a higher level of ambition. This is particularly so when considering costs and benefits from a life cycle perspective.
3. **Regenerative** – this scenario targets a net zero impact, with mechanisms in place for transition to net positive outcomes over the lifetime of Aerotropolis. Whist this 'future forward' scenario might seem ambitious today, it represents good risk and financial management for a strategic, large-scale new development that will put the infrastructure and buildings of tomorrow in place. Aerotropolis can be a leading precedent for urban development of the future.

	**BASELINE -** this is the 'business as usual' scenario, based on the minimum regulatory standards and policies that currently apply to Aerotropolis. It sometimes focusses on minimising adverse outcomes but is largely focussed on what we know and have done before		**LEADING INDUSTRY PRACTICE:** this scenario represents current leading local industry practice in sustainable development for Aerotropolis. It is focussed on minimising adverse outcomes.		**SUSTAINABLE REGENERATIVE;** this scenario targets a net zero impact, with mechanisms in place for transition to net positive outcomes over the lifetime of Aerotropolis. It is focussed on creating a net positive outcome with cyclical resource flows.

We recommend that Aerotropolis invests in further scenario modelling to understand the implications, costs and benefits of the regenerative scenario in more detail, and to learn from some of the other international cities who have implemented or are planning regenerative scenarios such as Amsterdam (**Case Study 1**).

Case studies that demonstrate the opportunities recommended have been provided throughout this section, brief information is provided here with referencing providing further information if needed.

3.1.2 A regenerative sustainability scenario for the precinct

Aerotropolis provides an unparalleled opportunity to lead the way by showcasing the 'regenerative' development principles that cities of the future will need to embody. Regenerative development is the new frontier for city and precinct design. While the conventional approach to sustainable development is focused on minimising adverse outcomes, regenerative development targets 'net positive' outcomes and supports cyclical resource flows (**Figure 2**). Regenerative goals may seem ambitious and challenging in today's context, but they are a necessary path towards resilient, thriving cities and suburbs. As a significant new land release, Aerotropolis provides an effective opportunity to lock in the principles and foundations of regenerative development. While some outcomes may not be achievable upfront, the transition can be modelled and planned for (for example, transition to a carbon positive precinct by 2050).

How is 'regenerative sustainability' different to conventional understandings of sustainability?

- Performance is measured based on its absolute consequence on human and natural systems, not just relative to a benchmark
- The goal is to contribute to, rather than deplete, natural and social capital. In other words, net positive outcomes for social, economic, and ecological health
- It supports cyclical resource flows (circular economy principles)
- Design is fundamentally based on an understanding of, and response to, local place and ecosystem (an alignment with Aerotropolis's landscape led approach)
- Governance is a key focus (e.g. integrated design methodologies, broad community engagement from as early on as possible)

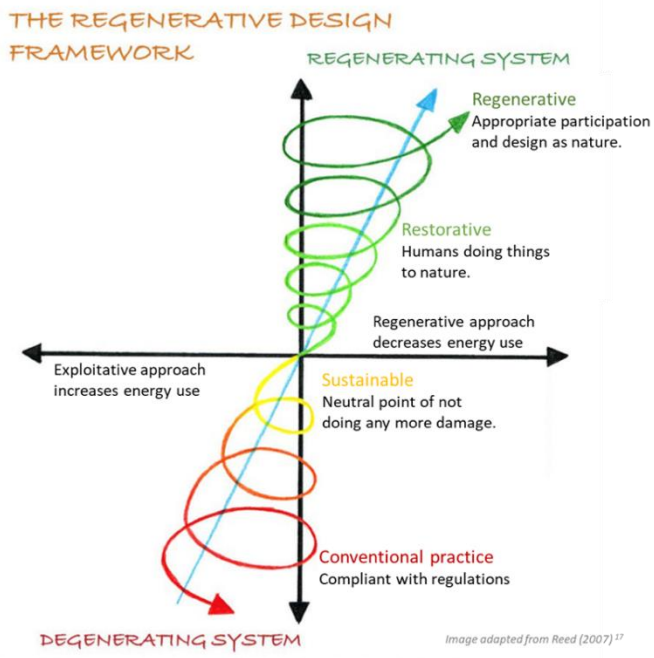


Figure 2 – *The sustainable regenerative scenario depicting a transition from conventional through to net zero and net positive – adapted from Bill Reed, 2007*

Why Western Sydney Aerotropolis?

- Western Sydney will face several challenges as the climate changes (e.g. managing urban heat has been identified as a priority). As an airport precinct with international exposure, Aerotropolis has an opportunity to provide a world-leading example of a response to these challenges (e.g. resilient, climate-positive urban development).
- Regenerative outcomes are most easily and cost effectively delivered for large scale new development, when there is an opportunity to influence planning and infrastructure design, as well as the controls that will govern building design, rather than retrofitting at a later date.

3.1.3 Frameworks, indicative targets, and benchmarks

Following a review of the current government targets, the vision and ambitions for sustainability in the Aerotropolis and the predicted population and jobs for each precinct we have outlined a summary (**Table 6**) of what each scenario might look like, in terms of *indicative* site-wide targets and building-specific benchmarks. These figures are drawn from previous modelling in other areas by ISF and are approximates only. They do however illustrate how each scenario would differ with a higher, more ambitious mandatory planning requirement e.g. if the NSW Building Sustainability Index (BASIX) were to be updated. To establish more confident targets site-wide targets and corresponding benchmarks would need to be modelled for the specific context and building development mix of Aerotropolis, this is outside the scope of this project and recommended as a next step. References to the frameworks and rating tools are provided in the Glossary (Section 6).

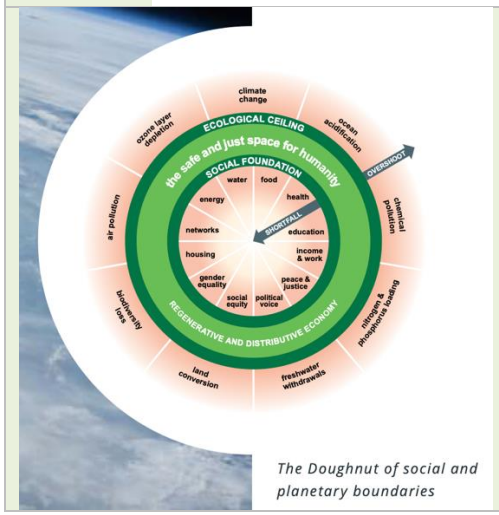
We have been provided with data on predicted residential population and from the Department Planning Industry and Environment Department of Planning, Industry and Environment for the year 2036, **Table 7**. We have used the 2036 data to project resource inputs (demand) and outputs (waste materials and emissions) for three scenarios as outlined in section 3 – Opportunities for the Precincts. Based on the projection and land use the proportion of waste from non-residential sector (commercial and industrial - C&I) is expected to be larger than from residential (municipal solid waste - MSW).

Aerotropolis

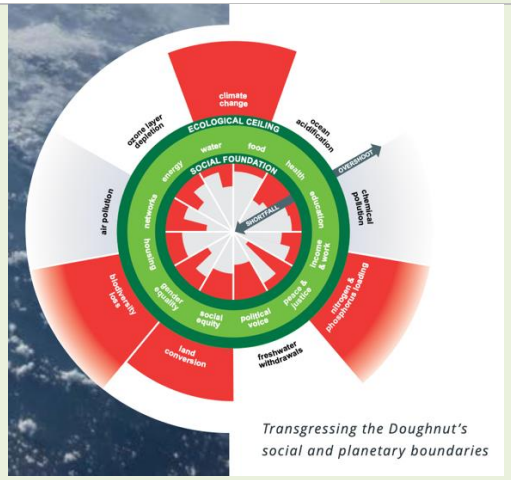
Case Study 1- The Amsterdam city doughnut – A tool for transformative action

Use of city scale Doughnut of social and planetary boundaries to become home to thriving people in a thriving place, while respecting the wellbeing of all people and the health of the whole planet.

	SOCIAL	ECOLOGICAL
LOCAL	What would it mean for the people of Amsterdam to thrive? 1	What would it mean for Amsterdam to thrive within its natural habitat? 2
GLOBAL	What would it mean for Amsterdam to respect the wellbeing of people worldwide? 4	What would it mean for Amsterdam to respect the health of the whole planet? 3



The Doughnut of social and planetary boundaries



Transgressing the Doughnut's social and planetary boundaries

Embrace the 21st century goal. Aim to meet the needs of all people within the means of the living planet. Seek to align your organisation's purpose, networks, governance, ownership and finance with this goal. Expect the work to be challenging, innovative and transformative.

See the big picture. Recognise the potential roles of the household, the commons, the market and the state - and their many synergies - in transforming economies. Ensure that finance serves the work rather than drives it.

Nurture human nature. Promote diversity, participation, collaboration and reciprocity. Strengthen community networks and work with a spirit of high trust. Care for the wellbeing of the team.

Think in systems. Experiment, learn, adapt, evolve, and aim for continuous improvement, Be alert to dynamic effects, feedback loops and tipping points.

Be distributive. Work in the spirit of open design and share the value created with all who co-create it. Be aware of power and seek to redistribute it to improve equity amongst stakeholders.

Be regenerative. Aim to work with and within the cycles of the living world. Be a sharer, repairer, regenerator, steward. Reduce travel, minimize flights, be climate and energy smart.

Aim to thrive rather than to grow. Don't let growth become a goal in itself. Know when to let the work spread out via others rather than scale up in size.

Table 6 – Potential targets for the Aerotropolis under the three 2036 scenarios

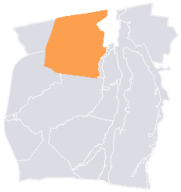
	BASELINE 2036	LEADING INDUSTRY PRACTICE 2036	SUSTAINABLE REGENERATIVE 2036
Site-wide targets	Baseline based on current applicable policies and standards (see Table 5 – Relevant adopted targets and directions relating to sustainability and heat)	***General*** Moderate reductions on baseline (~20-40%): • Greenhouse gas emissions (GHGE) • Potable water demand • Waste to sewer ***Materials management*** • Lot scale recycling and circularity transitioning to precinct-wide • Half food waste to landfill by 2030 (not more than 149kg/person/year) • 10% reduction of waste generation (all streams and sectors) per capita • 85% reduction in construction waste ***Integrated water cycle management with:*** • 20% reduction in stormwater pollutant loads and quantity management • Lot scale transitioning to precinct-wide water recycling • Isolated SMART cities and infrastructure ***Lower carbon at the lot scale transitioning to precinct*** • 50% renewable energy locally supplied • 100% renewable energy with remote PPAs • 100% electric government and commercial fleet vehicles • 20% electric vehicles overall garaged locally • Electric or hydrogen bus network • Moderate reduction in vehicle kms travelled • Transport mode splits: favour active and public transport • 30-minute precincts • 25% movements are walking or cycling • Some start up share-economy enterprises ***Heat adaptation:*** • 50% cooler buildings at individual lot scale – transitioning to precinct-wide developments	Towards net zero and net positive greenhouse gas emissions for (buildings) and towards net zero (transport) ***Water sensitive city outcomes:*** • 60-70% reduction in potable water demand • 75% reduction in stormwater run-off on Business as Usual for developed area • 100% fit for purpose water use • Export of excess treated recycled water ***Circular materials economy*** • Net zero municipal and commercial waste to landfill • 100% recovery and reuse of organic waste • 90% reduction in construction waste ***Low carbon (carbon positive) and cooler communities:*** • 'Cool precinct' developments (orientation, street layout away from grid to more comfortable microclimates • canopy cover – 40%) • 50% of movements are active modes – cycling and walking • Significant reduction in vehicle kms travelled • Greater than 100% (i.e. net export) renewable energy locally supplied • Greater than 90% electric vehicles garaged locally • Electric or locally produced hydrogen bus network • Electric or hydrogen refuelling for road transport • Transport model splits: favour active and public transport and minimise private vehicle use • Decouple carparking from apartment and office lots
Frameworks	Current planning policies and standards	One Planet Living AEMO Integrated System Plan BZE Energy- Efficient Buildings Plan	One Planet Living - LENSES Envision (infrastructure)
Applicable rating tools & benchmarks *(indicative only, Aerotropolis-specific modelling required to confirm)*	BASIX 25 -50 (energy) BASIX 40 (water) NatHERS 6 star	ISCA Infrastructure Sustainability (IS) CCAP Precinct (PRECINX) Green Star Communities 5+ stars Green Star – 5+ stars BASIX 45-60 (energy) BASIX 60 (water) NatHERS – 7 star WELL silver certification	ISCA sustainability (infrastructure) CCAP Precinct (PRECINX) Living Building Challenge Green Star Communities - 6 stars Green Star – 6 stars BASIX 70+ (energy) BASIX 60+ (water) NatHERS 8+ star/ Passive House WELL platinum certification

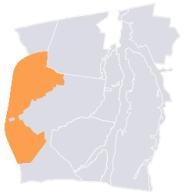
3.2 Western Sydney Aerotropolis Precincts

3.2.1 Precincts purpose, predicted populations and constraints

The Aerotropolis precincts that are the focus of this report, their projected residential population, jobs, purpose and sustainability constraints are outlined in **Table 7** below.

Table 7 – Priority Precincts – characteristics and constraints (Western Sydney Planning Partnership , 2020)

	**Aerotropolis Core – 1382 ha**		
	20,000 – 24,000	A diverse, and sustainable global airport city - a place of choice to do business, a new employment-focused metropolitan centre with an industry focus on advanced manufacturing, research and development and industry led educational facilities. The Aerotropolis Core will also take advantage of its proximity to the airside and facilitate development of a cutting-edge aerospace and defence industries. **Constraints:** • Airport restrictions for trees, greening and wildlife – birds • Salinity – specifically where cut and fill activities cannot be avoided or where increases in infiltration are proposed Urban heat from hardstand airport areas and westerly winds
	50,000 – 60,000	
	**Northern Gateway – 1616 ha**		
	8000-10,000	A major airport interface, a key strategic centre within the Western Economic Corridor – linking the Airport with the Western Parkland City through high frequency public transport, freight, road, and rail connections. It will build on the approved Sydney Science Park development to provide a variety of employment generating uses. Residential development will be located close to public transport and outside Australian Noise Exposure Contours / Australian Noise Exposure Forecast 20 (ANEC/ANEF 20) and above contours to ensure that airport operations are safeguarded, and residents can live in a 30-minute city. **Constraints –** • Airport restrictions for trees, greening and wildlife – birds • Salinity – specifically where cut and fill activities cannot be avoided or where increases in infiltration are proposed • Urban heat from north-westerly winds • Isolated areas of development due to significant infrastructure corridors
	19,000-21,000	
	**Badgerys Creek – 612 ha**		
	0	BC will support airport operations, the new urban centre in the Aerotropolis Core (south) and the Northern Gateway (west). There will be a range of employment generating uses that benefit from its proximity to the airport and the new urban centre, but do not require direct access to high capacity public transport. The precinct is not suitable for noise sensitive land uses (residential, schools and hospitals). **Constraints –** • Salinity – specifically where cut and fill activities cannot be avoided or where increases in infiltration are proposed • Urban heat from hardstand airport areas and westerly winds • Airport restrictions for trees, greening and wildlife – birds
	9,000-11,000	

<table>
<tr><td rowspan="3">  </td><td colspan="2">Agribusiness – 1572 ha</td><td></td></tr>
<tr><td>0</td><td rowspan="2">This site will focus on the long-term retention and growth of agriculture and agribusiness. The Precinct will build on existing agricultural operations and natural landscape character, acting as a catalyst for agricultural export from the region.
Constraints –
Urban heat from westerly and north westerly winds will impact this site
Airport restrictions for trees, greening and wildlife – birds
Salinity – specifically where cut and fill activities cannot be avoided or where increases in infiltration are proposed</td></tr>
<tr><td>8000-10,000</td></tr>
<tr><td>  </td><td colspan="3">Wianamatta-South Creek – 1392 ha
The Precinct is an important part of the broader Wianamatta–South Creek corridor, defined in the Region Plan vision for the corridor as the defining spatial element of the Western Parkland City. Protection of the Wianamatta–South Creek Precinct allows planning for the Aerotropolis to be structured around the landscape. The retention of water in the landscape, protection of significant remnant vegetation, and other Blue– Green Grid elements such regional parks will enable the greening of the Aerotropolis.
Constraints – while this land has been set aside for the blue green grid and it will perform a number of important functions for the Aerotropolis for biodiversity, water it is also likely to fall under Airport restrictions for trees, greening and wildlife – birds</td></tr>
</table>

3.2.2 Sustainability opportunities

Land uses for future development with the precincts have been developed using an Enquiry by Design process lead by Urban Design firms. The Aerotropolis Structure Plan (**Figure 3**) provides the current zoning for the Aerotropolis. The land use plans have been developed through the urban design process and examples of each initial precinct are provided below.

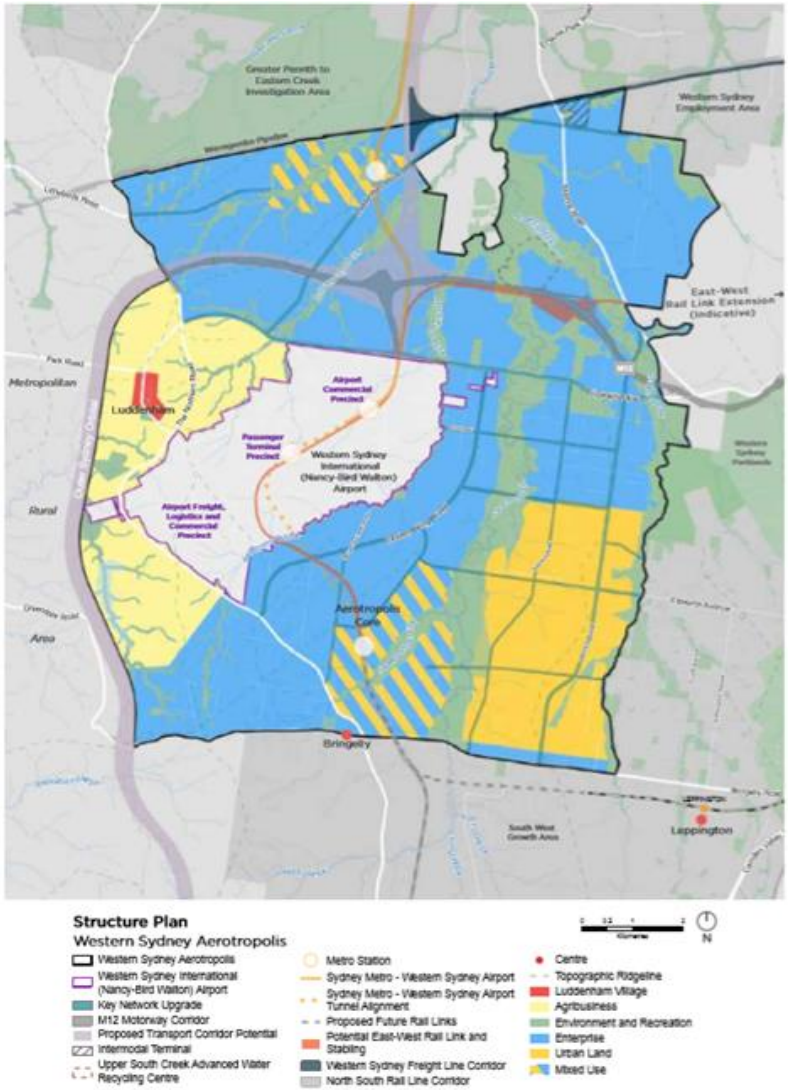
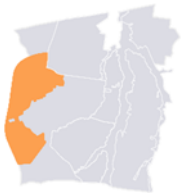


Figure 3. Aerotropolis Structure Plan (Western Sydney Planning Partnership , 2020)

3.3 Aerotropolis Core, Badgerys Creek and Wianamatta-South Creek precincts

3.4 Northern Gateway precinct

3.5 Agribusiness precinct



3.5.1 Infrastructure opportunities

Table 8, below outlines the land uses proposed for Aerotropolis and the zones suitable for sustainability infrastructure e.g. circular economy infrastructure, share facilities, energy generation, water management and treatment, adaptive infrastructure for temporary transitional uses - according to draft land use zones, theory objectives and permitted/prohibited uses.

Table 8 – Proposed land use zones for Aerotropolis, their prohibited uses and potential sustainability opportunities *(DPIE, 2020)*

	Objectives	Prohibited uses that may relate to sustainability	Sustainability Opportunities
Enterprise Zone	Employment uses**,** employment and businesses related to professional services, high technology, food production and processing, health and education and creative industries. Protect land that provides a transition between rural and employment uses.	Heavy industries, Forestry, Heavy industrial storage	Circular Economy (CE) hubs and CE industry - Community recycling centres - Industrial ecology, cascading resource management and processing infrastructure and facilities Encourage the development of integrated food and supply chain related industries which maximise Circular Economy Activities. Decentralised resource processing infrastructure – Closed system infrastructure such as rapid closed vessel composters and dehydrators, Soldier Fly factories, Anaerobic digestion, stormwater harvesting, waste-to-energy facilities, to avoid attraction of birds and wildlife Green infrastructure Controlled environment agriculture – use of urban roofs or vertical modular builds to grow urban food in a closed controlled environment, such as hydroponics, aquaponics and aeroponics. (**Case Study 2**) Urban heat buffers and transition zones from West – North Westerly winds of green infrastructure Adaptable infrastructure – temporary car parking, electric vehicle charging, share facilities, energy hubs. Commercial solar/storage microgrids with potential for green hydrogen production. Electric or hydrogen heavy transport hubs to support local traffic and long-haul trucking.

	Objectives	Prohibited uses that may relate to sustainability	Sustainability Opportunities
Mixed Use Zone	Mixture of compatible uses – business, residential, office, retail Maximise public transport patronage, walking and cycling Active streets and high level of urban design and amenity Appropriate development adjacent to environmental conservation zones	Depots; Forestry; General industries; Heavy industrial storage establishments; Heavy industries; Highway service centres; Sewage systems; Transport depots; Truck depots; Waste or resource management facilities; Water treatment facilities	Green infrastructure Controlled environment agriculture Adaptable infrastructure – temporary car parking, electric vehicle charging, share facilities, energy hubs Community Based Circular Economy Infrastructure – to support reuse, repair, recycling – close to residential areas and employment uses Closed, small scale waste management facilities, such as small-scale Anaerobic Digestion (AD) (underground or in the basement of the building, closed vessel composting or maggot farms (closed systems)
Environment and Recreation Zone	To protect, manage and restore areas of high ecological, scientific, cultural, or aesthetic values, including Wianamatta South Creek and its tributaries. To prevent development that could destroy, damage, or otherwise have an adverse effect on those values. To protect the ecological, scenic and recreation values of waterways. Land to be used as public open space and recreation Encourage pedestrian and cycling Appropriate for flood conveyance Conservation and protection of flora and fauna	Depots; Water treatment facilities; Transport depots; Warehouse distribution; Waste or resource management	Green infrastructure Urban heat buffers and transition zones from West – North Westerly winds of green infrastructure Community gardens with small scale organics management such as compost huts or composts. Adaptable infrastructure – temporary car parking, electric vehicle charging, share facilities, energy hubs Public Place Circular Economy Infrastructure for organics management only – allowing reuse and recycling and small-scale management of organics Dog waste infrastructure – dog waste composter or small AD

	Objectives	Prohibited uses that may relate to sustainability	Sustainability Opportunities
Agribusiness Zone	To encourage diversity in agribusiness enterprises and systems appropriate for the area. To encourage sustainable and high technology agribusinesses, including agricultural produce industries. To provide facilities and services to meet the needs of residents and workers. To enable sustainable agritourism in the area. To enable other development that is compatible with agribusiness uses. To maintain the character of Luddenham village. To maintain the rural landscape character, biodiversity, and sustainability of the area.	Forestry; General industries, Heavy Industries; vehicle repair stations; Vehicle sales or hire premises, water recreation structures	CE hubs - CE industry - Community recycling centres - Industrial ecology Decentralised infrastructure – Soldier Fly factories, Anaerobic digestion, stormwater harvesting, green infrastructure Green infrastructure Controlled environment agriculture – vertical modular builds to grow food in a closed controlled environment, such as hydroponics, aquaponics and aeroponics. Urban heat buffers and transition zones from West – North Westerly winds Adaptable infrastructure – temporary car parking, electric vehicle charging, share facilities, energy hubs?
SP2 Infrastructure Zone	To provide for infrastructure and related uses Prevent development not compatible with or that may detract from the provision of infrastructure	Any development not specified as permitted	Green infrastructure Controlled environment agriculture – use of urban roofs or vertical modular builds to grow urban food in a closed controlled environment, such as hydroponics, aquaponics and aeroponics. Urban heat buffers and transition zones from West – North Westerly winds Adaptable infrastructure – temporary car parking, electric vehicle charging, share facilities, energy hubs? Integrated infrastructure / utilities corridors Stormwater treatment and harvesting – effective perviousness of roads and motorways

A high level review of the proposed land use and prohibited uses within each zone identifies that there could be some barriers to adopting a circular economy, low carbon community and a water sensitive city if views, contradictory to the sustainable ambitions on the following uses are maintained:

- waste and resource management,
- water treatment
- vehicle repairs sales or hire

- transport depots

These uses are listed as prohibited in some zones – Mixed Use Zone, Environment and Recreation Zone and Agribusiness Zone. Definitions for the prohibited uses will likely need to be reviewed to provide flexibility and innovation. The major barriers to adoption of sustainability infrastructure across the Aerotropolis will be

- Pressures for increased developable area and larger footprint structures reducing the capacity to retain stormwater run-off, create cool buffers for urban cooling and climate adaptation, protect and expand biodiversity and create a city in a parkland environment
- Delay in provision of centralised sustainability infrastructure such as water recycling
- Failure of large infrastructure projects to assist in meeting sustainability ambitions
- Planning and coordination for the strategic positioning of businesses and servicing to support the circular economy
- Inability to define adaptable infrastructure that is flexible and able to change over time as new services and resource management comes one line e.g. temporary adaptable infrastructure for car parking as the Aerotropolis transitions to shared autonomous vehicles from majority privately owned vehicles
- Perceptions that sustainability and green infrastructure has a higher upfront capital cost than traditional approaches – provision of guides for and partnerships with developers to allow sustainable regenerative development will be essential
- Competition for space may be at a premium and may force lesser value operations outside the Aerotropolis
- Land constraints such as flooding and salinity – this will impact on the target of increased infiltration and tree canopy. A saline landscape will need to be managed and a transition landscape that includes salt tolerant species in the first instance in saline spots across the Aerotropolis
- Failure to adequately identify salinity and soil contamination and require lot and precinct–wide soil and water management

Case Study 2 – Gotham Greens Farm, New York USA

This is US first rooftop hydroponic, commercial farm using Controlled Environment Agriculture (CEA) in an urban setting. The project's mission was to design, build and operate an environmentally sustainable, urban CEA facility with the goal of producing agricultural products with less energy use, environmental impact and carbon emissions as compared to similar crops grown in open field conditions using conventional methods and seasonal production. Gotham Greens Farms grows over 100 tons of pesticide-free, premium-quality lettuce, salad greens and herbs in a greenhouse that optimizes energy efficiency and uses less land and water compared with conventional agriculture:

- 95% less water than conventional farms
- 97% less land than conventional farm
- Less energy, food miles and waste

The indoor facilities are sun (and wind) powered, and climate controlled for a year-round growing season. It uses hydroponic data driven, climate-controlled greenhouse technology, partnering with schools, community gardens and non-profits, and businesses.

https://www.gothamgreens.com/our-story/

Images sourced from www.gothamgreens.com

3.5.2 Major infrastructure – sustainability opportunities

The changes to be seen in the Aerotropolis and the landscape-led, beyond Business as Usual vision should be applied to all development across the Aerotropolis including large infrastructure projects to be developed by the NSW Government, local councils, other authorities and private interests for public transport, utilities, road and public domain, and education facilities. The sustainability principles recommended in this report for water, waste energy and heat apply to all projects within the Aerotropolis. **Table 9** below highlights the specific opportunities for infrastructure that should be prioritised and examples are provided in **Case Study 3.**

Table 9 - Sustainability actions for infrastructure

Infrastructure	Water	Waste	Energy / carbon	Heat
Public building infrastructure	Meet all Performance Outcomes for residential or employment lands	Meet all Performance Outcomes for residential or employment lands	Meet all Performance Outcomes for residential or employment lands	Meet all Performance Outcomes for residential or employment lands
Motorways and train lines / stations	Design for infiltration, harvesting and reuse of stormwater to meet the NSW Government water quality and waterway health objectives and management targets and consider more ambitious targets to achieve reduced run off from infrastructure to achieve a sustainable regenerative outcome (such as maintaining the current run-off volume) Design for ecosystem services as core part of the design Water management aiming to have **no negative impact** on the receiving waters of Wianamatta-South Creek or Nepean river Passive irrigation of green infrastructure Deep soil plantings where possible Outer Sydney Orbital should play a role in buffering the Aerotropolis area from hot westerly and north-westerly winds and providing a cooling effect for the Agribusiness precinct (**Case Study 3**)	Recycle construction waste Support public place circular economy / share economy facilities at stations (source separation, community drop off points, PAYT)	Provide adequate crossing points along motorways and major roads linear corridors to achieve a walkable Aerotropolis	Design with microclimate in mind – cooling with green infrastructure and materials choices on northern and westerly faces Provide vertical greening on large pylons

Infrastructure	Water	Waste	Energy / carbon	Heat

Town centres, streets, and public places	Permeable pavements Passive irrigation of vegetation Deep soil, large canopy trees Underground utilities	Support public place circular economy / share economy facilities at stations (source separation, community drop off points, PAYT) Recycled and recyclable materials Organics recovery	Car share Public place charging Adaptable temporary parking infrastructure Prioritise walking and cycling Open space within 10 min walk	Shade from trees, awnings, and buildings Fountains and water features Passive irrigation and misting where possible and where needed e.g. bush fire risk areas High albedo pavements

Case Study 3- Kunshan Ring Road project, Kunshan China

As a designated 'sponge city' by Chinese government Kunshan is a hub for technologies and techniques that promote infiltration, greening and integrated water management. The designation gives focus to opportunities in the city and has been supported by input from various researchers including the CRC for Water Sensitive Cities.

The Ring Road project was a multifunctional motorway with integrated green infrastructure to achieve the ambition to become a sponge city. The road has a major influence on city's urban design so local authorities wanted to improve ecological functionality systems services framework was developed to embed water, forest, food**,** and culture into a mosaic of open spaces across the city. The inner ring ecological corridor restores existing waterways while the outer ring ecological corridor was created along the Ring Road corridor. These two corridors link open spaces and provide city-wide connectivity.

The road landscape under the expressway places tanks every hundred meters to treat the rainwater; each tank is 1.5m wide, 15m long.

Total investment ~ 250M yuan (AUD$53.7M - May 2020).

https://watersensitivecities.org.au/wp-content/uploads/2019/10/191001_V5_CRCWSC-Kunshan-Ring-Road-Case-Study.pdf

Integrated design of a city-wide parkland corridor results in:

- Multifunctional landscapes — This project has been designed to support both water quality treatment and enhance amenity within an urban setting by designing a road corridor that is multidimensional and multifunctional.
- Road stormwater treatment — Utilising water sensitive urban design techniques, such as raingardens and constructed wetlands for water treatments, the Ring Road project provides immediate treatment to stormwater runoff from bridge surfaces, improving water health of receiving water bodies.
- Polder water treatment — Polder water is recirculated through constructed wetlands for greater waterway health.
- Self-maintenance - Once reaching system balance, the ecological system can achieve self-maintenance with minimal maintenance costs Ecological system of nodes and links — Parklands are designed and constructed at specific spots along the Ring Road, creating urban green spaces for local communities.
- Species enrichment - emergent plants and swamp forests introduced to enhance landscape.
- Use of shade tolerant plants in bioretention systems — Shade tolerant plants are selected for the bioretention systems under the Ring Road bridge.

3.6 Sustainability analysis for the Aerotropolis Precincts

3.6.1 A Water Sensitive Aerotropolis

In the Aerotropolis area potable water is currently supplied by Sydney Water with some lot scale dams and rainwater tanks. Wastewater is currently managed by Sydney Water through traditional sewer systems. The landscape is largely rural with water largely infiltrating or retained in local farm dams.

In Australia, the vision of the water sensitive city is widely used to represent a state where water is central in the planning and design of a city or urban place. Typically, a water sensitive city has:

- a mix of innovative centralised, decentralised, and distributed fit-for-purpose water supply and reuse systems
- urban design and green infrastructure that supports human and ecosystem wellbeing, providing environmental, economic, and social benefits
- government, business, and community able and active in working together to make plans, designs and decisions that are water sensitive. (CRC, 2018)

In 2018 the Cooperative Research Centre for Water Sensitive Cities (CRC), worked with 51 leaders and thinkers across water, planning, environment, and development in Greater Sydney to identify the steps to transition to a water sensitive city. The Transition Plan identified a 50-year vision for Greater Sydney:

> *Sydney is a beautiful, prosperous, and resilient city with thriving communities, healthy ecosystems and cherished urban landscapes supported by active water stewardship.*

The achievement of a water sensitive Aerotropolis will require significant alignment in policy and practice and the successful transition from the current business as usual will rely on commitment and action from many players.

The five major strategies (right) to support the transition to a water sensitive Aerotropolis are not focussed on technological solutions but rather on the way we plan, manage, and engage across jurisdictions and disciplines.

Strategies for a Water Sensitive Greater Sydney (CRC, 2018)	Application in Aerotropolis
Create formal and informal networks for driving Sydney's water sensitive city agenda to support a collaborative, flexible and integrated governance approach	Establish a coordinating authority to drive a sustainability regenerative agenda and the delivery of the State Environmental Planning Policy (Western Sydney Aerotropolis) 2020 (Western Sydney Aerotropolis SEPP) and Precinct Plans and operation of the Aerotropolis.
Embed Sydney's water sensitive city vision in organisational policies, plans and strategies	The focus on the Parkland City supports a water sensitive vision and plans and strategies, principles and solutions need to apply to all activities and projects
Establish a cross-organisational framework that enables and drives an integrated and strategic approach for managing the whole water cycle	Needs to be driven by a clear authority or coordinating body to work at the regional scale to share information implement water sensitive practices and monitor progress
Increase knowledge about the social, technical and design solutions that are not yet sufficiently developed to deliver the full scope of Sydney's water sensitive city vision	Focus on sharing information, working across disciplines, and learning from each project about the role of water in the landscape, in driving sustainability, prosperity and in liveability
Identify and establish pathways for implementing water sensitive solutions through innovation and investment	Long term targets and implementation programs tools and resourcing to assist all agencies, community, and industry in understanding their role in water management,

A WSC is one with integrated water management, where water is used as one of the foundations upon which all planning follows e.g. to achieve a liveable, cool, green Aerotropolis getting the water management right is fundamental.

Cities around the world are adopting more water sensitive practices (Case Study 5**,** Case Study 4**,** Case Study 6). Water Sensitive Urban Design is becoming more common in strategic plans and development policies and plans. However, the greatest focus is still on incremental and subtle change e.g. including water sensitive urban design (WSUD) controls or BASIX 40 in new developments (BASIX 40 refers to the reduction target of 40% which applies to 90% of new residential development and 98% of high-growth areas (NSW Planning Portal , 2020)., rather than on transformational change.

Recent research by Sydney Water proposed a series of ambitious urban typologies that, if adopted, could result in significant water quality and quantity benefits for the future Aerotropolis community and the receiving waters of Wianamatta-South Creek. The *Western Parkland City Urban Stormwater Solutions* (Hoban, 2020) report modelled the impacts of new types of development that would deliver the equivalent rainfall run-off that the area experiences now i.e. approximately 0.9ML/Ha/year. The report outlined that a target of 0.9ML/Ha/year was possible if a non-business as usual approach was taken. Achievement of this run-off amount would equate to a reduction in rainfall / stormwater run off of up to 75% on business as usual development.

Transformational change is about large-scale change – it brings about a revolution and not an evolution of practice.

The areas where the greatest impacts have been made are in the cities and places where there is complimentary change across multiple domains (including technological, economic, institutional, behavioural, and cultural) where a strong a clear vision exists and where all players are working synergistically to reinforce the change. (Brown, 2016)

For the Aerotropolis to become water sensitive the it should take on the many examples of better and best practice from around the country (Case Study 4 and Case Study 5*)* and focus on following:

- Aerotropolis specific guidelines that reflect priorities and constraints of the context – guidelines for installing green infrastructure, deep soils, stormwater harvesting at lot and neighbourhood scales
- Aerotropolis specific targets that support developers, agencies and land managers to implement water sensitive approaches
- design standards as recommended under the sustainable regenerative scenario and codes – for WSUD, rainwater harvesting, passive tree irrigation,
- appropriately trained professionals in government, design, development, and construction industries
- reinforce vision from the top down with the bottom up implementation
- revise policies, ordinances and practices which may conflict with the vision

Case Study 4- Lochiel Park South Australia

Aimed to achieve South Australia's Strategic Plan environmental targets, Renewal SA developed a Development Masterplan and Urban Design Guidelines to guide the development of a new ecologically sustainable development at Lochiel Park. Each dwelling was designed to meet a minimum 7.5 star energy efficiency rating (PV solar, solar hot water, double glazing, high levels of thermal insulation) and be water efficient with rainwater harvesting, aquifer storage and recovery for reuse and water efficient appliances and fittings. Reduction targets by 2018 (compared to the average Adelaide home in 2004):

- 78% mains potable water use
- 66% energy use.
- 74% greenhouse gas emissions.

A post-occupancy monitoring program was conducted (prior to the operation of the stormwater harvesting scheme and delays in the delivery of the water recycling scheme) found that Lochiel Park households, used on average 36% less mains water than the average Adelaide household. When the final water infrastructure is delivered it is feasible that Lochiel Park will achieve the potable water reduction target.

https://renewalsa.sa.gov.au/wp-content/uploads/2014/07/RSA_Corporate-brochure_Lochiel-Park.pdf

Case Study 5 - Sydney Olympic Park (SOP)

Urban water reuse and integrated water management

A local integrated water management approach to provide water services for the Olympic precinct (to expand as development increases). The Water Reclamation and Management Scheme (WRAMS) system provides a recycled water option for developments within the Park and its surrounding areas. Sydney Olympic Park Authority (the Authority) holds an Environmental Protection Licence under the NSW POEO Act 1997 for discharge of treated wastewater resulting from the recycled water process. Design and construction of the WRAMS cost ~AU$16 million (in 2000), with ~AU$1.5 million operating and maintenance budget over the 25-year life cycle of the asset. The WRAMS commenced operation at Sydney Olympic Park in July 2000. WRAMS is a large scale integrated urban water system incorporating collection and treatment of sewage and stormwater; supply of recycled water for non-drinking uses to all residents, commercial premises, and sporting venues; precinct-wide servicing for approximately 20,000 people.

Performance

During 2017-18, 919,821 kilolitres of recycled water (368 Olympic swimming pools) was produced for use in Sydney Olympic Park and the adjacent suburb of Newington.

Close to 100% of the wastewater is treated and recycled in the local area.

The WSUD was part of the site remediation which not only created a valuable public space in a part of the city that had previously been neglected but helped to restore biodiversity by creating habitats for a range of species including the iconic Green and Golden Bell frog (*Littoria aurea*).

Governance

A unique enabling aspect for the Sydney Olympic Park was the creation of a single entity that was responsible for delivering the development, allowing it to become a licensed water service provider. This approach circumvented major regulatory impediments at the time and ensured an integrated approach between the planning and design of the built

environment with water sensitive features. SOPA manages the whole precinct and operates as a water business. This approval overcame several major institutional barriers, including the need to ensure adequate monitoring and management of decentralised systems and integrating decentralised approaches with the centralised system to guarantee minimum levels of service.

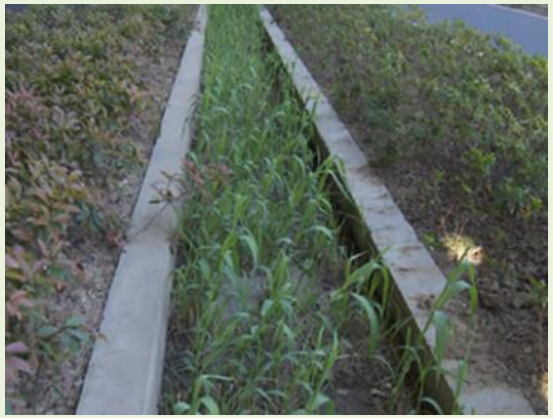
- The Olympic Coordination Authority's (OCA) approach was achieved using a framework of planning instruments; OCA Act, State Environment Planning Policy (SEPP) 38, Sydney Regional Environmental Plan (SREP) 24 Homebush Bay Area, OCA's Environment Strategy, Environment Policy and Environmental Tender Specifications (ETS). The combined effect of this guiding framework was that the developments exemplified outstanding innovation, imagination and resourcefulness to the extent that in many instances OCA's environmental achievements dramatically exceeded the early expectations of most stakeholders **(Campbell, 2001)**.
- The SOP Master Plan 2030 (State Environmental Planning Policy - State Significant Precincts 2005) is a plan guiding long-term development of Sydney Olympic Park with 5-yearly reviews required by NSW Department of Planning, Industry and Environment (Department of Planning, Industry and Environment). Revised Master Plan 2018 is supported by an amendment to the SEPP.
- SOPA, 2018 Master Plan 2030 Review https://www.sopa.nsw.gov.au/Developing-our-Park/Master-Plan-2030
- SOPA 2018 Infrastructure Technical Design and Construction Manual https://www.sopa.nsw.gov.au/resource-centre

Case Study 6 - Kunshun - Sponge City

Cities in China are undergoing such transformations. The city of Kunshan is one of 16 Sponge Cities across China. A Sponge City contains a series of water storage and treatment systems for range of uses. The principles of Sponge Cities incorporate elements of green infrastructure from the United States, Australia, and United Kingdom.

The vision is supported by the Central Government and guidelines have been developed by Ministry of Housing and Urban-Regional Development. The transformation includes a range of WSC initiatives which are being built immediately, together and at scale – an opportunity rare in Australian context - but with enormous potential at Aerotropolis.

The Jiangnan Lixiang community of Kunshan is piloting the "sponge" system, an ecologically friendly drainage system with rainfall gathering tanks installed along the roads. The rainwater on the building roofs and roads will run into the roadside tanks first. Aquatic plants will be used to remove nitrogen and phosphorus and purify the rainwater before it flows into the terminal tanks. The Central Elevated Expressway is also part of the project where the landscape under the expressway features numerous tanks, placed every hundreds of meters, in order to restore and purify the rainwater, with each tank at 1.5 meters wide and 15 meters long. The city has around 100 "sponge city" projects, under construction or completed, of various functions and types, such as inside the parks, public buildings, residential communities, and along the roads. **(CRCWSC, 2018)**



Principles

To achieve the vision of a city in its landscape that is sustainable and creates a liveable environment a set of sustainability principles are required. These principles will guide development and ongoing management of places within the Aerotropolis.

The Western Sydney Aerotropolis Plan identified a range of principles that would be applied to the Aerotropolis (below left), we have recommended a number of additional principles be included to see development of a water sensitive Aerotropolis (below right).

Aerotropolis PRINCIPLES

- Retain and enhance natural features such as waterways, vegetation and landform and culturally significant landscapes.
- Integrate Blue–Green Grid links and public open spaces, maximising opportunities for connections, an urban tree canopy and active use of the floodplain.
- Retain water in the landscape by maximising permeable surfaces and developing appropriate urban typologies.
- Retain and protect wetland environments to support plant animal communities and to mitigate wildlife attraction or wildlife strike.
- Plan stormwater and wastewater in the Wianamatta–South Creek Catchment to minimise potential hydrologic and hydraulic impacts on ecology, creek structure, infrastructure, water quality and the natural water cycle. Integrate water sensitive urban design and use stormwater or recycled water to irrigate streets and public open space to support public amenity and urban cooling. Co-locate industrial water users, where appropriate.
- Protect, maintain and improve the water quality and flow to meet the NSW Government waterway health targets.
- Protect high value terrestrial and aquatic ecosystems to enhance biodiversity and protect environmental values.
- Adopt an integrated water management approach that considers urban form and streetscape, trunk drainage land and assets, waterway health and flood management.

(Western Sydney Planning Partnership , 2020)

Guiding and Relevant documents

- *Greener places 2020*
- *Penrith Council - Cooling the City Strategy 2015*
- *Resilient Sydney Strategy 2018*
- *Risk-based Framework - Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions 2017*
- *Sydney Water – Western Parkland City – Urban Typologies and Stormwater Solutions 2020*
- *WSROC Turn Down the Heat Strategy 2018*
- *Vision and Transition Strategy for a Water Sensitive Greater Sydney 2018*

RECOMMENDED ADDITIONAL PRINCIPLES – ALL PRECINCTS

Fit for purpose water is supplied from within the catchment as the priority (rain and stormwater to be used first then recycled water then potable)

Co-governance / compliance arrangements are place to share water across property boundaries

Protection natural soils, protecting and enhancing the existing areas of remanent native vegetation and biodiversity.

Green infrastructure to provides water treatment, urban cooling, ecosystem services and amenity is integrated into built, landscaped and natural environments

Aerotropolis is designed as a sponge to increase perviousness

Landscapes potentially adversely impacted by contaminated soils and salinity are actively managed and restored

Rainwater is captured at a range of scales – lot, neighbourhood, regional

Vegetation/trees in the public and private domain is supported by soil volumes and passive irrigation

Tree canopy targets are met at the neighbourhood scale

incorporate development that protects, maintains, or restores waterway health and the

community's environmental values and uses of waterways through a risk-based approach to

managing the cumulative impacts of development.

Stormwater run-off targets (infiltration and harvesting) are applied at the lot and neighborhood scale

Retreat - Adapt – Defend options for flood management are integrated and coordinated

Incorporate development that protects, maintains, or restores waterway health and the community's environmental values and uses of waterways through a risk-based approach to managing the cumulative impacts of development.

Water Sensitive Aerotropolis Precinct Scenarios -

An analysis of practices when the three possible scenarios for water management in the Aerotropolis is applied. The following table provides a description of the water management features to achieve the sustainability, resilience and liveability principles and performance outcomes.

BASELINE 2036	LEADING INDUSTRY PRACTICE 2036	SUSTAINABLE REGENERATIVE 2036
Actions to achieve a 40% reduction in water use in homes: • Water efficient devices to meet target of 40% savings - WELS for; showerheads, taps and tap outlets, toilets, appliances (unit developments only) • Alternative water sources including rainwater, stormwater, grey water, recycled effluent, and for single dwelling developments only, private dams. • Alternative water supply able to be used for; garden and lawn, toilets– only if all toilets are connected, laundry, hot water– only if all hot water uses the alternative water source, household uses– only if all water uses the alternative water source, pool and spa top-up, cooling tower make-up water • Most commonly water savings are made with efficient fixtures and rainwater tanks with potable back-up supply and open space being serviced by potable water	Actions to achieve a 60% reduction in water consumption in all buildings and landscapes includes all actions covered in the Business as Usual scenario as well as: • Lot scale or networked wastewater treatment and supply • Some reuse of harvested rainwater on the lot and neighbourhood scale for gardening and irrigation • Smart metering and integrated management of fit for purpose water • Some improvement to environmental flows and protection of receiving waters • Most likely scenario is large investment in networked third pipe recycled water supply for all non-potable uses including public greening, with some lot scale stormwater harvesting and reliance on potable back-up supply, irrigation limited to playing fields and high priority public spaces	Actions to achieve 75% reduction in water use in all buildings and landscapes includes all actions covered in the Business as Usual scenario as well as achievement of the Parkland City vision where stormwater reuse is the priority with recycled water then potable water backup as well as: • Rainwater capture and infiltration on lot and at scale in the neighbourhood to meet NSW water quality objectives for South Creek and match where possible current stormwater runoff from the Aerotropolis (• Recycled water as back up for use in homes and buildings, irrigation for vegetation maintenance and cooling • Excess treated wastewater of such a quality to be suitable for a range of uses including environmental flows or top up to dam storages • SMART infrastructure to integrate quality and quantity management of water across a region and on-site detention and storage for stormwater run-off mitigation and management • Environmental flows, recharging of water resources locally and regionally • Achievement of NSW water quality and waterway health objectives through protection of receiving waters from excessive and polluted stormwater run off

Precinct data and possible future scenarios

Possible future water supply and waste water scenarios, **Table 10** have been generated to demonstrate the benefits of adopting a water sensitive approach to the Aerotropolis. The Asset Lifecycle Group within Sydney Water Corporation provided information to inform ongoing work with the Western Sydney Planning Partnership on sustainable development in the Aerotropolis. The information provided has been used to demonstrate the a range of water management scenarios across stormwater, potable water and waste water suitable for the Business as Usual, Industry Best Practice and Sustainable Regenerative scenarios (Sydney Water Corporation , 2020) (Hoban, 2020).

Table 10 – Possible water supply and wastewater futures

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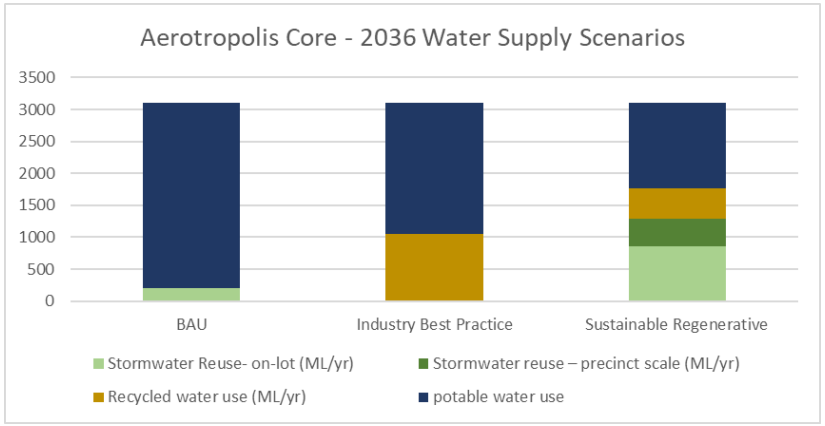
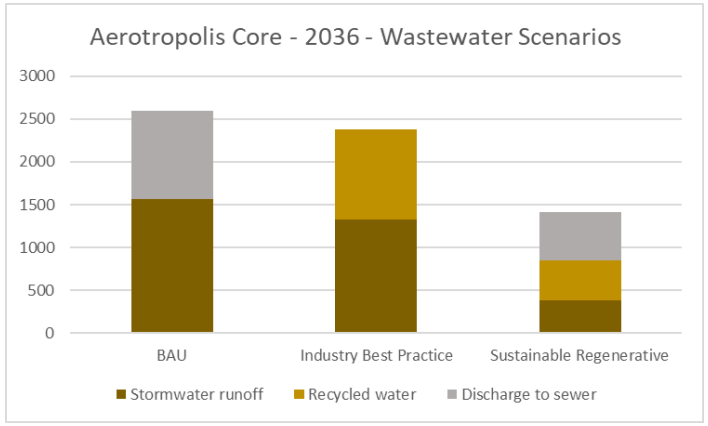
<tr><td> 
</td><td> 
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<tr><td></td><td>Northern Gateway</td><td></td></tr>
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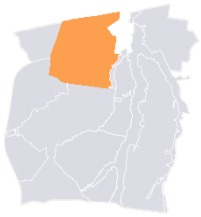
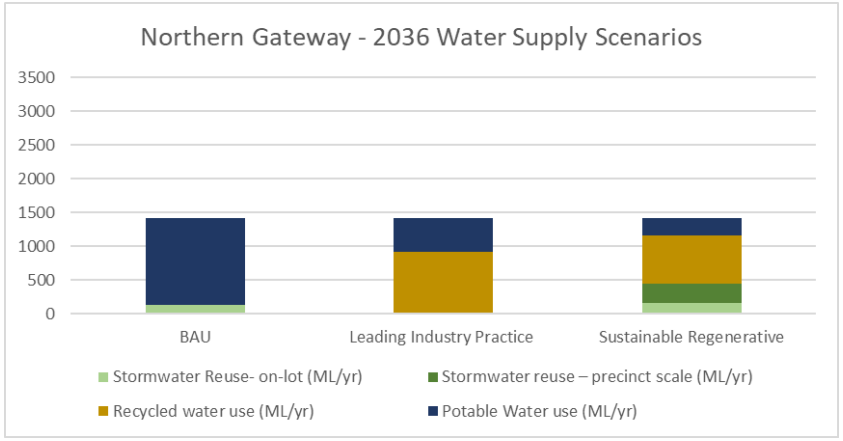
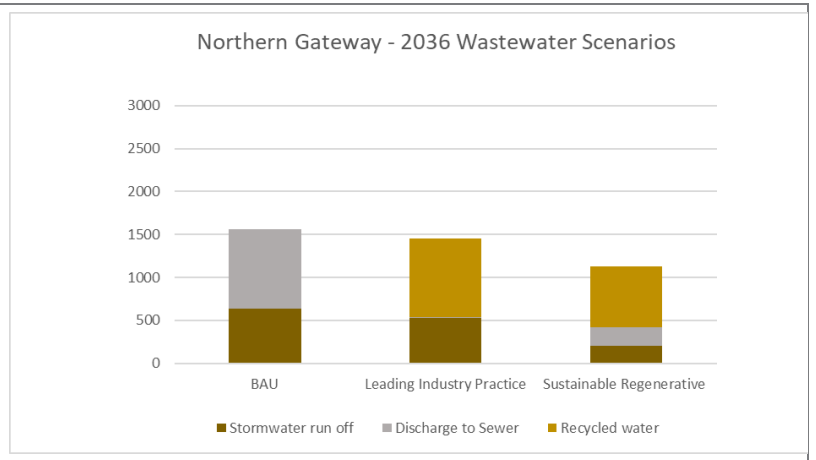
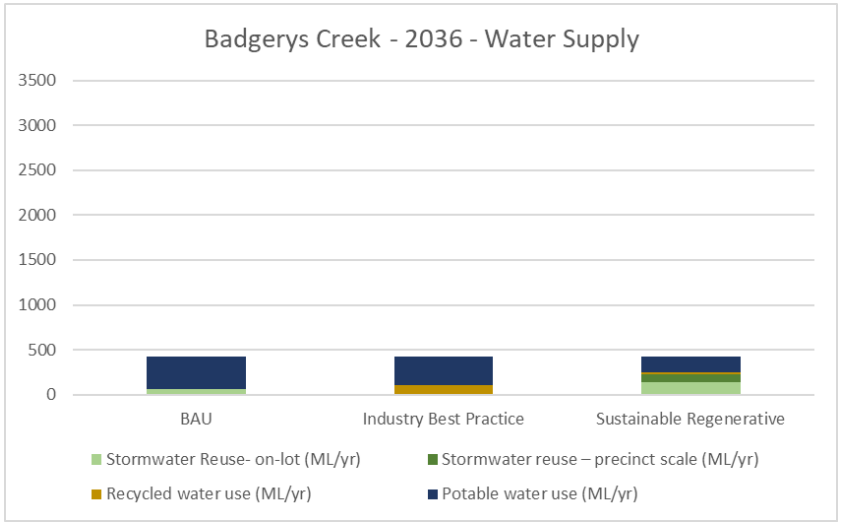
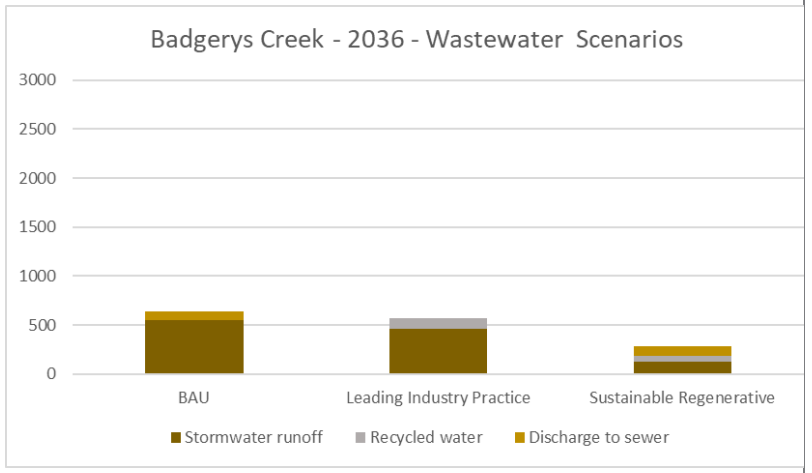




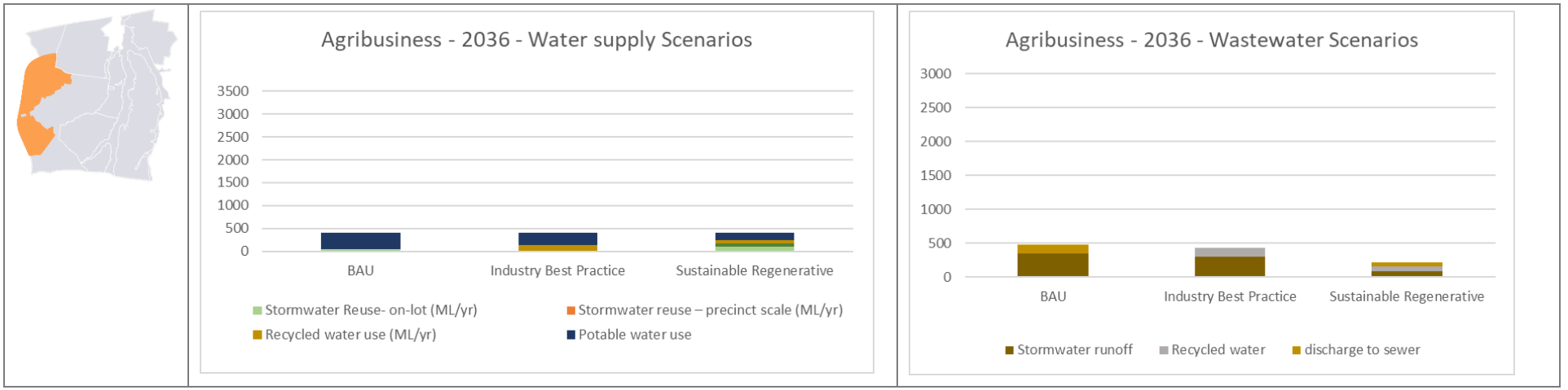


Badgerys Creek





Agribusiness



**No water balance has been provided for Wianamatta-South Creek Catchment*

The data on water supply and wastewater for each of the precincts demonstrates that to achieve the landscape, greening and cooling vision for the Aerotropolis the sustainable regenerative scenario is the only one that will be able to deliver on Aerotropolis objectives:

- Resource efficiency - with a significant reduction in potable water consumption and reuse of stormwater and wastewater
- Protection of the sensitive receiving waters of Wianamatta-South Creek from poor quality water and excessive volumes of stormwater
- Cooling and greening of the region through reuse of waste waters for irrigation

3.6.2 Zero Waste and Circular Economy Aerotropolis

Circular Economy Cities Context

Circular economy city is one that keeps resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end their life. It is a more efficient and environmentally sound alternative to the traditional linear economy in which we make, use, and dispose of resources:

- Things are made smarter, cheaper and more resource efficient
- Recovery of the resources and synergies between companies
- Incubators for circular economy start-ups, markets, and innovation
- Carbon neutral
- Transition from waste landfills to resource recovery.
- City that is fairer, more inclusive, and more sustainable.
- Sharing economy
- Enabled through procurement

Source: (Climate-KIC, 2018)

Relevant documents

- *National Waste Policy, Less waste, more resources*
- *National Waste Policy Action Plan*
- *National Food Waste Strategy*
- *Australian Packaging Covenant Strategic Plan 2017-2022*
- *National Television and Computer Recycling Scheme*
- *Penrith Waste Strategy 2017-2026*
- *Sustainable Packaging Guidelines*
- *20- Year Waste Strategy for NSW*
- *NSW Waste Avoidance and Resource Recovery Strategy 2014-21*
- *NSW Circular Economy Policy Statement*
- *Western Sydney Regional Waste Avoidance and Resource Recovery Strategy 2017-2021*
- *Western City District Plan*
- *NSW EPA Better practice guide for resource recovery in residential developments*

WSAP Principles

- Develop vibrant centres with high quality public domain, a rich urban tree canopy, and well-designed buildings and areas that attract workers and investment.
- Use innovative and integrated approaches to achieve higher standards of resource recovery, waste management, water management and renewable energy.
- Adopt a collaborative approach to precinct planning and master planning with all three levels of government, the community, industry, and landowners.
- Create valued public and private places and activate open spaces in line with Better Placed, Greener Places and the Premier's Priority for Greener Public Spaces.
- Provide multi-purpose and intergenerational community and cultural facilities and services which meet the needs of the community and bring people together.
- (Western Sydney Aerotropolis Plan, 2020)

Additional Waste and Circular Economy Principles Recommended – ALL PRECINCTS

- Adopt principles of AVOID first, REDUCE, REUSE, RECYCLE last in material choices and construction methods
- Educate and embed behaviours, practices, and systems through adoption of Sustainability / Resilience Framework and planning controls, services and information and education – individuals and businesses
- Design out waste in supply chain and manufacturing and eliminate single use items:
  - by using design guides for buildings with prefabricated/modular, long life and loose fit, flexible and adaptable solutions
  - adaptable and reusable infrastructure - temporary facilities that can be remodelled as the Aerotropolis grows/changes
  - eliminate construction waste with programs with volume builders to encourage waste minimisation in building design
  - design for end-of-life disassembly and recovery
  - use of recycled and renewable materials
- Establish Circular Economy Hubs for innovation and including Resources Recovery Processing infrastructure
  - plan now to process materials locally establishing local economies and circular systems within the Aerotropolis and on the boundary with Western Sydney councils
  - match suppliers with the local markets
  - testing innovative construction approaches - link with new CRC
- Source separate for CE
  - design infrastructure, collection, processing, policy, procurement, pricing, and behaviours to produce high quality outputs for high quality inputs to other processes
  - consider combining services for transport efficiency (commercial industrial and residential) around materials rather than land use e.g. organics, plastics, residual waste
  - provide processing and treatment facilities at a range of scales - lot, neighbourhood, regional – basement processing, micro-factories, large scale processing where possible
  - establish network based drop off points in preference of door to door collection.
  - think of adopting PAYT to encourage waste separation
- Design for share economy - encouraging collaborative housing models that reduce waste/encourage sharing
- Adopt Product Stewardship approaches - policy and regulations already in place (CDS, Computers and TVs) and consider the schemes in the development phase (batteries, PVs, e-waste) including EPR
- Joint procurement for new commercial markets – councils, State and Local government with revised serving contracts – bundle for efficiencies and economies –education, customer services, collection, servicing, processing, reporting

Waste management plays a central role in transition to the circular economy operation that Wester Sydney Aerotropolis aspires to achieve. It requires a transition from a linear approach of TAKE – MAKE – THROW, the disposal of waste to a recognition of waste as resource with circularity, where discarded materials are resources in another process in a TAKE- MAKE – RECOVER – REMAKE model (***Case Study 7***). It requires the establishment of resource separation, collection and processing or repair and reuse, for the residential, commercial, and institutional sectors. While historically energy and water have been attentively considered in sustainability planning, waste is often not, despite its significant contributions to greenhouse gasses emission and the innovation opportunities for urban resource recovery and job creation. The following sections analyse the role waste and resources play and the steps that could enable the transition to a circular economy. Table 11 outlines the three scenarios for the Aerotropolis with respect to waste management.

Case Study 7- Sustainable Building Research Centre, University of Wollongong, NSW – Living Building Challenge

First development in Australia to achieve the Living Building Challenge Accreditation. The Sustainable Buildings Research Centre (SBRC) is a multi-disciplinary organization that brings together a wide range of researchers to holistically address the challenges of making our buildings sustainable and effective places in which to live and work. The SBRC's mission is to assist in the rapid decarbonisation of our built environment.

01. SITE PETAL	Limits to growth imperative Urban agriculture imperative Habitat exchange Car free imperative
02. WATER PETAL	Net zero water imperative Ecological water flow imperative
03. ENERGY PETAL	Net zero energy imperative
04. HEALTH PETAL	Civilized environment imperative Healthy air imperative Biophilia imperative
05. MATERIALS PETAL	Red list imperative Embodied carbon footprint imperative Responsible industry imperative Appropriate sourcing imperative Conservation and reuse imperative
06. EQUITY PETAL	Human scale + human places imperative Democracy + social justice imperative Rights to nature imperative
07. BEAUTY PETAL	Beauty + spirt imperative Inspiration + education imperative

Photo Courtesy of University of Wollongong

Circular Economy Aerotropolis Precinct Scenarios –

Table 11 – Summary of outcomes for each scenario for a circular Aerotropolis

BASELINE 2036	LEADING INDUSTRY PRACTICE 2036	SUSTAINABLE REGENERATIVE 2036
Construction Current best practice in large constructions applied to smaller scale projects, where most of construction and demolition waste is landfilled. Voluntary recycled content use	**Construction** At least 80% of construction waste is recycled Prescribed recycled content with performance and safety standards 25% recycled content Aim to increase recycling and not only recovery (through downcycling) Planning for minimising waste generation and use	**Construction** Use of durable materials and design for disassembly Process on site as much as possible Content in building and construction materials - at least 50% to be renewable or recycled Public procurement for circular economy principles including recycled content Aim for zero waste to landfill
Infrastructure Safe transfer of bins for waste collection Building and road access for waste collection Allocated space for waste separation and collection at the building and precinct scale Transfer stations and processing facilities Access to CDS Design for visual amenity	**Infrastructure** Access to organic waste collection/drop off points Drop off points for special waste such as soft plastics, e-waste, hazardous waste, etc. Expanded Container Deposit Scheme (CDS) to multiple material steams Coordinated and efficient collection of municipal solid waste (MSW) and C&I Enabling waste source separation for C&I (safety, hygiene, and odour management) Flexibility in the design allowing for future changes in waste generated, materials collected and methods of collection Innovative collection systems e.g. underground bins or automated waste collection system Centralised infrastructure for processing organics	**Infrastructure** Drop off point for multiple material streams Circular economy hubs Decentralised local processing waste opportunities Organic waste to sewer opportunity for recovery as biosolids and energy Access to multiple options for organics waste (e.g. composting at community gardens, small scale composting facilities such as rocket composter, AD, dehydrators, etc.) Libraries of things (e.g. tools, toys, specialised equipment) Second-hand and repair shops Design for community recycling Decentralised, on-site closed cycle organics processing (energy generation, nutrients recovery and new products creation)
Operation Uniform waste signage Providing organics and recycling service to all households	**Operation** Waste data collection in MSW and C&I Generation of energy from organic waste Utilisation of Badgerys Creek organic waste processing facility for waste generated in the precincts	**Operation** Aim for zero waste to landfill Integration of organics stream for energy generation and nutrient recovery All businesses engaged in local / regional circular economy (**Case Study 8** and **Case Study 9**)
Policy and Regulation • Current waste policies and regulations	**Policy and Regulation** • Adoption of circular economy policies	**Policy and Regulation** • Policies and standards that allow for circular economy and innovative operation while maintaining human health and wellbeing and not harming the environment

**This analysis is limited to the construction, municipal, commercial, and industrial waste streams. It does not include littering, hazardous, or bio-hazardous waste (such as quarantine waste generated at an international airport).*

Case Study 8- Advance London: Circular Economy Small-Medium Enterprise (SME) Business Support Programme for London

Advance London is a circular economy programme created by the London Waste and Recycling Board to provide business advisory services and investment guidance to SMEs. Engagement with the SMEs includes exploring new circular economy business models, markets, and revenue streams. Participating SMEs address five focus areas identified in London's 2017 Circular Economy Route Map, which include: built environment, food, textiles, electronic goods, and plastic.

The program is co-funded by the London Waste and Recycling Board and the European Regional Development Fund which each contribute GBP 0.7 million. The London Waste and Recycling Board also invests in three stand-alone funds for qualifying SMEs. The funds each target a different stage of enterprise development - from product conception to scaling up established products.

POINTS OF INTEREST / INNOVATIONS:

- *Supporting circular business models from idea to scaling*

As of the end of 2018 one third of SMEs engaged, from start-ups to existing companies scaling up, had secured funding through grants, equity, or loans within 18 months.

- *Facilitating the design of circular products and services*

The programme has helped to facilitate 20 product-market collaborations which have generated five new circular products or services, including: thermal packaging made from surplus feathers; a returnable packaging service for drinks; a food sharing app for local shops to share surplus food; a refillable perfume bottle scheme; and the small-scale production of a mycelium (fungi) based construction product. **(LWARB, 2020)**

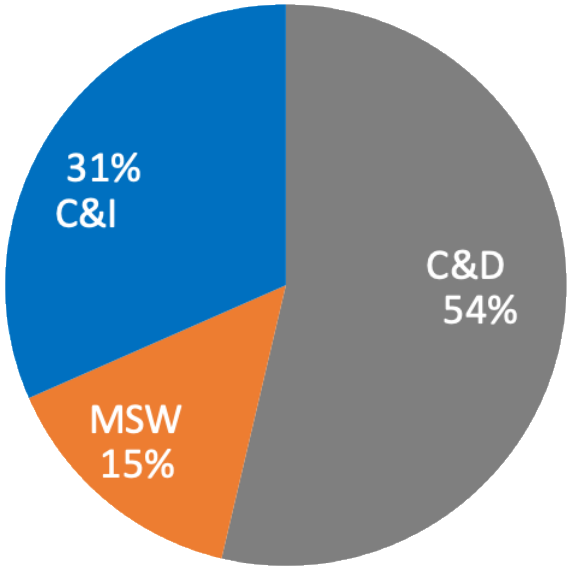
In the **baseline** scenario waste is predominately linear where the recycling material is predominantly downcycled with significant amounts of waste is still disposed to landfill.

In the **leading industry practice** scenario, the targets are focused on waste avoidance and diversion from landfill, with improved infrastructure enabling waste separation and collection and setting up the environment for circular economy practices.

In **sustainable and regenerative** scenario, the systemic change occurs enabling circular economy practices to flourish and zero waste disposal to landfill. In addition to the transformation of collection and separation of waste, the selection of materials and design of products is set for durability, reuse, and repurpose following the principles of circular economy. The design of products and selection of materials allows for recycling and minimalisation of hazardous waste, allowing all the resources to be captured and reused in way that is safe for humans and the environment. Ideally the materials selected and used are safe to be returned to the biosphere at the end of life achieving zero waste operation. Targets and benchmarks used in the scenarios are highlighted in **Table 11**.

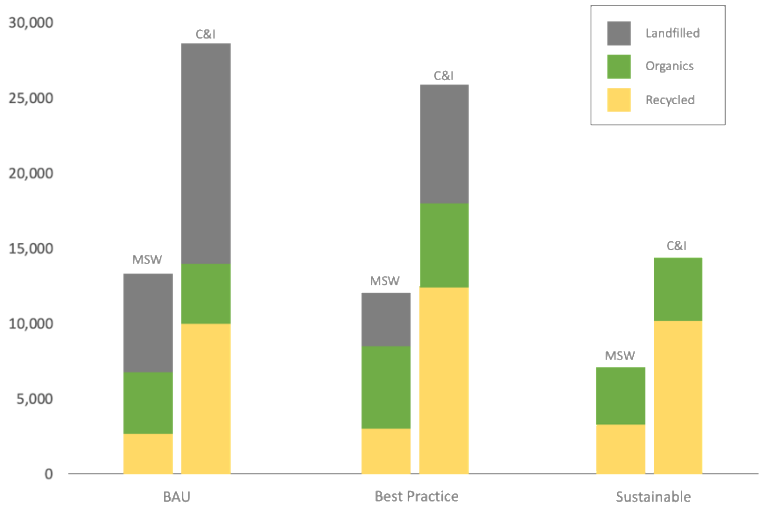
Precinct data and possible future scenarios

High level estimates for the waste materials from construction and demolition (C&D), commercial and industrial (C&I) and municipal solid waste (MSW) have been determined using the data from the Australian waste report, audit data from Liverpool Council and the available population and jobs projection data for the Aerotropolis for 2036. Most of the waste generated in Aerotropolis is expected to be from the construction and demolition stream (54%). While generally waste generated in municipal waste stream is comparable to the waste generated in commercial and industrial stream, in the case of Aerotropolis, the C&I stream is larger due to the projected activity in the industrial sector and the number of jobs. It should be noted that the estimates are only average, and the volumes and composition of waste would be largely depended on the type of businesses established at Aerotropolis. The Agribusiness precinct organic waste volumes are based on the population and number of jobs and could vary significantly depending on the size or type of agriculture operation. If a controlled environment agriculture model is applied (which would also comply with regulatory restrictions due to airport proximity), the efficiency of the operation and waste generation volumes would be smaller when compared to traditional land farming. It is however expected that the organic waste would be processed locally in both, best practice as well as sustainable regenerative scenario. The assumptions used in the calculations are summarised in Table 13.

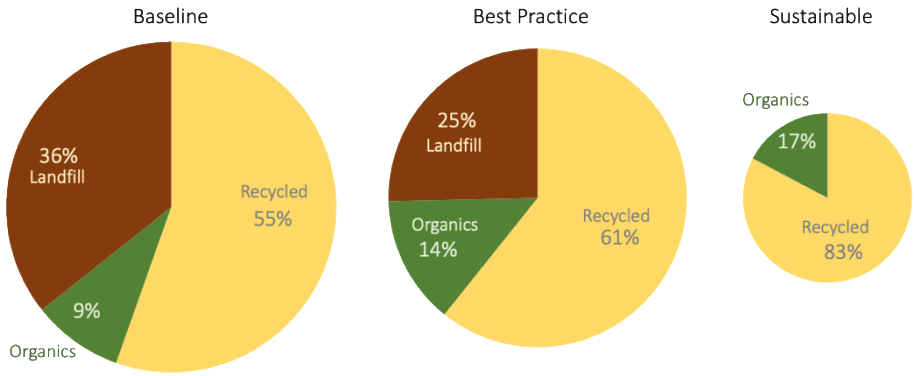


Estimates of waste generation from the Aerotropolis priority precincts (weight based) – Commercial and industrial (C&I) waste is significantly higher than municipal solid waste (MSW) based on the projected jobs.

Waste generation [tonnes/year] for the MSW and C&I waste stream - 2036



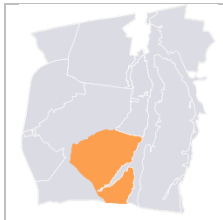
Recycling rates for the three scenarios -2036



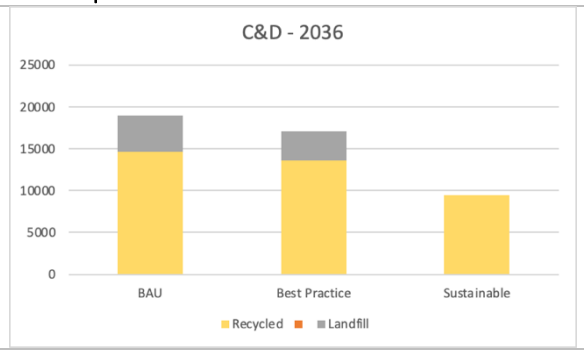
Modelling of even preliminary data demonstrates the value of the sustainable regenerative scenario. In this scenario landfill is eliminated and materials are retained in circulation in the local and more regional economy. This data does not include the avoided waste should a share economy also be established in the Aerotropolis.

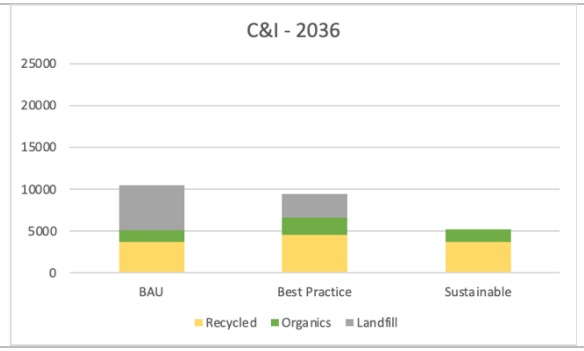
Data for each of the priority precincts is provided below in **Table 12**.

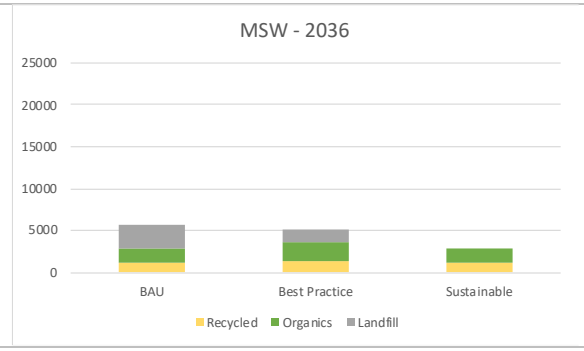
Table 12 – Waste generation for each precinct over the three possible future scenarios [t/y]

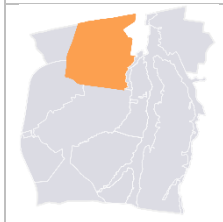


Aerotropolis Core

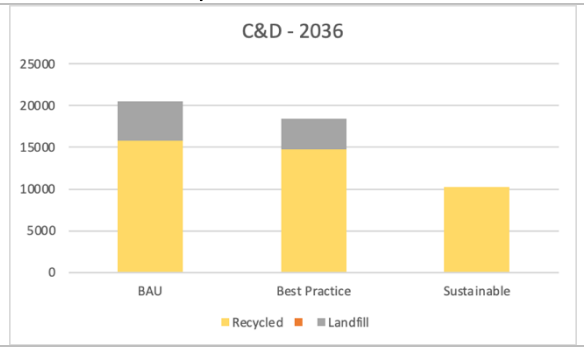


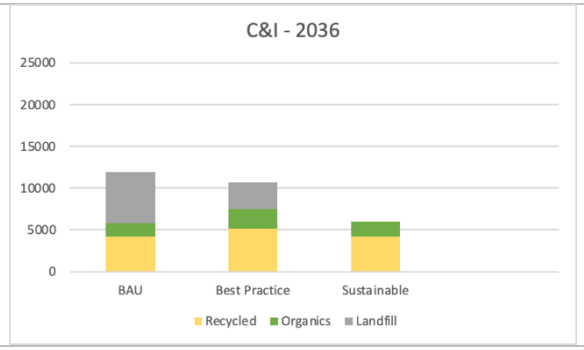


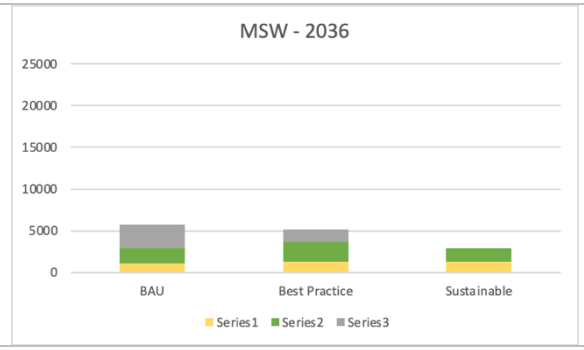


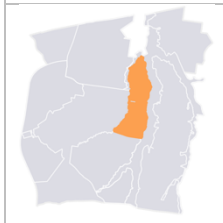


Northern Gateway

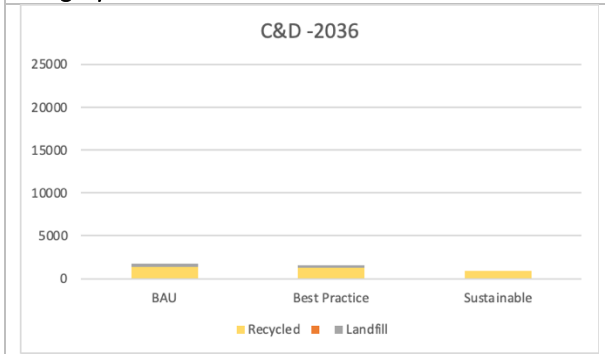


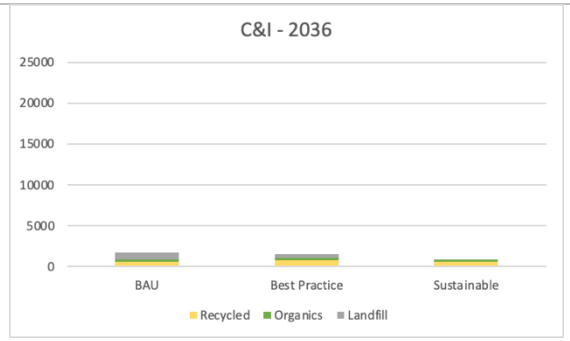


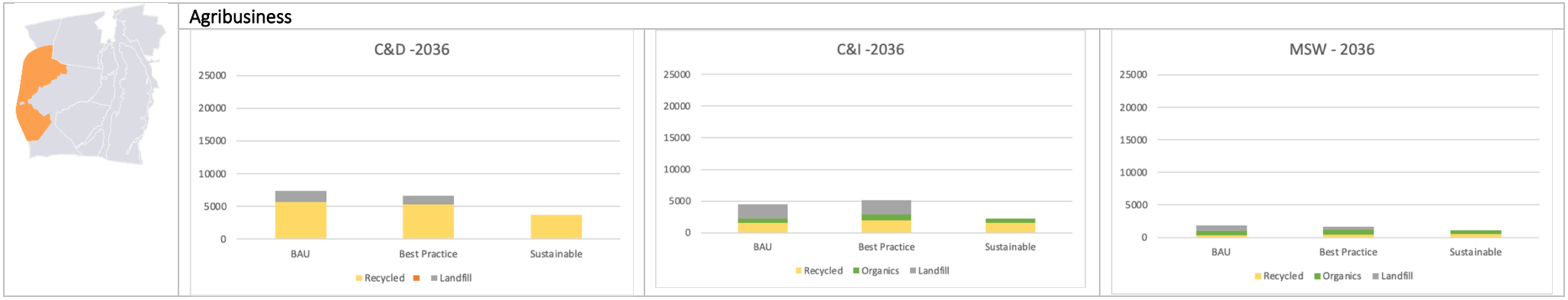




Badgerys Creek







This analysis focuses only on the five Precincts in scope for this report. It should be noted that in the design of circular economy solutions available resources from the adjacent precincts and wider LGA should be also considered. For example, the estimated available 10kt/y of organic waste in 2036 (based only on the population and jobs projections) could be much larger. From the consultations with relevant stakeholders, it was estimated that in the Western Sydney Aerotropolis area, there could be 480 kt/y of organic waste (140kt from commercial sector) providing an opportunity for processing organics on a large scale and/or combined with the sewage in a large AD plant, which could be strategically located within the Agribusiness precinct.

Table 13 - Assumptions used in the waste modelling

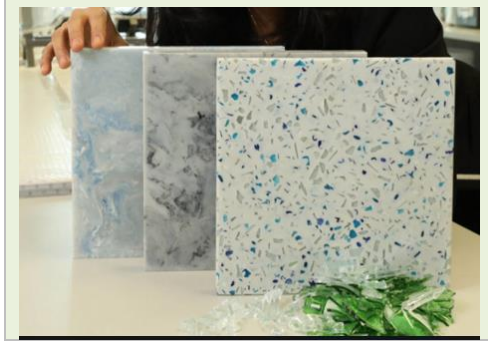
ASSUMPTIONS IN MODELLING	C&D	C&I	MSW	Source
Generation rate	0.84 t/capita	0. t/capita	0.56 t/capita	National waste report (DEE, 2018)
Business as Usual diversion rate	77%	49%	44%	National waste report (DEE, 2018)
Best practice diversion rate	80%	70%	70%	WARR Strategy (EPA, 2014)
Sustainable/regenerative diversion rate	100%	100%	100%	
Food waste in residual waste			45%	Liverpool Council Audit (LCC, 2020)
Food waste in residual waste – best practice		Half of Business as Usual	Half of Business as Usual	National Food Strategy (National Food Waste Strategy, Halving Australia's Food waste by 2030, 2017)
Food waste in sustainable/regenerative		zero	zero	
Garden organics in residual waste		51%	6%	Situational Analysis (PWC, 2019), Liverpool Council Audit (LCC, 2020)
Total organics		29%		Situational Analysis (PWC, 2019)
Recyclables in residual waste			16%	Situational Analysis (PWC, 2019)
Organics in recycled C&I		28%		Situational Analysis (PWC, 2019)

Case Study 9 - Showcasing UNSW SMaRT Centre – micro-factories for e-waste (http://www.smart.unsw.edu.au/)

Description

UNSW's modular micro-factories can operate on a site as small as 50 square metres and can be located wherever waste may be stockpiled. A micro-factory is one or a series of small machines and devices that uses patented technology to perform one or more functions in the reforming of waste products into new and usable resources.

The e-waste micro-factory that reforms discarded computers, mobile phones and printers has several small modules for this process and fits into a small site. These transformed materials include metal alloys and a range of micromaterials. The micromaterials can be used in industrial-grade ceramics while the specific quality plastics from computers, printers and other discarded sources can be put through another module that produces filaments suitable for 3D-printing applications, while the metal alloys can be used as metal components for new or existing manufacturing processes



Innovation

The e-waste micro-factory was the first of a series under development and in testing at UNSW that can turn consumer waste such as glass, plastic, and timber into commercial products.

New economies

This shifts the traditional recycling process completely and creates a new system for supplying waste resources to industry and to manufacturers.

Source separation for high value capture

It is possible to use waste materials as raw materials for manufacturing processes. And that is really where the shift in thinking comes in. Cities, councils, and the manufacturing industry are in the perfect position to redesign the waste stream system at a local level that will benefit local communities in cities and rural communities.

3.6.3 Low Carbon Aerotropolis

Low Carbon Cities

Low carbon city is a sustainable urbanization approach that centres on curtailing the anthropogenic carbon footprint of cities by means of minimizing or abolishing the use of energy sourced from fossil fuels. It combines the features of low carbon society and low carbon economy while supporting partnerships among governments, private sectors, and civil societies by:

- Low carbon energy production, efficient consumption, and integration of supply variability with demand flexibility and storage.
- Green and energy-efficient buildings in cooling, heating, and lighting systems.
- Low carbon transportation and sustainable land use
- Sustainable waste management – low carbon landfill design and operation, organic waste diversion, thermal treatment of waste, reduction of waste, reuse of resources and recycling.

Source: (Ismaila, 2019)

Renewable energy from solar and wind power is one of the cheapest forms of carbon abatement, in fact it is a net benefit being cheaper than grid-supplied power derived from fossil fuels in most of Australia. As the largest single contributor to greenhouse gas emissions the electricity sector can have the largest single in reducing those emissions. By combining renewable electricity strategies with the electrification of transport, or the production of green hydrogen for heavy transport, another large source of emissions and particulate pollution can be addressed.

Low Carbon Electricity Supply

Interpreting the leading industry practice in this context, the electricity supply should establish a rapid path towards using local renewable energy, especially solar energy which is cheap and abundantly available on Western Sydney rooftops:

- 50% renewable energy locally supplied, which can be largely achieved from solar rooftops on residential and commercial buildings, combined with the grid supply which itself is reducing in carbon intensity over time: and
- as an interim measure for a higher level of ambition, purchase of the balance of energy needs via power purchase agreements (PPAs) with renewable energy generators elsewhere in NSW or the national grid.

WSAP Principles

- Use low carbon, high efficiency strategies to reduce emissions and energy use in line with NSW net zero emissions target and mitigate urban heat through urban development and building design.
- Orient urban development towards creeks and integrate into the landscape through quality open space, a high degree of solar access and tree canopy.
- Ensure walking or cycling is the most convenient option for short trips around centres and local areas.
- Prioritise public and active transport in centres with general through traffic and freight directed outside of these centres. (Western Sydney Planning Partnership , 2020)

Recommended Principles – ALL PRECINCTS

- Plan for greater than 100% renewable energy supply to make Aerotropolis a net exporter of clean energy to the NSW grid.
- Include diversity of renewable energy supply including solar, wind, green hydrogen, and bioenergy (anaerobic digestion of organic waste)
- Provide decentralised local generation and supply
- Develop integrated systems for energy generation – waste and water
- Develop multi modal transport system that prioritises walking and cycling in the 30-minute city
- Promote pedestrian and cycling network
- Design and regulate for greening Infrastructure in public realm and private spaces for cooling, shade, amenity
- Implement in the Street Design Guidelines the transition from individual use of infrastructure such as on and off road to shared adaptive infrastructure
- Adaptable infrastructure for Charging stations – public facilities transition to private charging (**Case Study 11**)
- Design roof space for energy generation, open space and amenity, gardens, food production, water harvesting, urban cooling
- Provide space for local food production and distribution / retail / sharing – via markets, community gardens on public land and private spaces - lot, neighbourhood, and regional scale
- Create equity of access to solar or renewables - removal of barriers to solar or renewables - Cost, rentals, heritage, solar access
- Establish circular economy markets to reduce waste and transport emissions
- Distributed and diverse share economy facilities and libraries - cars, books, tools, equipment, toys, parking spaces and infrastructure, bikes, kitchens, living and dining rooms - at a range of scales

By this strategy 100% renewable energy supply can be achieved, but by creating a dependence on the regions from which energy is purchased. This is sustainable when viewed nationally, but not regenerative in the sense of the target scenarios developed above. However, Australian distribution networks that connect households and commercial properties to the national grid are on track to be net exporters of renewable electricity, due to Australian customers installing world-leading amounts of rooftop solar generation.

Up to half of Australia's total electricity supply is expected to come from distribution networks, and particularly from customer solar generation, by the middle of the century. This means the energy producing regions will be have much greater number and diversity than in our present, still largely centralised grid. Two kinds of region will be unable to sustain themselves and will therefore rely on external grid supply:

Central business districts have high customer density compared to available roof space.

Zones of heavy industry or commercial activity are characterised by high energy consumption and 24/7 operation which is not well matched to solar generation output.

But the Aerotropolis will be characterised by substantial residential developments and broad commercial and mixed zones well suited to rooftop solar generation. Combined with other local generation opportunities that will be identified, such as waste-to-energy projects, a stretch target corresponding to the regenerative scenario is:

- the Aerotropolis (potentially excluding some energy-intensive commercial areas) can become, and can remain through its growth, a net producer of renewable energy for the national grid. (***Case Study 10***).

Enabling Partnership with Endeavour Energy

Net renewable energy targets apply to average production and consumption and rely on the electricity grid to balance generation and consumption from day to day and from hour to hour. This is illustrated in **Figure 4** in the case of greater than 100% local renewable energy generation.

Endeavour Energy owns and operates the electricity distribution network serving the area that will become the Aerotropolis. Normal planning processes already allow for the anticipated growth of electricity demand of this area, shown in **Figure 5**, and they are making relevant observations of demand growth, or decline, in industrial areas of the kind that will be established there.

A review of established industrial areas has identified a stabilisation in the decline in demand in those areas. This trend will be closely monitored over the coming years to determine if growth in demand in these established industrial areas re-emerges. (Energy, 2019)

It will be crucial to engage with Endeavour Energy's planning and grid transformation teams to establish the infrastructure required for ambitious targets.

Indicative future energy use and energy mix

To show the substantial change that can be achieved with local energy solutions, **Table 14** shows future energy use and sources for some parts of the Aerotropolis, under the assumptions in **Table 15**. The main drivers are high solar penetration, which can generate net export in the regenerative scenario, or can be supplemented by renewable energy purchased from other locations under industry best practice.

Relevant documents

- *NSW Electricity Strategy*
- *NSW Climate Change Policy Framework*
- *NSW Net Zero Plan Stage 1: 2020-2030*
- *Future Transport 2056*
- *Roads and Maritime Services Environmental Sustainability Strategy 2019-2023*
- *Western Sydney Energy Program 2020*
- *Penrith LSPS*
- *Liverpool LSPS*

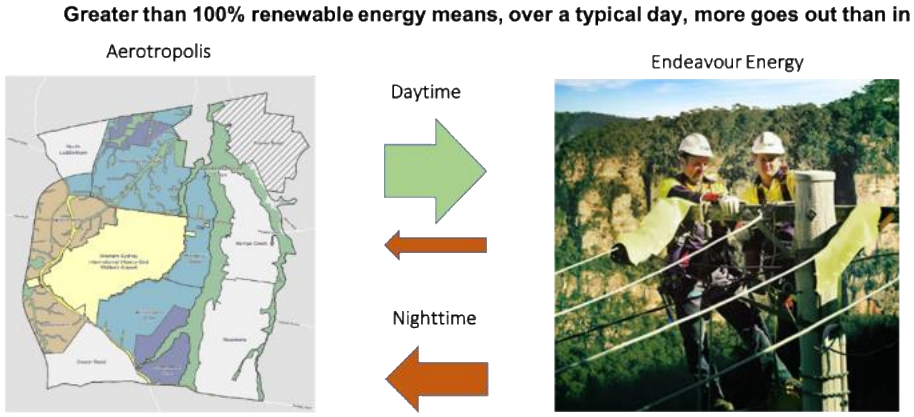


Figure 4 - Net renewable energy export from the Aerotropolis is an average outcome, with daytime production exceeding daytime and night-time consumption.

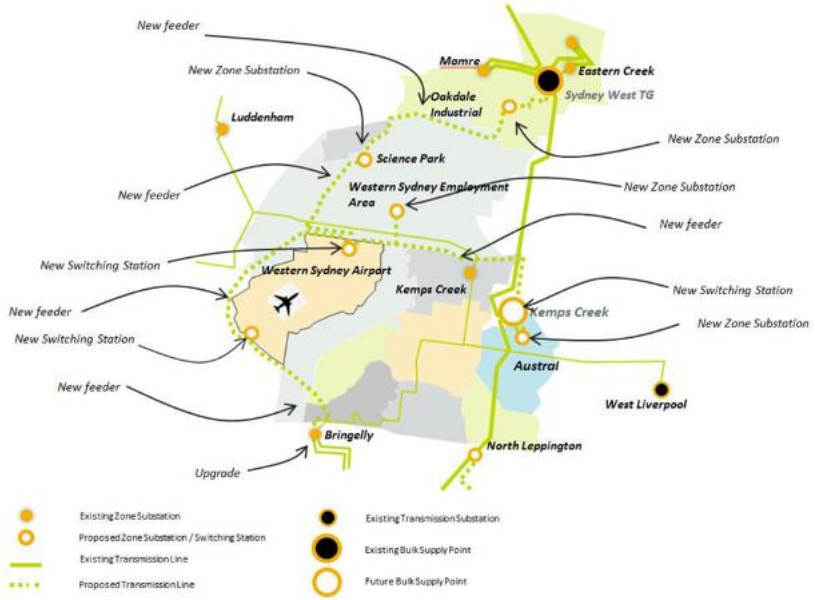


Figure 5 - Existing and planned Endeavour Energy substations and major transmission lines serving the area that will become the Aerotropolis.

Case Study 10- Huntlee Off Grid Development: Microgrid Project Hunter Valley

Description

Developed by LWP Property Group, Huntlee will house 20,000 new residents in 7,500 homes to be built over 25yrs. The beginnings of the "autonomous town" project began in earnest in early 2012 after LWP property NSW General Manager Ian Wilks, agreed to incubate and fund the challenging journey Damien Griffith and the Huntlee Energy Technology Alliance (HETA) were proposing to decentralise utilities and take the town off grid. Off-Grid Energy were selected as the HETA renewable energy and battery storage experts, and were tasked with providing detailed electrical demand modelling and project feasibility study

Off-Grid Energy, together with co-gen and thermal network experts Simon's Green Energy found that the levelised cost of energy per lot is substantially lower for the microgrid than if the development were to connect to the national grid. The initial design found the optimal balance between sufficient baseload power, and maximum renewable content.

Innovation

- Load control: Load control at individual premises and demand side management functionality will be included in Huntlee house design.
- Electric vehicle charging: Electric vehicle (EV) charging at the premise has been included in the utility design, and the potential for time-of-use EV charging incentives has been identified.
- CO_2 Emissions: 6 tonnes of CO_{2e} saved per dwelling in Huntlee per annum.

Source:

https://www.offgridenergy.com.au/project/huntlee-off-grid-development/

Table 14 – Energy use and energy mix for the three possible future scenarios (in 2036)

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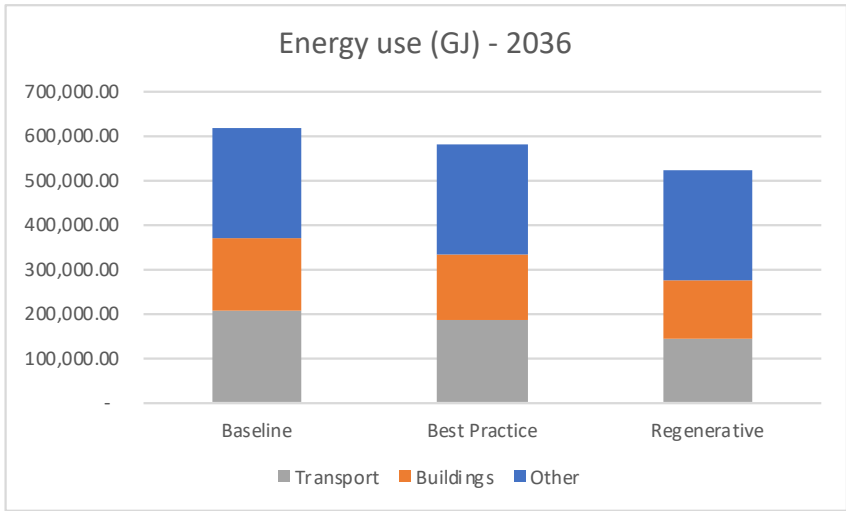
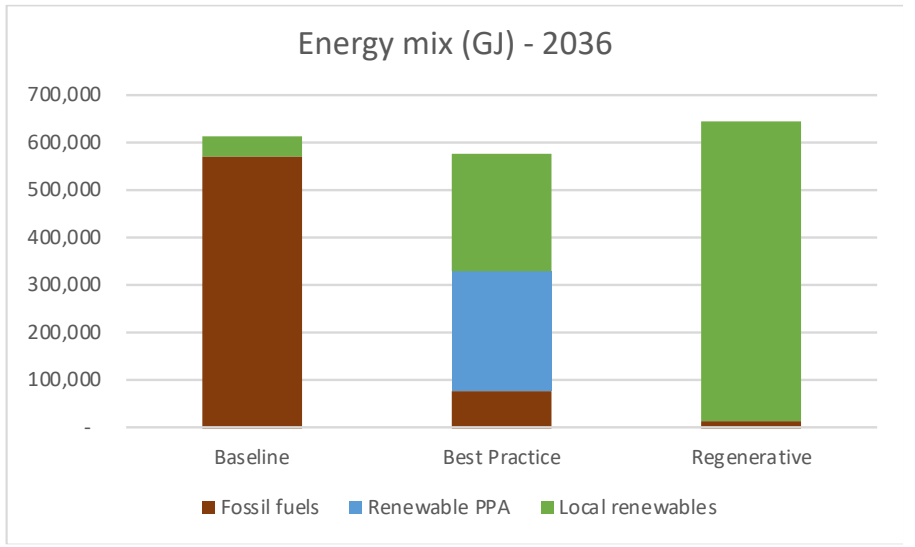
<tr><td> 
</td><td> 
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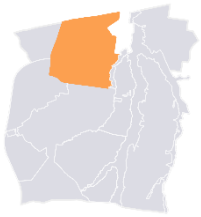
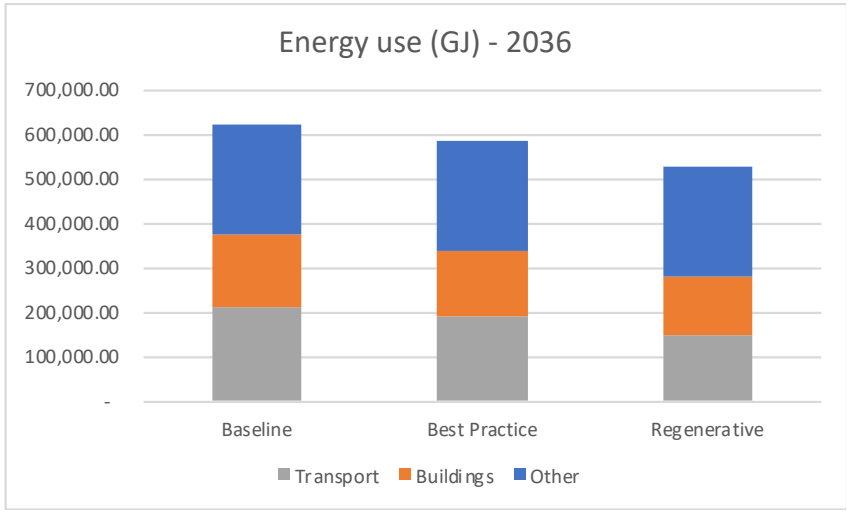
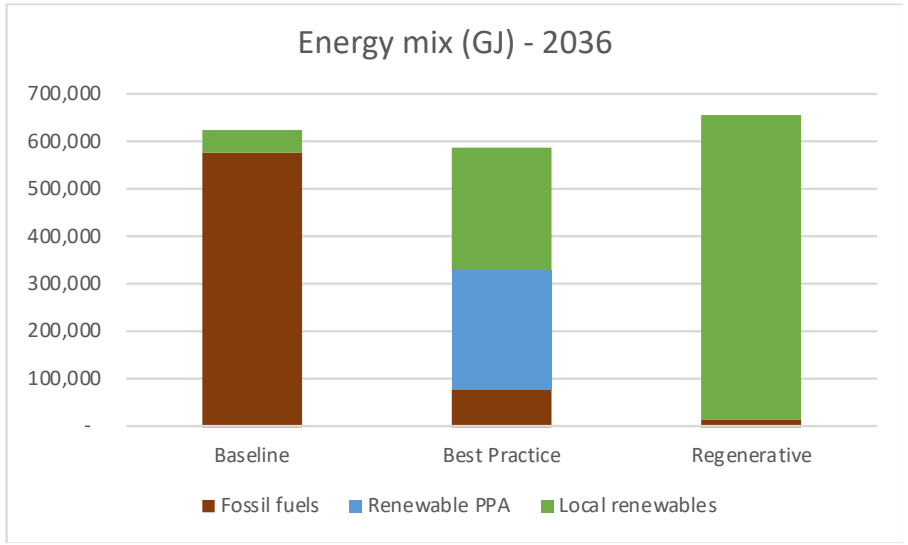
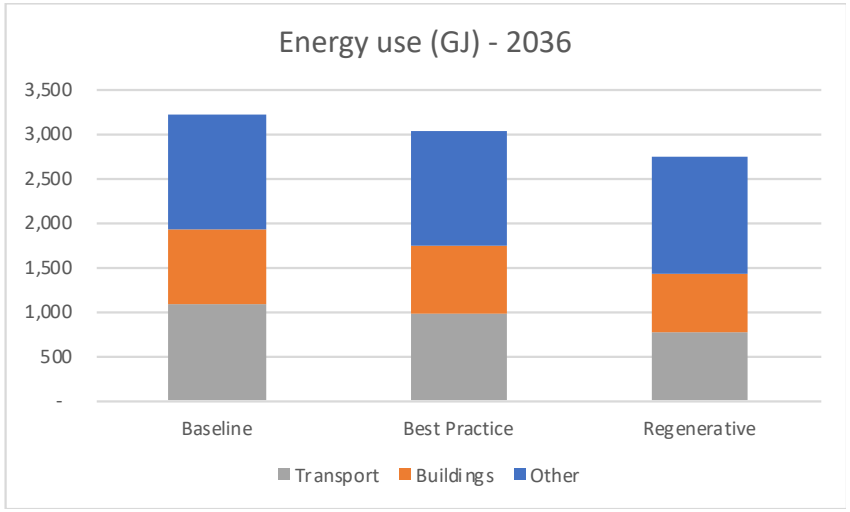
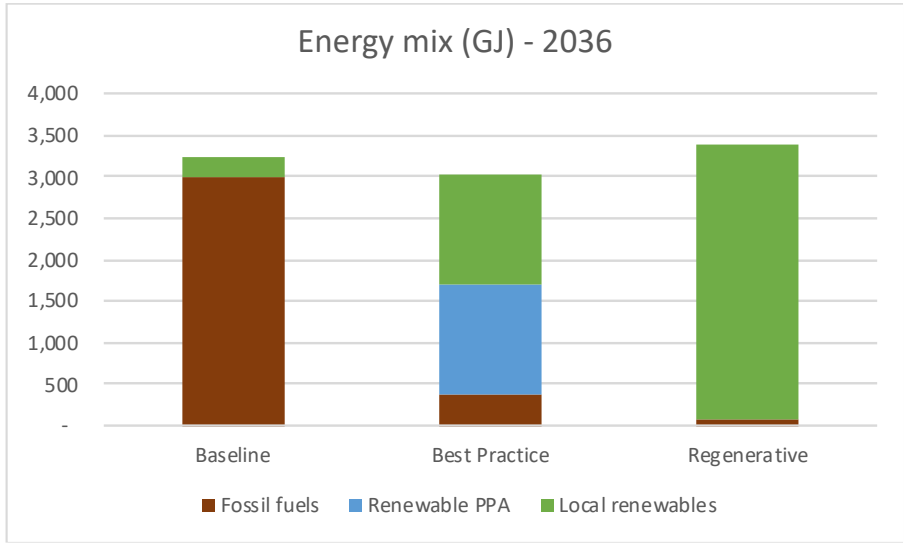




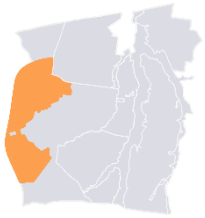


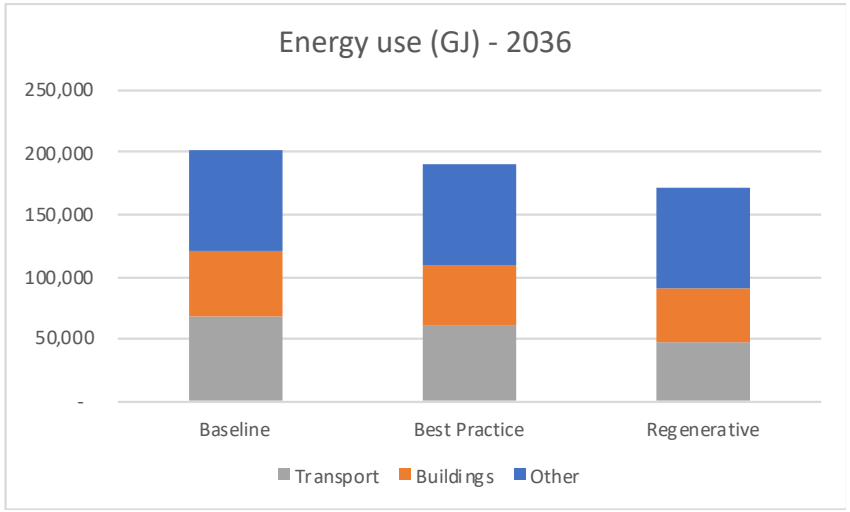
Badgerys Creek





Agribusiness





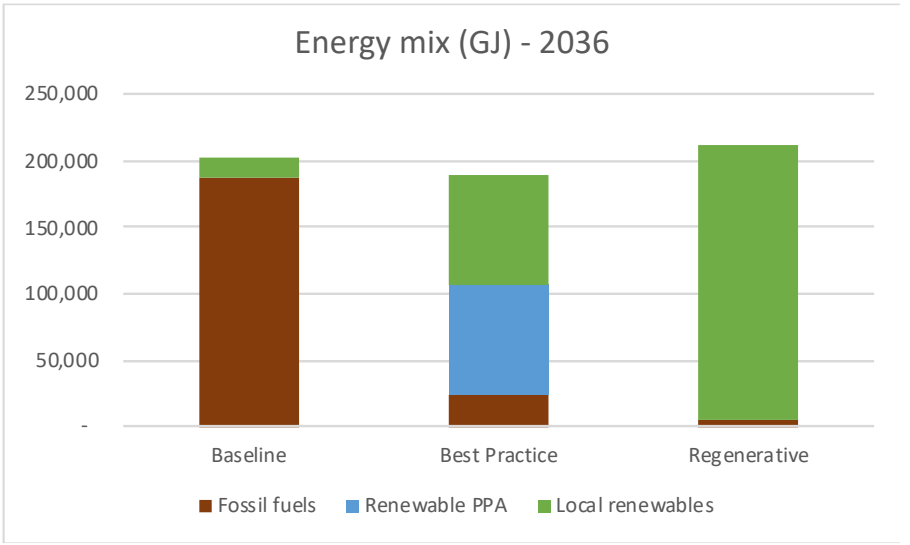


Table 15 - Assumptions used in the energy modelling

ASSUMPTIONS IN MODELLING	ESTIMATE
Fraction of transport energy for local travel	30%
Transport energy reduction in best practice case	10%
Transport energy reduction in regenerative case	30%
Fraction of residential and commercial energy for buildings	50%
Building energy use reduction in best practice case	10%
Building energy use reduction in regenerative case	20%
Residential energy presently supplied by rooftop solar	25%
Renewable energy by remote PPA in best practice case	50%
Local renewable electricity in best practice case	50%
Transport switched to electricity/hydrogen in best practice case	60%
Transport switched to electricity/hydrogen in regenerative case	90%
Excess renewable generation in regenerative case	25%

Case Study 11 – Adaptable Infrastructure – Car parking

For infrastructure to be adaptable in a meaningful way it must be relatively cost effective and easy to change the purpose and function of a facility e.g. if an adaptation process involves demolishing and rebuilding 50% or more of an item, it could not be described as an adaptation but rather a demolition, disposal of economic value, and reconstruction.

Adaptability of infrastructure can apply to several different aspects of its responsiveness to changing needs. Ideally, we would require rapid, easy, and c**ost-effective** ways to achieve the following:

- Adaptability in deployment to allow efficient construction as needs become apparent.
- Adaptability in function to allow efficient change in use for either a range or foreseen needs, or for emerging needs.
- Adaptability in recovery to allow it to be moved or recycled and re-used when it unexpectedly emerges that it is no longer necessary – or that better alternatives have appeared. **(Aucamp, 2017)**

To prepare for the impact of automated vehicles on real estate, designing for adaptable parking infrastructure that can be repurposed, renovated, or redeveloped in the future, at less cost is key.

While the industry may not be ready to remove parking for automated vehicles today, the ability to repurpose, renovate and redevelop in the future starts today's planning. The ability to adapt parking in the future is critical for several reasons:

1. Planning for parking adaptability can extend the economic lifespan of a property or a development project
2. It reduces the potential for future grey field sites
3. It makes grey field sites easier to improve, revitalise and redevelop with minor modifications and capital expenditures
4. It avoids the need for costly and disruptive excavations for potentially redundant basement car parking.

Parking adaptability has the potential to minimize and mitigate future grey field blight due to an oversupply of underused parking in the future. Architects, engineers, and developers should design for adaptable parking today. And cities should require it as part of local building codes **(Shaheen, 2018)**

An example of innovation around car parking that can be adopted in the future as car use changes is this addition to an existing steel parking complex, "Parking & More". It combines a parking lot with eateries, sport facilities, and shops, "creating a vibrant and lively street and a partially covered urban plaza. **(Arcilla, 2020)**

Parking & More is a public facility and mixed-use structure for parking and a variety of public and private programs. "The goal is to create intense and multilayered infrastructure, which works as an urban hinge, connecting and regulating different type of mobility flows, both from north to south and east to west. The fully open structure has ceiling heights which are slightly above standard heights for parking to accommodate other permanent and temporary built-in programs."

Establishment of Water-Energy-Waste Nexus in an Established Circular Economy Practice

There is a potential for Aerotropolis to establish a biorefinery (***Case Study 12***) that would use as a feedstock wastewater sludge and industrial and municipal bio-waste in co-digestion generating energy (biogas) and nutrients (biosolids). There is further potential to convert the biogas to a biofuel, that can be used in transport, purify it for application in gas grid (to be mixed with natural gas or to replace it), to generate electricity and feed it to the electricity grid as a renewable resource (Jazbec, Wastewater gas recovery opportunities in a circular economy, report prepared for Sydney Water, 2020). Biogas can be also processed further into H_2 and graphite as demonstrated in ***Case Study 13***. Generated biosolids can be processed further to extract phosphorus, nitrogen, and potassium, used in artificial fertilisers. Alternatively, they can be used in the generation of bioplastics providing an alternative to fossil fuel generated plastics.

Case Study 12- Billund Biorefinery, Denmark

Description

Billund Biorefinery is a publicly owned company providing services in water supply and waste management to the municipality of Billund. The plant co-digests industrial and municipal bio-waste with wastewater sludge, producing biogas and providing excellent effluent quality. The plant, using thermal hydrolysis, is optimised to be energy efficient in operation and producing commercially valuable phosphorus. In addition, the company generates revenue by contracting the export of sustainable technologies and projects.

Business case

Biogas plant capital cost: $13mil (2017), operation cost $2.5 mil/year. In 2016 the plant employed 30 people and had a turnover of $19.6 mil.

Innovation

Biogas (CH_4 and CO_2) is used to produce electricity and heat, use of CH_4 and H_2 in fuel cells in future. Biogas can be also used as biofuel in cars, for production of biodegradable bioplastics, protein production, CO_2 can be stored in algae production.

Heat is used for the plant consumption and the excess is supplied to the public district heating system and local industry and farmers.

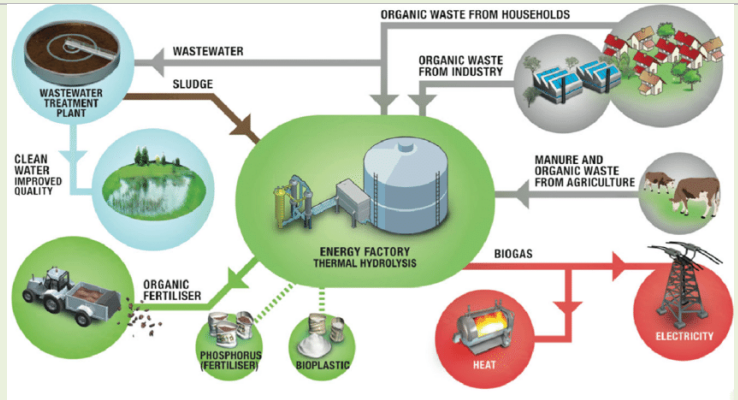
Electricity is supplied back to the community.

Phosphorus used in production of artificial fertiliser

Bioplastics that are biodegradable can be used instead of plastics

Source:

http://www.billundbiorefinery.dk/en/



Biorefineries offer additional opportunities to establish a truly circular economy hubs, where businesses can coexist and providing a cascading value supply chain of the products and waste each generates that is an input and resource into another process (Jazbec, Creating a circular economy precinct, report prepared for Sydney Water, 2018). Establishing such a symbiotic process in Aerotropolis provides an opportunity and advantage of carefully planned and most efficient process as it can be established from scratch and not retrofitted.

There are additional benefits and side productions of this process to the ones presented in the ***Case Study 12*** and ***Case Study 13***, utilising all the by-products of the bio-refinery, which can be expanded even further utilising the recycled waste stream resources. The biorefinery location within a circular economy hub, that would also enable co-existence of research and innovation companies would benefit all parties. Also, exploring business models where communities can be involved would expand the circular economy benefits beyond the material circulation, job creation and environmental benefits, to direct social benefits.

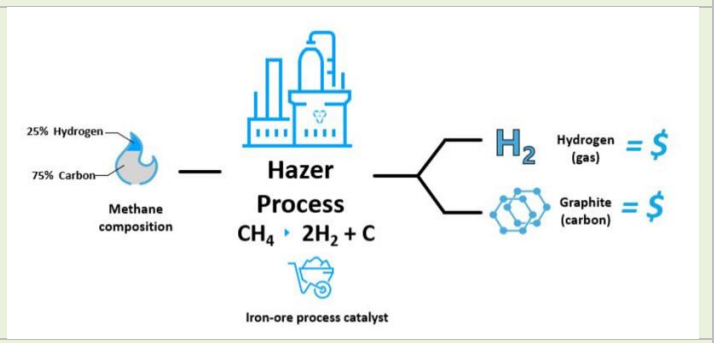
Case Study 13- Generation of Hydrogen from biogas, Hazer Group Australia

Description

The Hazer process has been installed in a demonstration plant at Woodman Point WWTP in Munster, WA to convert bio-methane generated in the WWTP to hydrogen and graphite using iron ore as a catalyst, creating an alternative pathway to the traditional generation of H_2 approaches of steam methane reforming and electrolysis.

Business case

The project was funded by ARENA and is estimated to cost $22.6 mil/y for 100 tonnes H_2 and 380 tonnes of graphite.



Innovation

The process uses a cheap iron ore catalyst and captures carbon in graphite, that is used in batteries, while H_2 is used as a fuel.

Source

https://hazergroup.com.au

3.6.4 A Cooler Aerotropolis

Cool Suburbs Context

Urban areas tend to have a different microclimate from rural areas. They are often hotter and drier due to a phenomenon known as the urban heat island effect. Factors that contribute to the urban heat island effect include (Oke, 1987):

- Dense dark surfaces such as bitumen on roads and building materials absorb heat and then emit it increasing the air temperature
- A lack of vegetation and surface water reducing their shading and evaporative cooling effects
- Heat from air conditioning units, traffic, and people themselves

Heatwaves are the most deadly natural disaster in Australia, causing more fatalities since 1890 than tropical cyclones, severe storms, earthquakes, floods and bushfires combined (Hughes, Hanna, & Fenwick, 2016). Heatwaves can also amplify the urban heat island effect (Rogers, Gallant, & Tapper, 2019) resulting in a higher risk of deadly heat stress in cities in the current and future climate (Fischer, Oleson, & Lawrence, 2012).

Cities are densifying and expanding their urban boundaries increasing their local urban heat island effects. In Sydney, research has shown that urban expansion will likely increase night time temperatures due to having more surfaces such as buildings and roads storing heat during the day and releasing it at night (Argueso, Evans, Fita, & Bormann, 2014). The effect of city expansion in Sydney was shown to also increase the incidence of heat stress in the current and future climate with "substantially more frequent adverse conditions in urban areas" than rural areas (Argueso, Evans, Pitman, & Di Luca, 2015). City expansion is also expected to dry the new urban areas as a Business as Usual city contains less vegetation and water than a rural area. Research has shown that numerous methods are effective at cooling Sydney in the current and future climate (Case Study 14, Case Study 15). These include cool roofs, irrigated green roofs, and installing solar panels on roofs (Ma, Goldstein, Pitman, Haghdadi, & MacGill, 2017; Ma, et al., 2018).

Green infrastructure, climate sensitive planning, material selection and operation

The management of urban heat is increasingly important. In the Aerotropolis the landscape led vision and current urban heat work by others – Penrith Council and WSROC – are important foundations for improving the resilience of Aerotropolis to the impacts of heat. There is a crucial role for

- green infrastructure,
- climate sensitive planning (awareness of street and building orientation, prevailing hot winds)
- improved building design through selection of appropriate materials and
- an ongoing focus on the organisational capacity for resilience management, communications, community building, maintenance, operation, and management of the area to maintain resilience

The challenge for the Aerotropolis and authorities who will be responsible for controlling and managing the development will be to demonstrate the extremely important role green infrastructure will play in mitigating some of the impacts of urban heat. In the NSW Governments recently released Green Places Guide green infrastructure is well defined and the Minister for Planning, Rob Stokes says:

Well-planned green infrastructure is fundamental in fostering healthy, happy communities that are sustainable now and into the future. That is why it is so important for us to think of these critical parts of the city as infrastructure, just like our roads, hospitals, schools, and transport networks. Many cases can be quoted where the benefits of green infrastructure have been monetised. This can however weaken the case for green infrastructure, especially if there is a focus on narrow costs at the expense of broader benefits for individuals, the community, and the environment.

The business as usual approach is to look at issues with singularity and maximise areas dedicated to development. Research finds that there is greater benefit in providing and upscaling green infrastructure success stories especially where a range of outcomes, including urban heat, can be demonstrated and even when those demonstrations are small in scale and local in their initial impact. Some of the cases studies presented in this report (Case Study 4, Case Study 14, Case Study 16) are examples of smaller scale development that demonstrates green infrastructure. The elements needed to achieve and sustain green infrastructure, as for other sustainability transition work (Brown, 2016) are:

- leadership and champions in both the political and professional arms of governments involved, leading to high-level commitments.
- longer-term partnering with diverse stakeholders, including residents, industries, and universities.
- the tying together of green infrastructure with wider programmes of urban renewal, climate adaptation and urban greening.
- a willingness to learn about and explore innovative methods of addressing core urban infrastructure responsibilities, including through pilot programmes and research and development partnerships; and
- networking with other cities and agencies with similar responsibilities. (Norman, 2019)

Case Study 14 - Jordan Springs Community Hub – Penrith The Jordan Springs Community Hub has used design and planning to ameliorate the effects of urban heat through:

- Lighter coloured surfaces and materials
- Ensuring there is adequate shade outdoor and for the building through planting trees and having awnings
- Insulation through recycled building materials such as cross laminated timber
- Passive building design principles to maximise natural light, ventilation, and air circulation
- Pervious garden surfaces to capture rain run off

To reduce heating and cooling costs the building also contains a geothermal heating and cooling system that will pay for itself in savings in less than 10 years, has 20kW solar panels on the roof to reduce carbon dioxide emissions by 25 tonnes per year and is water smart through a combination of water efficient fittings and a 16,000L water tank.

Planning and constructing a sustainable building of this nature involved a large commitment from Penrith City Council and the developers to ensure that the building was feasible, affordable, and appropriate for the community. This project involved multiple community engagement stages and a new working framework between Council and the developers. **(Penrith C. , 2018)**

Case Study 15 - Cool City, Los Angeles (Cagle, 2019)

Los Angeles is a large sprawling and car centric city that experiences more than 300 days of sunshine per year. Heat related deaths in Los Angeles are increasing, and heat-related deaths are now occurring in winter too. Los Angeles experiences similar issues to Sydney where coastal areas are often significantly cooler than inland areas. There is also an economic disparity where the most disadvantaged people and those without access to air conditioning also live in the hottest suburbs.

Cooling the city is being tackled in multiple ways in Los Angeles focusing on cool building materials and surfaces as well as blue and green infrastructure. It is this combined approach that is likely to produce the largest cooling effects, with principles and ideas that can be applied at Aerotropolis.

Built environment

In 2015 an ordinance came into effect in the city of Los Angeles requiring all new or refurbished roofs to be cool roofs, meaning they reflect more sunlight and absorb less heat. This was shown to be effective and the city expanded to implementing cool roads, as 15% of the land in Los Angeles is city streets, while parks comprise 13%. This represented a great opportunity to cool the city.

Blue and green infrastructure

Los Angeles is also implementing permeable pavements and bioswales that catch and filter runoff for reuse in the urban landscape. These have been implemented across several major thoroughfares and smaller residential side streets. This city is also looking to increase shade by increasing canopy by at least 50% by 2028 in areas that currently have minimal shade.

Principles

Cool cities are a newer idea that is gaining traction in Australia and around the world. Cooling cities builds resilience to climate change and directly addresses the impacts of deadly urban heat. Cool cities are assessed through multiple indicators such as:

- Air temperature
- Surface temperature
- Human thermal comfort measures, which quantify the effects of heat on human health

Cooling cities is usually addressed through modifying the built environment and increasing blue and green infrastructure (**Case Study 16**). As such, addressing urban heat generally produces co-benefits such as improving waterway health, improving mental health, improving health outcomes and access to green space.

Guiding and Relevant documents

- *NSW Premier's Priorities*
- *Greener places 2020*
- *Penrith Council - Cooling the City Strategy 2015*
- *Resilient Sydney Strategy 2018*
- *Risk-based Framework - Considering Waterway Health 2017*
- *South Creek Urban Cooling Technical Report 2020*
- *Sydney Water – Western Parkland City – Urban Typologies and Stormwater Solutions 2020*
- *WSROC Turn Down the Heat Strategy 2018*
- *Vision and Transition Strategy for a Water Sensitive Greater Sydney 2018*
- *Penrith LSS Penrith Waste Strategy 2017-2026*

WSAP PRINCIPLES RELEVANT TO URBAN HEAT

There were no explicit principles listed for urban heat - principles for water (3.3.1.2) are relevant here

Western Sydney District Plan has the following objectives for heat with are highly relevant and recommended to be referenced in the Aerotropolis planning controls:

- People and places adapt to climate change and future shocks and stresses.
- Exposure to natural and urban hazards is reduced.
- Heatwaves and extreme heat are managed. (Western Sydney Planning Partnership , 2020)

RECOMMENDED ADDITIONAL PRINCIPLES – ALL PRECINCTS

Green infrastructure

- Vegetation – larger natural areas offer multiple benefits in terms of cooling and biodiversity providing (evapotranspiration, shade from large trees)
- Water providing (evaporative cooling through misting and irrigation breezes over water bodies, healthy vegetation, green roofs, walls, and facades providing shade, insulation, and evapotranspiration
- Design of places providing air flow, green open space, and appropriate building morphology so that the cooling from green space can be harnessed and spread throughout the city, e.g. having green open space upwind of the area of interest.

Built environment

- High albedo building materials to reflect light and heat
- Shade through eaves and overhangs, awnings
- Permeable pavements
- Street tree pits redesigned for deep soils and passive irrigation
- Dimples not pimples in the landscape (make dips and concave spaces to trap water and reduce run off)
- Passive irrigation of vegetation to increase evapotranspiration
- Adequate vegetation around the buildings
- Natural ventilation
- Solar panels for shading

Case Study 16 - Cool streets Blacktown City Council

Street trees are one of the most effective urban heat mitigators in the public domain as they shade people and hard surfaces from solar radiation as well as cooling the air through evapotranspiration. They also can reduce air pollution, improve mental health, and increase house prices. However, trees are not always accepted by their communities and young trees are often subject to vandalism.

The Cool Streets Pilot Program in Blacktown was a collaboration between Council, Cool Streets and Gallagher Studio where the program aimed to educate and empower communities about the benefits of trees and help select trees in their local area. The project focused on the cooling benefits of street trees (and the positive effect this would have on household electricity bills) as well as the carbon capture and storage benefits.

A pilot program was devised for two existing streets that did not have tree cover and invited residents to collaborate and develop the tree design for the street. While residents initially chose smaller homogenous trees for their street, once educated on the cost and carbon savings associated with larger and more diverse trees they agreed upon that design.

POINTS OF INTEREST / INNOVATIONS:

This award winning project (Award of Excellence at the 2017 Australian Institute of Landscape Architects National Landscape Architecture Awards) was an outstanding example of collaborative community engagement and design as well as educating the community about the benefits of trees in their neighbourhood. (GA, 2020)

Cool Suburb Aerotropolis Precinct Scenarios -

An analysis of practices when application of the three possible scenarios for urban heat in the Aerotropolis is outlined in **Table 16,** it includes an assessment of needs for planning standards and benchmarks required to achieve resilience and liveability principles and performance outcomes.

Table 16 - Summary of outcomes for each scenario for a cool Aerotropolis

BASELINE 2036	LEADING INDUSTRY PRACTICE 2036	SUSTAINABLE REGENERATIVE 2036
• Most of a block is covered in hard surfaces such as the building and driveway • No trees in the private realm • Street trees are small and separate along the street • Irrigation is limited to sports fields	0.5˚C air temperature reduction in the local urban heat island effect through adoption of: • Lot scale or networked wastewater treatment and supply • Some reuse of harvested rainwater on the lot and neighbourhood scale for gardening and irrigation • Housing blocks with room for trees and gardens • Street trees with enough space and water above and below ground to flourish and grow to their full size • Healthy vegetation across the public and private realm • Green infrastructure, blue infrastructure and WSUD are widespread on public land • Most likely scenario is large investment in networked third pipe recycled water supply for all non-potable uses including public greening, with some lot scale stormwater harvesting and reliance on potable back up supply, irrigation limited to playing fields and high priority public spaces.	2˚C air temperature reduction in the local urban heat island effect through adoption of: • Rainwater capture on lot and at scale in the neighbourhood to support irrigated landscapes and misting of large hardstand areas e.g. industrial roof spaces (Hoban, Western Parkland City Urban Typologies and Stormwater Solutions, 2020) • Lots for multi-unit dwellings and employment / commercial use contains blue and green infrastructure such as irrigated green roofs, green walls, and trees • Permeable building materials used, including permeable paving • Cool materials used in footpaths, roads, and buildings • Connected network of street trees for shading pedestrian and cycling paths • Irrigation of all public and private open space • At the precinct to suburb scale the prevailing hot winds are blocked through green infrastructure and design. While this could create updrafts, it is only the lower levels of wind that would be blocked so the updrafts would have a small magnitude. The updrafts are also unlikely to compare in scale to the heat emanating off the urban surfaces. • Recycled water as back up for use in homes and buildings, irrigation for vegetation maintenance and cooling

*Estimated temperature reductions are based on recent modelling of urban heat against urban typologies (Mosaic Insights, Sydney Water, 2020)

Precinct data and possible future scenarios

BASELINE – Business as usual

The summertime surface urban heat island was calculated at the modified Mesh Block 2016 scale (defined by the Australian Bureau of Statistics) for Sydney, based on observations of the land surface temperature from the Landsat8 satellite over the summer of 2015-16. The urban heat island was defined by comparing the temperature across the Sydney urban area to surrounding reference rural areas. The current location for the Western Sydney Aerotropolis (Aerotropolis) has a summertime urban heat island of 2–7˚C (**Figure 6**). However, neighbouring suburbs to the east, built under a business as usual scenario, experience urban heat islands more than twice those currently at the Aerotropolis, where the urban heat island ranges from 10–13˚C.

The Heat Vulnerability Index (HVI) was calculated at the Statistical Area 1 scale (defined by the Australian Bureau of Statistics) for Sydney. The HVI is an index that quantifies how vulnerable a population is to suffering health related issues from exposure to heat. The HVI combines the urban heat island with vegetation cover data and the Socio-Economic Indexes for Areas (SEIFA), a measure of socio-economic advantage and disadvantage. This ensures the HVI addresses indicators for exposure, sensitivity, and adaptive capacity to deal with heat. In the HVI, 1 represents low exposure or high adaptive capacity and 5 represents high exposure, high sensitivity, or low adaptive capacity. The map indicates that some of the most heat vulnerable areas are in the currently developed areas of Western Sydney, built under a Baseline – business as usual sceanrio (**Figure 6**). It is very likely that if the Aerotropolis is built under a Business as Usual, then it will also be one of the most heat vulnerable areas in Sydney.

In addition to the current high urban heat island and heat vulnerability in Western Sydney, the world is currently tracking on the high emissions climate change scenario (Schwalm, Glendon, & Duffy, 2020). In a high emissions climate change scenario, a compilation of eight climate models shows that average January temperatures **are expected to rise by 1.23˚C by 2035 in Sydney** compared to the average climate of 1986–2005. While this may seem small, the largest changes in temperature are likely to be seen in the extremes, with Sydney expecting a rise in the number of heatwave days per summer to approximately 20-25 days by 2081-2100 in a high emissions scenario (Cowan, et al., 2014). ***This indicates that almost one third of summer will be classified as heatwaves.***

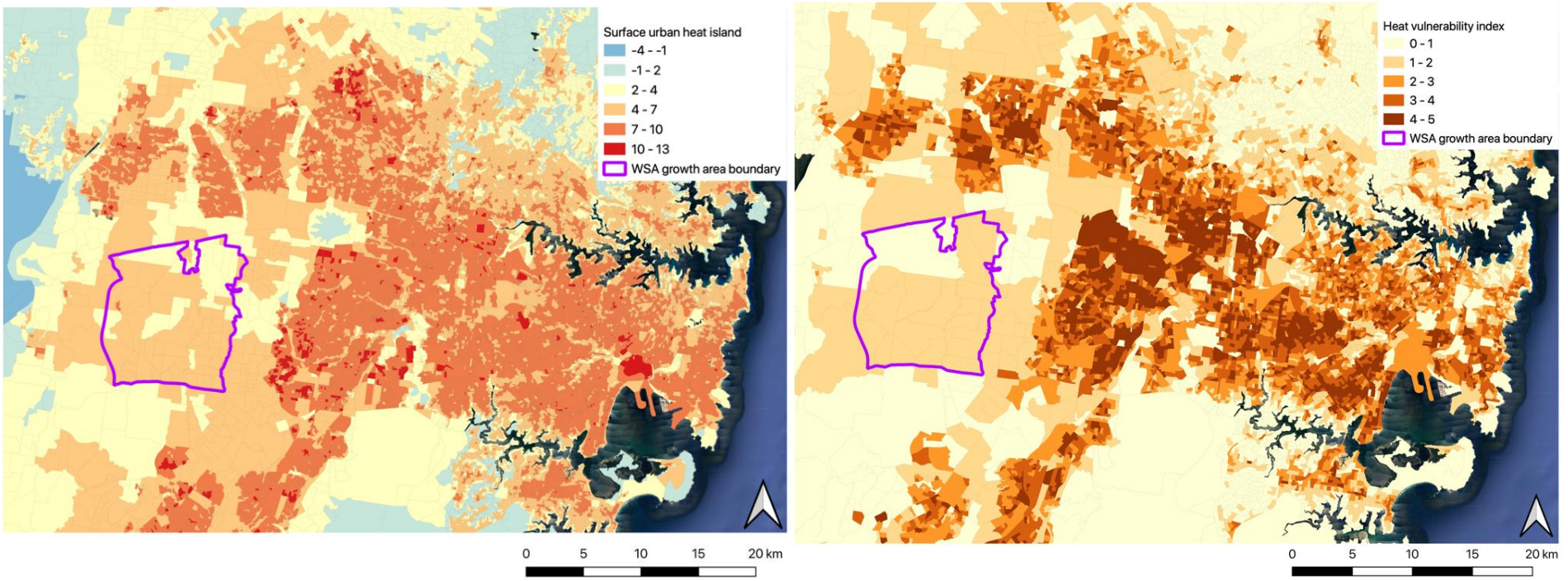


Figure 6 – The surface urban heat island (˚C) for Sydney at the 2016 mesh block level and the heat vulnerability index (HVI) at the Statistical Area 1 scale. Measurements taken over summer 2015-16.

On extremely hot days where the maximum temperature exceeds 40˚C winds are most commonly from the west at speeds of 5 – 10 metres per second (18 – 36 kilometres per hour) bringing hot air from the desert to the Aerotropolis. This hot air combines with the urban heat island effect resulting in high air temperatures in urban areas during summer (**Figure 7**). Western Sydney is also too far inland for sea breezes to have a cooling effect. Temperature modelling in these conditions (maximum temperature = 44.5˚C at 4:30pm) for a Business as Usual residential precinct in the Wianamatta-South Creek catchment demonstrates that built up areas such as buildings and roads are several degrees warmer than grassed areas (**Figure 8**). Understanding these hot and cool spots across a precinct can lead to targeted strategic urban cooling measures. Based on the map of the temperature, shading on roads needs to be addressed while cooling technologies would reduce the temperature of the buildings. These are targeted in the sustainable regenerative scenario.

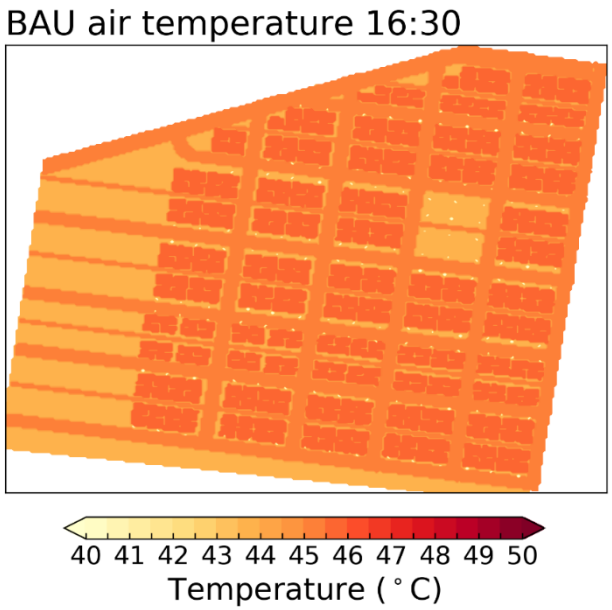


Figure 7 – Under the Business as Usual scenario, on a 44.5˚C day hard stand areas are several degrees hotter than vegetated areas.

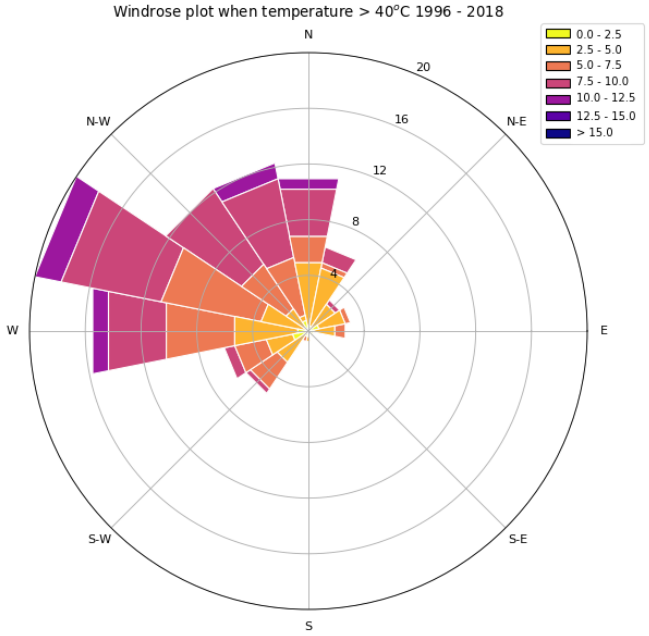


Figure 8 – Prevailing winds from the West North-West on hot days bring hotter air into Aerotropolis

In the current climate, the **Baseline - Business as Usual** scenario results in 66 days with either moderate or strong heat stress during summer, and 13 days of very strong heat stress and extreme heat stress (**Figure 9**). In this instance heat stress has been defined by the Universal Thermal Climate Index (UTCI) (Brode, et al., 2012) and sourced from the ERA5 dataset (Napoli, Barnard, Prudhomme, Cloke, & Pappenberger, 2020). These values are expected to increase with climate change.

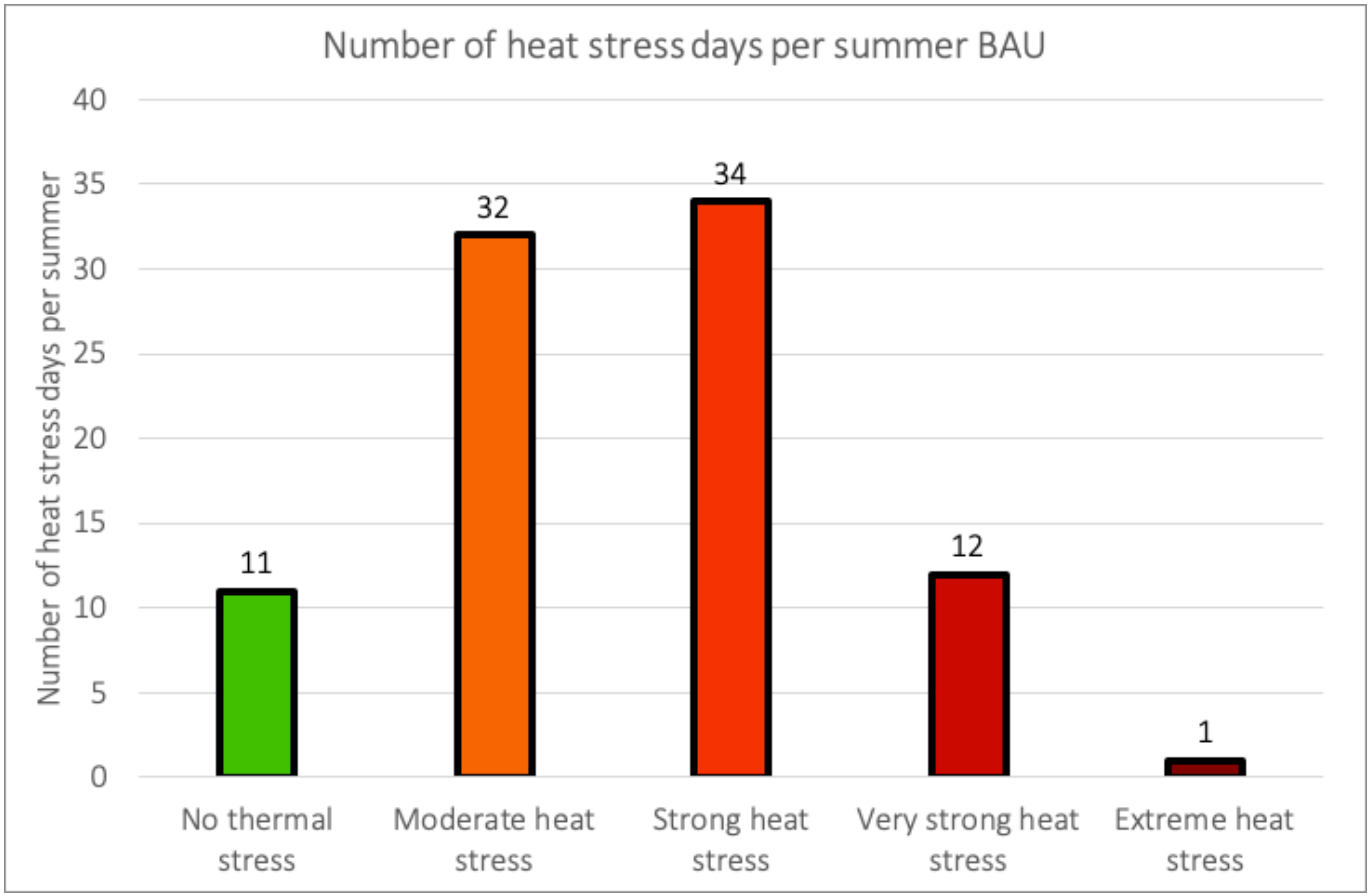


Figure 9 – *The number of days of heat stress experienced in 2036 under a Baseline – Business as Usual scenario*

	LEADING INDUSTRY PRACTICE

Modelling has not been conducted to quantify the changes in air temperature and human thermal comfort for the leading industry practice scenario. However, assuming that the UTCI is, on average reduced by 2.5˚C, then the resulting number of strong, very strong and extreme heat stress days per summer will decrease by 20, while increasing the number of days with no thermal stress or moderate stress (**Figure 10**).

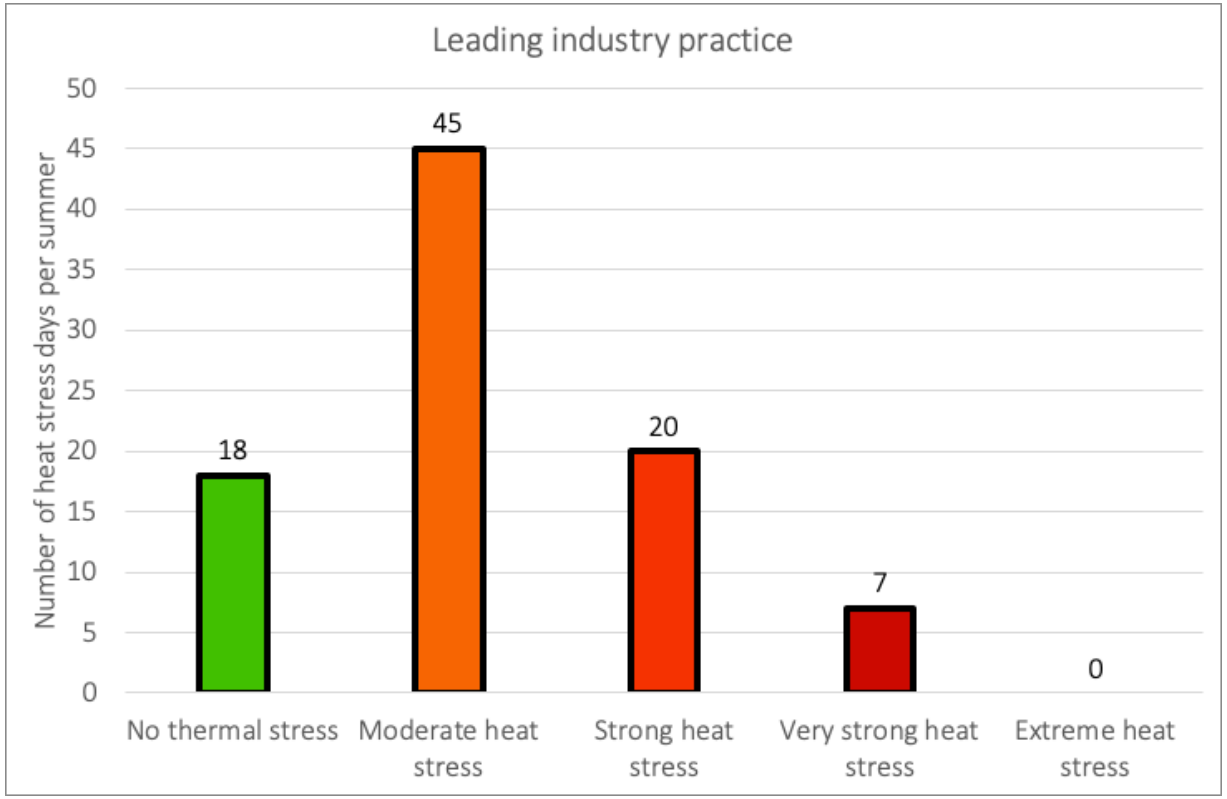


Figure 10 – *Under the leading industry practice scenario it is anticipated that there will be less heat stress days in Aerotropolis*

	SUSTAINABLE REGENERATIVE –

The sustainable regenerative scenario was drawn from urban cooling modelling completed with Sydney Water for the effects of urban water typologies on air temperature and human thermal comfort using their water-centric urban typologies. (Mosaic Insights, Sydney Water, 2020; Hoban, 2020). This demonstrates that significant cooling benefits can occur when significant investment in blue-green infrastructure is applied to a site, adding cooling as a co-benefit to improved stormwater quality. The sustainable regenerative approach was very successful in reducing the temperature compared to the Baseline - Business as Usual. On an extremely hot day where the maximum temperature is 44.5˚C at 4:30pm, the air temperature in the sustainable regenerative scenario is **3.4˚C cooler than the Baseline scenario (Figure 11)**. This was the maximum cooling effect achieved. The UTCI was also on average 5.7˚C cooler (**Figure 12**) resulting in the number of days with no thermal stress increasing dramatically while reducing the incidence of heat stress days overall. As **Figure 12** outlines the number of heat stress days has shifted from Extreme and Very Strong and Strong to Moderate and No Thermal Stress.

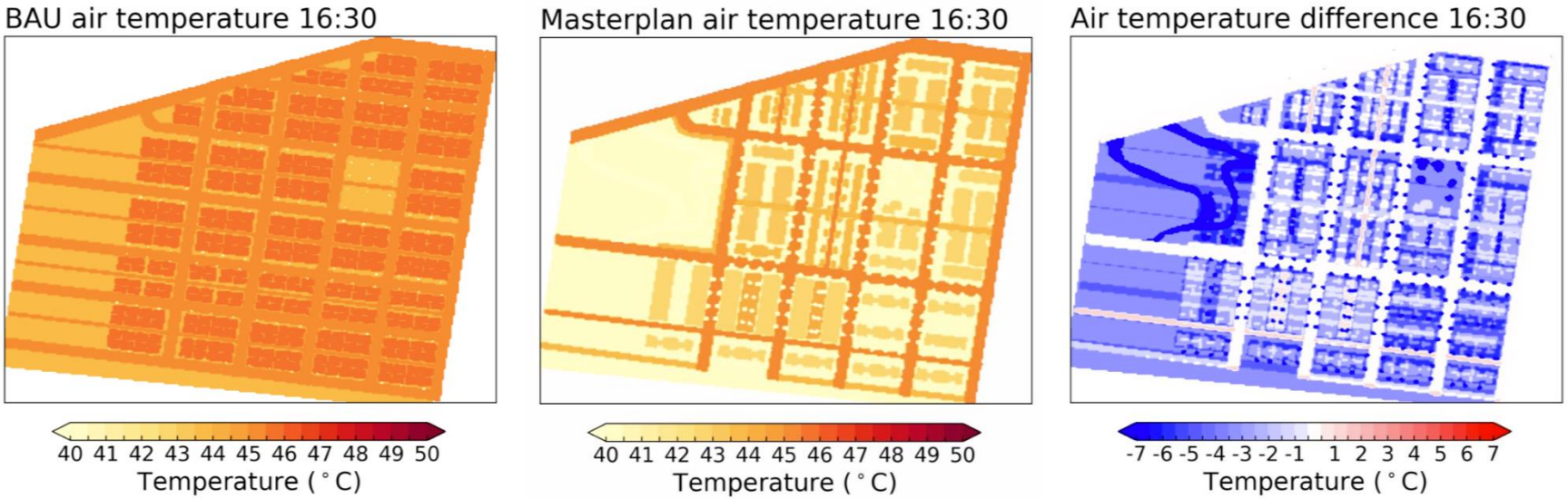


Figure 11 – *The sustainable regenerative scenario has a significant impact on urban heat in 2036*

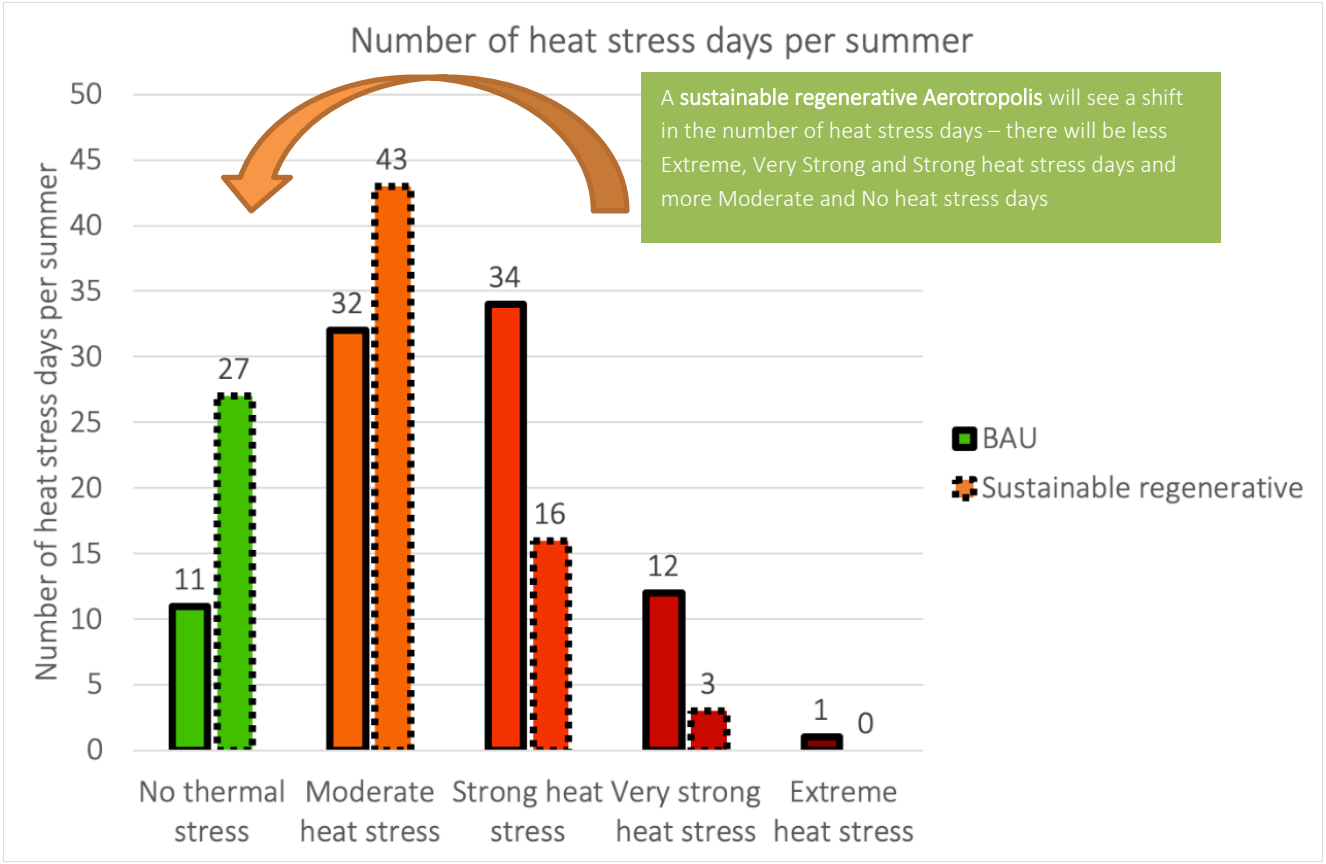


Figure 12 – *Under the sustainable regenerative scenario there is a significant shift in the number heat stress days*

Reflective materials, also known as high albedo, have also been shown to be effective heat mitigators in Sydney. Cool roofs were modelled during January 2007, 2008 and 2009 for Sydney with modelling studies demonstrating cooling of more than 1˚C in the high density areas between approximately 10am and 4pm (**Figure 13**) (Ma, et al., 2018). This is because reflective materials are most effective when the sun is overhead.

As shown in the previous paragraph modelled cool roofs are effective at reducing air temperatures at street level. Other reflective materials like cool pavements are also effective at reducing the temperature, but they have been shown to increase glare for pedestrians and in some cases, this makes them feel hotter (Yang, Wang, & Kaloush, 2015). Generally, it is recommended to use high albedo materials such as cool pavements in low pedestrian areas to reduce glare, or above street level such as cool roofs.

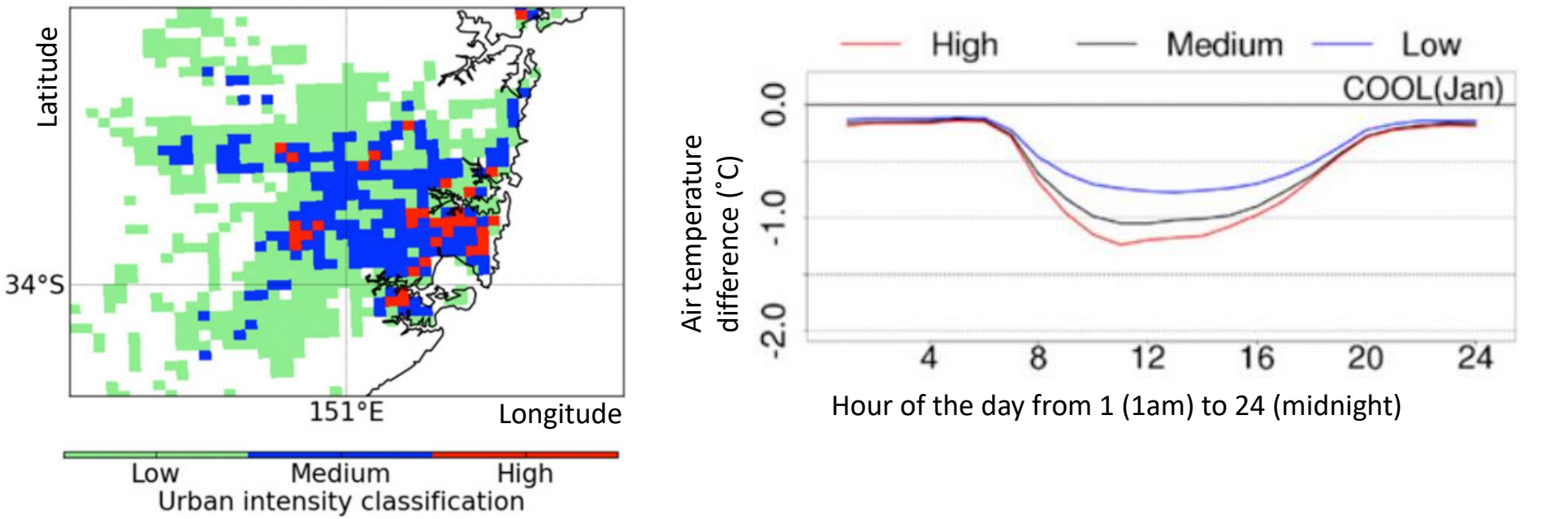


Figure 13 – *Map of the low, medium and high density urban classification as well as the reduction in 2m air temperature throughout a summers day from cool roofs (Ma, et al., 2018)*

4 Recommendations

The sustainable regenerative scenario is recommended as a model that would achieve the brief from Department of Planning, Industry and Environment for:

- A reimagining of traditional methods to formulate planning controls that are innovative and reflect best practice
- An extension beyond the Business as Usual (Business as Usual) approach to deliver on the Western Parkland vision for the Aerotropolis and
- Innovative and flexible planning solutions which respond to emerging issues such as urban heat, water management and circular economies.

It is acknowledged that the achievement of the sustainable – regenerative model will not be evident immediately and that the sustainable - regenerative performance of the Aerotropolis will evolve over time. It is crucial that the upfront and early planning provides for innovation and the beyond business as usual approach if the area is to deliver on its vision.

Recommendations for Sustainability and Heat have been broken into two sections:

- General recommendations in relation to achievement of sustainability ambitions and future management of the Aerotropolis
- Specific principles and performance outcomes for the Precinct Plans to achieve a sustainable regenerative scenario
- A range of possible solutions that will directly inform the development of the Aerotropolis Development Control Plan.

An attempt has been made to allocate a responsible agency and timing for each recommendation. Given the advisory nature of this report none of the agencies nominated below have confirmed these suggestions.

4.1 Sustainability and Future Management Recommendations:

The following are actions recommended to ensure that any sustainability measures suggested for the Aerotropolis planning instruments can be implemented by developers, supported by agencies and authorities, and deliver on sustainability outcomes as envisaged in the short, medium and long term.

	Recommendation	Timing	Responsible Body
	Short Term: 0-5 years Long Term: 16 years + Medium Term: 6-15 years Ongoing		
1	Align precinct plans and master plans with the recommendations to work towards the sustainable regenerative scenario.	Short term	Western Sydney Planning Partnership
2	Develop Phase 2 Development Control Plan performance outcomes / benchmark solutions in accordance with the recommendations in Section 4.1 and 4.2 the Principles and example Performance Outcomes identified.	Short term	Western Sydney Planning Partnership
3	**Coordinating body** Identification of a coordinating body to provide governance, decision-making and the coordination needed to deliver the sustainability vision of the Aerotropolis, bringing the various jurisdictions and systems together to facilitate the movement to a sustainable regenerative scenario (e.g. all stakeholders including Aboriginal community, utilities, infrastructure for water, energy and waste, public domain, buildings). Suggestions for suitable agencies are Western Sydney Parkland Authority and the Western Sydney City Deal (**Case Study 17**)	Short term	Western Sydney Planning Partnership

	Recommendation	Timing	Responsible Body
	Short Term: 0-5 years Long Term: 16 years + Medium Term: 6-15 years Ongoing		
4	**Sustainability / resilience framework** Adopt a guiding framework aligned with sustainable regenerative development and resilience. Use of a leading edge, internationally recognised framework would help to guide the process, and provide recognition through the certified rating. Examples include One Planet Living (already applied in Sydney at Barangaroo) and LENSES. As frameworks, they guide the development of strategies that can be customised to suit the unique context of WSA. Below these frameworks, local tools like Greenstar (communities' tool and tools for the various building types) could be used to help benchmark targets set by the overall framework. For example, the process would be to select an overarching framework, set goals and targets, and model and meet the corresponding targets in Greenstar, BASIX, etc. (**Table 6 – Potential targets for the Aerotropolis under the three 2036 scenarios**). Adoption of these tools and frameworks requires commitment to the relevant certification processes. Establishing a framework would result in a common management approach for agencies, consultants, developers, and all stakeholders – common use of evidence, methods of communicating, objectives and use and reporting against robust indicators. This approach would also integrate and embed cultural, social, and economic outcomes sought for the WSA.	Short term	Western Sydney Planning Partnership / Relevant Stakeholders / Industry
5	**Review of BASIX Targets in Aerotropolis** As part of the guiding framework of the Aerotropolis, a review of BASIX targets is recommended that includes modelling and viability testing across the current BASIX areas of water and energy and which includes waste and resilience / heat.	Short term	Western Sydney Planning Partnership

	Recommendation	Timing	Responsible Body
	Short Term: 0-5 years Long Term: 16 years + Medium Term: 6-15 years Ongoing		
6	**Develop WSA specific strategies** Some specific and detailed strategic direction is needed for the Aerotropolis to fix targets (based on detailed modelling of resource demands completed with the BASIX work) and support the transition to the sustainable regenerative outcome: 1. WSA specific waste management – circular economy investigation to transition from the current servicing and processing to a circular economy with specific targets through detailed modelling that deliver as close to net zero waste (or net positive where possible) with a plan to transition to net positive over a set timeframe. 2. An integrated water management strategy – providing clear direction and targets for local councils, developers, residents and occupants of buildings in the Aerotropolis on stormwater management – run off volumes and water quality, pollution control, wastewater, irrigation needs, and potable water supply 3. A Carbon management / reduction strategy to achieve a low carbon Aerotropolis with specific targets (derived through detailed modelling) that are as low (or net positive where possible) with a plan to transition to net positive over the medium to long term.	Short to medium term	Western Sydney Planning Partnership
7	**Create partnerships and establish cogovernance arrangements for multifunctional outcomes** Cogovernance (glossary) model for precincts short and longer term management should be investigated where the delivery and management of services and infrastructure is shared through transdisciplinary, multi-agency cooperation e.g. engagement with Endeavour Energy around planning for the transformation to assist in meeting renewable energy and emissions reduction targets. The Planning Partnership is already an excellent example of inter-agency cooperation around planning. Establishing a longer term cogovernance process will see this collaborative approach continued into the operating and delivery phase of the Aerotropolis. Ensure that relevant stakeholders are forthright in sharing of information, and identification of opportunities for shared collective outcomes for Precincts. In the longer term, work towards the creation of cogovernance arrangements.	Short term to long term	Western Sydney Planning Partnership / Council / Infrastructure Delivery Agencies / Landowners

	Recommendation	Timing	Responsible Body
	Short Term: 0-5 years Long Term: 16 years + Medium Term: 6-15 years Ongoing		
8	**Review resourcing policy and regulations** Review the current resourcing mechanisms available to local government and other authorities to manage / maintain new areas of green space, new green and circular infrastructure and increasingly complex and integrated infrastructure. This should include a review of current Local Government Charges and a funding potential under local, precinct, state infrastructure contributions planning.	Short - medium term	Western Sydney Planning Partnership
10	**Develop WSA specific** plans that include guidelines and measures for developers and land managers to assist with resourcing, implementation, monitoring and reporting and ongoing operations: • soils (salinity) management to address the impacts of salinity across the public and private domain with an objective of delivering the parkland city vision • long-term tree (urban forest) management to achieve the Premier's priority and canopy targets, identify suitable species and locations for public realm street trees and trees for the private and public open spaces to reach the tree canopy target, address soil management concerns and establish a strong and sustainable urban forest – use whole of life costing tools (e.g. Hort innovation's Tree Budget Tool) to plan for capital and ongoing urban forest management needs for the Aerotropolis • share-economy development to expand current share economy businesses (car share, air BnB) and community-oriented sharing such as community gardens, car-pooling, libraries (books, tools, toys etc) skill share (repair cafes) • carbon management and renewable energy that supports equity of access to reliable renewable energy, establishes partnerships for the supply of energy under Power Purchase Agreements through Solar Gardens and other community solar initiatives	Short Term	Western Sydney Planning Partnership
11	**Undertake an Urban Cooling assessment** Assess microclimate impacts for the Aerotropolis to assist with planning and designing for a cooler community. Work across agencies and build on the recent work by WSROC to • Deliver the physical assets needed for a cooler Aerotropolis • Establish a heat-prepared community – who know where to find and how to access cool places including in public venues, transport systems and commercial sites	Short term	Western Sydney Planning Partnership / Other

	Recommendation	Timing	Responsible Body
	Short Term: 0-5 years Long Term: 16 years + Medium Term: 6-15 years Ongoing		
12	**Engagement and upskilling of developers about beyond BAU approach** Resource and prioritise early and deep engagement with industry (developers, occupants) to provide specific advice for sustainability planning controls and guidance (education and information) on sustainability outcomes, their benefits, and how they can be achieved especially in relation to areas where there is a significant shift from business as usual. Clear and direct communication with developers about the vision of the Aerotropolis, the benefits of the sustainable regenerative model and the methods of delivery will be essential to avoid pressures from developers or community for avoided targets. This will reduce the capacity of the Aerotropolis to retain stormwater run-off, create cool buffers for urban cooling and climate adaptation, protect and expand biodiversity and create a city in a parkland environment.	Short Term – Long Term	Western Sydney Planning Partnership / Industry / Community
13	**Codesign a circular Aerotropolis with relevant stakeholders** Including Aboriginal community - innovative, commercial solutions to achieve the circular economy in and achieve the principles	Ongoing	Western Sydney Planning Partnership / EPA / DPIE / Treasury
14	**Review Land Use Categories for Adequacy Over Time** To review the standard instruments over time to allow for adaption to the sustainable regenerative scenarios, which may not current fit the standard instrument definitions e.g. the identification of prohibited uses (in the Enterprise zone particularly) is a strong starting position in the Western Sydney Aerotropolis. Uses should be periodically reviewed to ensure that those which are consistent with the sustainability ambitions assist with development of the sustainable regenerative outcomes Aerotropolis.	Ongoing	Western Sydney Planning Partnership
15	**Ongoing and regular review of related policy / plans** Review of all related documents to update with the Aerotropolis sustainable/regenerative principles to cover not only the planning of private and public spaces but to support the design and delivery of infrastructure and the ongoing management of the Aerotropolis.	Ongoing	Western Sydney Planning Partnership
16	**Improve capacity of agencies and individuals** Staff in agencies will need training and leadership in sustainability and resilience management through mentoring, use of evidence, digital platforms and data, and transdisciplinary projects. Staff will need to manage complexity and diversity and transition to a new business as usual and to deliver on the Premier's priority for a world class public service.	Ongoing	Western Sydney Planning Partnership / Council / Industry

Case Study 17- the Western Sydney City Deal

The Western Sydney City Deal is a tri-level government structure which could be the ideal authority for longer term coordination and oversight for the sustainable operation of the Aerotropolis.

Vision - A thriving future-focused city that is highly connected, innovative and liveable

Objectives

- Realising the 30-minute city by delivering public transport for the Western Parkland City
- Creating 200,000 jobs by supercharging the Western Parkland City
- Skilling our residents in the region and initiating new education opportunities
- Respecting and building on local character, enhancing liveability and improving the quality of the local environment
- Innovative approaches to planning and delivery of housing
- Getting on with delivering for the Western Parkland City through enduring tri-level governance

Governance

- Getting on with delivering for the Western Parkland City through enduring tri-level governance
- Establishment of tri-level governance through Leadership Group, Implementation Board and Coordination Committee with regular meeting regularly since April 2018
- Release of an implementation plan which clearly defines how and when the City Deal commitments will be delivered, who will be responsible and key performance metrics

4.2 Precinct Plan Sustainable Regenerative Principles

Without modelling it is not possible to provide detailed targets for the Aerotropolis to achieve its vision and objectives. A set of principles (detailed earlier in this report) are provided below to guide the Precinct Plans for water, waste, energy, and heat. These are **in addition** to the principles identified in the Aerotropolis Plan 2020.

These example performance outcomes are listed as desirable outcomes that would contribute to creating a sustainable, resilient and liveable Aerotropolis.

	PRINCIPLES	EXAMPLE PERFORMANCE OUTCOMES
WATER	Fit for purpose water is supplied from within the catchment as the priority (rain and stormwater to be used first then recycled water then potable) Co-governance / compliance arrangements are place to share water across property boundaries Protection natural soils, protecting and enhancing the existing areas of remanent native vegetation and biodiversity. Green infrastructure to provides water treatment, urban cooling, ecosystem services and amenity is integrated into built, landscaped and natural environments Aerotropolis is designed as a sponge to increase perviousness Landscapes potentially adversely impacted by contaminated soils and salinity are actively managed and restored Rainwater is captured at a range of scales – lot, neighbourhood, regional Vegetation/trees in the public and private domain is supported by soil volumes and passive irrigation Tree canopy targets are met at the neighbourhood scale Incorporate development that protects, maintains, or restores waterway health and the community's environmental values and uses of waterways through a risk-based approach to manage the cumulative impacts of development. Stormwater run-off targets (infiltration and harvesting) are applied at the lot and neighborhood scale Retreat - Adapt – Defend options for flood management are integrated and coordinated Incorporate development that protects, maintains, or restores waterway health and the community's environmental values and uses of waterways through a risk-based approach to managing the cumulative impacts of development.	Buildings • Stormwater to be harvested for reuse on all lots • Fit for purpose water supply to all homes and buildings – Water sources within buildings to be of potable standard suitable for consumption, and sanitation – Harvested stormwater to be the priority water supply with back up from recycled wastewater then potable water – Water supply to come from a diversity of interconnected sources on the lot, neighbourhood, or regional/networked scale – Water servicing and supply infrastructure to be integrated and use SMART metering, management, and treatment • Potable water consumption to be reduced by using harvested stormwater and recycled water (third pipe) Landscaped areas Stormwater run-off to be reduced via harvesting or infiltration – consider and develop an appropriate targe that sees the run-off mirror, where possible current run-off volumes Stormwater to meet NSW water quality objectives Fit for purpose water supply to all open spaces and public domain landscaped areas Water sources to be fit for purpose for consumption, landscape maintenance, cooling (irrigation) and food production Water supply to come from a diversity of interconnected sources and harvested stormwater to be the priority water supply with back up from recycled wastewater then potable water Water servicing and supply infrastructure to be integrated and use SMART metering, management, and treatment Potable water consumption to be reduced by 75% (BASIX 75)

	PRINCIPLES	PERFORMANCE OUTCOMES
WASTE	• Adopt principles of AVOID first, the REDUCE, REUSE, RECYCLE in material choices and construction methods • Educate and embed behaviours, practices, and systems through adoption of Sustainability / Resilience Framework and planning controls, services and information and education – individuals and businesses • Design out waste in supply chain and manufacturing and eliminate single use items: – by using design guides for buildings with prefabricated/modular, long life and loose fit, flexible and adaptable solutions – adaptable and reusable infrastructure - temporary facilities that can be remodelled as the Aerotropolis grows/changes – eliminate construction waste with programs with volume builders to encourage waste minimisation in building design – design for end-of-life disassembly and recovery – use of recycled and renewable materials • Establish Circular Economy Hubs for innovation and including Resources Recovery Processing infrastructure – plan now to process materials locally establishing local economies and circular systems within the Aerotropolis and on the boundary with Western Sydney councils – match suppliers with the local markets – testing innovative construction approaches - link with new CRC • Source separate for CE – design infrastructure, collection, processing, policy, procurement, pricing, and behaviours to produce high quality outputs for high quality inputs to other processes – consider combining services for transport efficiency (commercial industrial and residential) around materials rather than land use e.g. organics, plastics, residual waste – provide processing and treatment facilities at a range of scales - lot, neighbourhood, regional – basement processing, micro-factories, large scale processing where possible – establish network based drop off points in preference of door to door collection. – think of adopting PAYT to encourage waste separation • Design for share economy - encouraging collaborative housing models that reduce waste/encourage sharing • Adopt Product Stewardship approaches - policy and regulations already in place (CDS, Computers and TVs) and consider the schemes in the development phase (batteries, PVs, e-waste) including EPR • Joint procurement for new commercial markets – councils, State and Local government with revised serving contracts – bundle for efficiencies and economies –education, customer services, collection, servicing, processing, reporting	**Construction and Demolition** • 90% of construction and demolition waste is recycled • Designed for circularity (repurpose, reuse, rebuild and recycle) • Design with a circular economy approach • Design so waste is avoided where possible and recycling can be processed easily on site, reused and if required moved off site. • Design considering and planning to maximise reuse of resources by establishing connections between those who generate waste, reprocess, or recycle materials and users of end products. • Range of source separation options provided to support longer term transition to a circular economy • Uniform waste management design and colour coding for better waste education and performance • Source separate as many as possible materials: plastics (hard and soft), metals, glass, paper, organics (food waste and garden organics), e-waste, batteries, textiles, Styrofoam, carboard, chemicals and hazardous waste, ink cartridges etc **Source separation** • Adequate and functional space for waste storage and waste separation • Materials are separated at source for higher value recovery • Easy access to waste disposal in high rise buildings • Easy presentation of bins to the kerbside for the single dwelling units • Easy to read waste signage • Adequate storage space in each dwelling for sorting materials ready for disposal in the correct bin • Advanced technologies for organic waste separation • Work areas are designed for waste and recycling **Waste collection** • Flexibility in design allows for future changes in waste generation rates, materials collected and methods of collection • Designed for minimal noise during waste collection • Safe and easy access to waste and resource recovery areas for residents, building managers and collection contractors • Public multiple-stream waste collection/drop off points **Waste processing** • Communal composting and/or worm farming • Total recovery of organics and Energy generation from organic waste (anerobic digestion) at lot and precinct scale • Integration with businesses using waste as resource **Waste avoidance** • Knowledgeable residents about waste impact and how to avoid generation of waste • Multi-purpose spaces to support share economy (tools, re-use, repair and recycle products) **Landscaped areas** • 100% recovery of organic materials

	PRINCIPLES	PERFORMANCE OUTCOMES
ENERGY	• Plan for greater than 100% renewable energy supply to make Aerotropolis a net exporter of clean energy to the NSW grid. • Include diversity of renewable energy supply including solar, wind, green hydrogen, and bioenergy (anaerobic digestion of organic waste) • Provide decentralised local generation and supply • Develop integrated systems for energy generation – waste and water • Develop multi modal transport system that prioritises walking and cycling in the 30-minute city • Promote pedestrian and cycling network • Design and regulate for greening Infrastructure in public realm and private spaces for cooling, shade, amenity • Implement in the Street Design Guidelines the transition from individual use of infrastructure such as on and off road to shared adaptive infrastructure • Adaptable infrastructure for Charging stations – public facilities transition to private charging • Design roof space for energy generation, open space and amenity, gardens, food production, water harvesting, urban cooling • Provide space for local food production and distribution / retail / sharing – via markets, community gardens on public land and private spaces - lot, neighbourhood, and regional scale • Create equity of access to solar or renewables - removal of barriers to solar or renewables - Cost, rentals, heritage, solar access • Establish circular economy markets to reduce waste and transport emissions • Distributed and diverse share economy facilities and libraries - cars, books, tools, equipment, toys, parking spaces and infrastructure, bikes, kitchens, living and dining rooms - at a range of scales	**Energy generation on site** • Design for renewables, feed in grid and/or battery energy storage on site • Residential developments with 100% solar rooftops (and other suitable renewables) achieved with developer and community-led programs accessible to everyone **Energy efficiency and net zero emissions building** • Buildings designed to 6-Star rating under GreenStar • Maximise NatHERS ratings 8+ star • Customers understand about cheapest and most efficient home solutions • Buildings designed to minimise energy demand • Buildings connected to lot or regional scale bioenergy or waste to energy • Energy orchestration program with network, market, water utilities, and local aggregators to achieve 100% local supply and energy exports • Increased BASIX benchmarks achieved e.g. BASIX 70 **Transition from fossil fuels and transition to net zero emissions** • 10% hydrogen in gas network • Net zero (energy) emissions by 2030 • Infrastructure supporting electric cars

	PRINCIPLES	PERFORMANCE OUTCOMES
HEAT	Green infrastructure • Vegetation – larger natural areas offer multiple benefits in terms of cooling and biodiversity providing (evapotranspiration, shade from large trees) • Water providing (evaporative cooling through misting and irrigation breezes over water bodies, healthy vegetation, green roofs, walls, and facades providing shade, insulation, and evapotranspiration • Design of places providing air flow, green open space, and appropriate building morphology so that the cooling from green space can be harnessed and spread throughout the city, e.g. having green open space upwind of the area of interest. Built environment • High albedo building materials to reflect light and heat • Shade through eaves and overhangs, awnings • Permeable pavements • Street tree pits redesigned for deep soils and passive irrigation • Dimples not pimples in the landscape (make dips and concave spaces to trap water and reduce run off) • Passive irrigation of vegetation to increase evapotranspiration • Adequate vegetation around the buildings • Natural ventilation	• The number of very strong heat stress days and extreme heat stress days per summer are reduced by 50% • 50% of north-south oriented streets have adequate shade for pedestrians during the hottest times of the day • 80% of east-west oriented streets have adequate shade for pedestrians during the hottest times of the day • Cool building roofs and facades to minimise heating and cooling demand indoors • Development precincts to be on average 1˚C cooler during extreme heat days than Business as Usual developments

4.2.1 Development Control - Performance outcomes and Benchmark Solutions

The development of the Principles and Performance Outcomes will assist the Western Sydney Planning Partnership with the development of more detailed guidance and controls.On ground solutions to achieve these Performacne Outcomes will be included in the Development Control Plan.

ItGlossary and Notes

5 Explanatory notes

5.1 Frameworks and tools

Regenerative frameworks:

- One Planet Living - internationally used sustainability framework that also lends itself to regenerative sustainability: https://www.bioregional.com/one-planet-living
- Living Environments in Natural, Social and Economic Systems (LENSES) - specially for regenerative development: https://www.clearabundance.org/lenses/
- Envision – an international framework for assessing sustainability and resilience in infrastructure: https://sustainableinfrastructure.org/envision/overview-of-envision/

Rating tools – precinct scale:

- CCAP Precinct – software for modelling development scenarios against some sustainability metrics: https://kinesis.org/ccap-precinct
- Green Star Communities – sustainability assessments of precinct, neighbourhood and community-scale development: https://new.gbca.org.au/rate/rating-system/communities/

Rating tools- infrastructure:

- The IS Rating Scheme (IS) - Australia's rating system for sustainability in infrastructure: https://www.isca.org.au/is_ratings

Rating tools/ benchmarks - buildings

- Living building challenge – an international rating tool for regenerative buildings: https://living-future.org.au/living-building-challenge/
- Green Star – Australia's sustainable building rating tool, available for a range of building types: https://new.gbca.org.au/rate/green-star/
- BASIX – NSW Government's energy, water and thermal comfort benchmark for residential buildings: https://www.planningportal.nsw.gov.au/basix
- NatHERS – a rating system for the thermal energy efficiency of residential buildings: https://www.nathers.gov.au
- Passive House – an international standard for low energy homes with high thermal efficiency: https://passivehouseaustralia.org
- WELL – an international health and wellbeing standard for buildings, see: https://www.wellcertified.com

5.2 Glossary

Aerotropolis	A metropolitan area where infrastructure, land uses and economy are centred on an airport and includes the outlying corridors, and aviation orientated business and residential development that benefit from each other and their accessibility to the airport.
Aerotropolis Core	This is the central city at the core of the Aerotropolis activity associated with the Airport. The combination of uses, activities, development and places are reliant on and complementary to the operation of a global airport.
Agribusiness	Businesses associated with the production, processing, marketing and distribution of agricultural products, especially at a large and integrated scale.
Agriculture	Generally associated with traditional primary production. It includes the cultivation of land for the growing of crops and breeding of animals.
Agriport	A high-tech food production facility that enables industry collaboration at scale to intensively and sustainably produce fresh value-added high-quality produce and pre-prepared food.
Amenity	The 'liveability' of a place that makes it pleasant and agreeable for individuals and the community. Amenity includes, but is not limited to, the enjoyment of sunlight, views, privacy and quiet.
C&I	Commercial and Industrial waste
C&D	Construction and Demolition waste
CDS	Container Deposit Scheme – current scheme in place in NSW for recovery and recycling of beverage containers
Circular economy	Circular economy is about changing the way we produce, assemble sell and use products to minimise waste, and to reduce our environmental impact. The circular economy can also be great for business; by maximising the use of our valuable resources, and by contributing to innovation, growth, and job creation. (EPA, 2020) – It is a whole-of-system approach that accounts for the full cost and lifecycle of materials and retains the value of materials in the economy for as long as possible, reducing the unsustainable depletion of natural resources and impacts on the environment Looking beyond the current take-make-waste extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles: Design out waste and pollution Keep products and materials in use Regenerate natural systems (Ellen MacArthur Foundation , 2020)
Circular Economy: **Hub** **Design** **Infrastructure**	NSW EPA definitions: A circular economy hub is a collection of businesses that come together on one site and which are located and designed to: maximise the opportunities for the by-products of businesses to be used as a resource (including material, energy, or water) in other business(es) (including within the hub) closing the loop on material use.

	which incorporate circular economy design principles into the buildings and supporting network (including transport/delivery of materials between buildings) to maximise the recycling and reuse of materials which maximise the use of recovered materials in buildings, infrastructure, and the public domain Minimise inefficient transport of used resources Circular economy design is a set of design principles applied to buildings, infrastructure and public domain precincts that maximise the circularity of the materials used in construction. This includes designing in a way where the materials can be easily identified for future recovery; designing buildings and infrastructure so they can be disassembled or demolished in a way that will maximise the value of the recovered materials; designing public spaces and precincts to allow for the separation of waste materials in a way that will maximise their value; designing to maximise the inclusion of recovered materials. For the purpose of transitioning to a circular economy, we wish to prioritise activities/facilities which maximise *re-use, re-purposing and re-manufacturing* of resources and minimise inefficient transport Circular Economy infrastructure focuses on facilities that collect used resources, reuse, repurpose or remanufacture materials and goods, to *retain their productive value* and prevent their disposal to landfill. Examples of circular economy infrastructure includes reuse and repair facilities, sharing and leasing facilities, reverse vending machines, community recycling centres, collection points for producer responsibility schemes, water reuse schemes, material reprocessing and remanufacturing, washing or pelletising facilities, reverse logistics facilities, anaerobic digestion and chemical treatment of waste etc. Circular Economy infrastructure can also include, in certain circumstances, the more 'traditional' waste and resource recovery facilities as defined in the Standard Instrument such as material bulking, storing, sorting, resource recovery facilities, transfer stations, and compost facilities. However, the role of these facilities needs to be clarified as a *supporting* role for facilities to promote higher order 'reuse'.
Climate change	A change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability.
Cogovernance	Cogovernance is a broad concept which includes the roles played by the community sector and the private sector in managing and planning regions and cities. It involves the government, community and private sectors communicating with each other and working together to achieve more than any one sector could achieve on its own.
Community solar	Community solar projects offer an exciting opportunity to get involved in small-scale ethical investment, earning a modest return for member-shareholders, and enabling consumers who may not otherwise be able to put solar on their own roofs to access the benefits of distributed generation.
Consent Authority	The same meaning as in Section 4.5 of the *Environmental Planning and Assessment Act 1979*.
Contaminated land	Land in, on or under which a substance is present at a concentration above that normally present in, on or under (respectively) land in the same locality, being a presence that presents a risk of harm to human health or any other aspect of the environment.
Cumberland Plain Conservation Plan (CPCP)	Will address impacts on biodiversity from urban growth through a conservation program that includes commitments and actions designed to improve ecological resilience and function over the long-term. The CPCP will enable land to be certified for development and areas avoided from development conserved. The CPCP will enhance a network of green spaces, natural and semi-natural systems in Western Sydney.
Development	As per the EP&A Act, development includes any of the following: the use of land; the subdivision of land; the erection of a building; the carrying out of a work; the demolition of a building or work; or any other act, matter or thing that may be controlled by an environmental planning instrument.
Ecologically sustainable development	Same meaning as in Section 6 (2) of the *Protection of the Environment Administration Act 1991*. ecologically sustainable development requires the effective integration of social, economic and environmental considerations in decision-making processes. Ecologically sustainable development can be achieved through the implementation of the following principles and programs:

	the precautionary principle—namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by: careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and an assessment of the risk-weighted consequences of various options, inter-generational equity—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations; conservation of biological diversity and ecological integrity—namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration; improved valuation, pricing and incentive mechanisms—namely, that environmental factors should be included in the valuation of assets and services, such as: polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement; the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste; and environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.
Evapotranspiration	Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.
Floodplain	An area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
Greater Sydney	The local government areas within the boundary shown on the map in the Greater Sydney Region Plan and Schedule 1 of the Greater Sydney Commission Act 2015.
Green Grid	The network of high-quality green spaces and tree lined streets that supports walking, cycling and community access to open spaces. It will provide cool, green links throughout the Aerotropolis and connect more broadly to the Western City District and Greater Sydney.
Green infrastructure	the network of green and blue spaces which includes waterways, bushland, parks, open spaces and tree canopy that are strategically planned, designed and managed to support a good quality of life in an urban environment.
Growth Area	Identified by the NSW Government as major greenfield development or urban renewal areas.
Integrated water cycle management	An approach to the management of water that considers aspects of water including rainwater, stormwater, groundwater, water supply and use, reuse and treatment.
MSW	Municipal Solid Waste
National Airports Safeguarding Framework (NASF)	National land use planning framework to improve community amenity by minimising aircraft noise- sensitive developments near airports and improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions on various safety related issues.

PAYT	Pay as you throw system of waste management – in these models the pricing system to be used depends on the driver for the system. Each system has its own advantages and disadvantages. Some systems might offer greater revenue stability, for example, while others create a stronger waste reduction incentive for residents. There are three types of pricing systems in use under a pay-as-you-throw (PAYT) program: proportional, variable rate, and multi-tiered.
Performance outcome	A general statement of the means of achieving the intent of the applicable objectives of this development control plan.
Permeable surface	A surface that permits or facilitates the infiltration or penetration of water such as grass, landscaping or porous paving.
Precinct planning	Identifies the development intent and development capacity across a precinct by allocating land uses, densities, housing types, built form, infrastructure and environmental and open space.
PPA - Power purchase agreement	A contract between two parties, one which generates electricity (the seller) and one which is looking to purchase electricity (the buyer). The PPA defines all the commercial terms for the sale of electricity between the two parties, including when the project will begin commercial operation, schedule for delivery of electricity, penalties for under delivery, payment terms, and termination.
Public domain	Any publicly or privately owned space that can be accessed and used by the public and/or is publicly visible.
RFID - Radio Frequency Identification	Technology used in SMART city developments e.g. materials recovery, waste bins
Salinity	The salt content in water or soil.
Solar gardens	Solar gardens are an energy system in which a central solar PV system is installed, likely close to residential areas. Customers can lease or buy panels in the 'garden', and a participating retailer credits the energy from those panels against each customer's home electricity bill
State Environmental Planning Policy (SEPP)	Environmental planning instruments that address planning issues of State significance.
State Environmental Planning Policy (Sydney Region Growth Centres) 2006	The environmental planning instrument which sets controls for the North West and South West Growth Areas of Sydney.
Stormwater	Untreated water that originates from rainfall or snow/ice melt and soaks into the ground (infiltrate), is held on the surface and evaporates, or runs off to streams, rivers or other water bodies (surface water).
Streetscape	The character of a street and its close surrounds defined by the spatial arrangement and visual appearance of built and landscape features when viewed from the street.
TOTEX - Total Expenditure Investment	A concept adopted recently within regulated industries which are heavily dependent on infrastructure assets. It looks at both the capital and operating expenditure over the life of the project and serving to assist in making decisions
Urban heat island effect	An agglomeration of hard and dark-coloured surfaces such as roads and roofs which cause excessive localised warming.

Urban typologies	Precinct-scale snapshots of various forms of urban development incorporating built form, roads and subdivision pattern and open space.
WSUD - Water Sensitive Urban Design	A way of planning our cities to minimise water runoff and ensure any runoff causes the least amount of damage. It is also about wise use of that water to improve our urban environment. Cities alter the way water flows through the natural environment.
Western Parkland City	Broadly, Penrith, Liverpool, Campbelltown, Hawkesbury, Wollondilly, Camden, Fairfield and Blue Mountains LGAs, anchored around Liverpool, Greater Penrith and Campbelltown–Macarthur, with the new Airport and Aerotropolis geographically at its centre.
Western Sydney Aerotropolis Plan (WSAP)	A strategic plan that provides the vision, principles and planning framework for the Western Sydney Aerotropolis.
Western Sydney Planning Partnership	A local government-led initiative comprising of representatives of all eight Western Parkland City councils as well as Blacktown Council, and representatives from the NSW Department of Planning, Industry and Environment, Transport for NSW, Sydney Water and the Greater Sydney Commission.
Wianamatta-South Creek Catchment	Includes most of the Cumberland Plain of Western Sydney and is a defining central element of the Western Parkland City and the Aerotropolis.

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