Sydney WATER

Urban Typologies and Stormwater Management

– achieving a cool, green, liveable Western Parkland City

A summary of the Western Parkland City: Urban Typologies and Stormwater Solutions report

(2020: Sydney Water, Bligh Tanner, Architectus)

Wianamatta – Mother Place

'Wianamatta' is the indigenous name for South Creek, meaning 'Mother Place'.

Sydney Water and all those who worked on this report acknowledge the traditional owners of the lands that include the Western Sydney Region and the living culture of the traditional custodians of these lands. We recognise that the traditional owners have occupied and cared for this Country over countless generations and celebrate their continuing contribution to the life of Western Sydney.

Foreword

The NSW Government has a vision for Western Sydney to be a green, liveable and sustainable city offering opportunity, connection and amenity for future communities. *Urban Typologies and Stormwater Management* is another step toward making that vision a reality.

Green infrastructure – such as urban tree canopy, ground cover, bushland, waterways, parks and open spaces – will be valued for its economic, social and environmental benefits. It will help to establish the Greater Sydney Green Grid, a network of walking and cycling links that will become increasingly important in daily travel arrangements, improving sustainability and the wellbeing of residents, while reducing temperatures by well over four degrees on the hottest summer days.

The recent drought reminded us how precious water is as a resource and that, in a sunburnt country like Australia, using it wisely and respectfully should always be on our minds. This report provides planners and developers with a practical guide to designing the city in ways that are water-smart and cost-efficient.

The typologies show how taking a water-led approach to planning the Western Parkland City is both possible and necessary. They demonstrate how straightforward it could be to keep stormwater in the landscape where it can irrigate green and leafy places to keep us cool and connected to our environment and reduce stormwater flows to Wianamatta – the blue spine of our city – preventing erosion, flooding and pollution.

Western Sydney is home to one in 10 Australians and is one of our fastest growing cities. We have an opportunity now to ensure future generations can enjoy a healthy, green and sustainable parkland city and adoption of these urban typologies will help us deliver it.

The Hon. Melinda Pavey, MP
Minister for Water, Property and Housing

Our vision at Sydney Water is to create a better life with world-class water services. It's a vision that fits perfectly with that of the Western Parkland City as a green and liveable place.

As a burgeoning city in its early development, the Western Parkland City presents a unique opportunity to consider how water management can be effectively integrated with the urban form to deliver sustainable outcomes for people and the environment.

Sydney Water's starting point was stormwater and the potential increase in runoff caused by urbanisation. Conventional stormwater retention solutions need a lot of space, which drove us and our partners to think imaginatively about how landscape and built-form could be integrated to retain stormwater in-situ.

Our work has not only addressed the primary challenge of stormwater – runoff is modelled to reduce by around 75% – it has also addressed the broader challenge of urban heat. Adopting the typologies in this report will deliver three and a half times the tree cover in the parkland city and significantly reduce temperatures during summer months.

Planning a parkland city's built-form (the grey) needs to start with the blue and the green. The typologies in this report show how this could be done. They are necessary and they are achievable. We look forward to working with planners, developers and the community to make a green parkland city a reality.

Roch Cheroux
Managing Director,
Sydney Water

The NSW Government's aspirations for a cool and green Western City will require a change in current planning and design practice. Sydney Water is taking an active role in turning these aspirations into reality through contemporary, integrated water cycle planning for Western Sydney.

Urban Typologies and Stormwater Management – achieving a cool, green, liveable Western Parkland City has been developed for the planning and development community, to guide them on new and realistic approaches to landscape led design. Implementing these will enable a cool, green and liveable Western Sydney with healthy waterways, and result in better health outcomes for future communities.

Thank you to our partners Bligh Tanner, Architectus and Mosaic Insights who worked with us on the full report and modelling which sits behind this summary, along with many collaborators from across government and industry. *The Western Parkland City: Urban Typologies and Stormwater Solutions Report* and the *South Creek Urban Cooling Modelling: Draft Technical Report* are available on Sydney Water's website.

Integrated water cycle management is vital to achieving a greener, cooler and liveable Western Parkland City

Sydney Water is working with a range of agencies to plan for projected growth in Western Sydney in line with the government's vision for a liveable, productive and sustainable city. Wianamatta South Creek will be the green spine and centre of amenity for the new community.

Until now, greenfield development in Western Sydney has typically been characterised by sprawling suburbs, large homes, small lots, land clearing and extensive levelling. Continuing this approach to the planning and urbanisation of the Wianamatta South Creek catchment will produce business-as-usual outcomes, including:

- hot urban areas up to 10 degrees hotter than coastal areas of Sydney
- limited tree canopy (10% or less, significantly short of the 40% target for metropolitan Sydney – outlined in the government's *Greener Places* policy)
- erosion of the area's intrinsic landscape character and values resulting in a poor sense of place and local identity
- degradation of the local waterways, remnant vegetation communities and indigenous history and connection
- propensity for compromised physical and mental health outcomes for the future community.

The opportunity to create a new, vibrant and liveable city in a greenfield location is a unique, once-in-a-generation chance to set new benchmarks in urban planning integrated water management. To do this, we need to bring together strategic land use planning and water cycle management to achieve fully integrated water management: 'a process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare, in an equitable manner without compromising the sustainability of vital ecosystems' (Global Water Partnership, 2000).

Adopting the urban typologies and stormwater solutions presented in this report and integrating water cycle management into the earliest stages of strategic land use planning, will enable a cool, green and liveable Western Sydney with healthy waterways.

The outcomes presented challenge a business-as-usual approach, but are not unachievable or unrealistic, and they promise some fantastic benefits to future workers and residents.

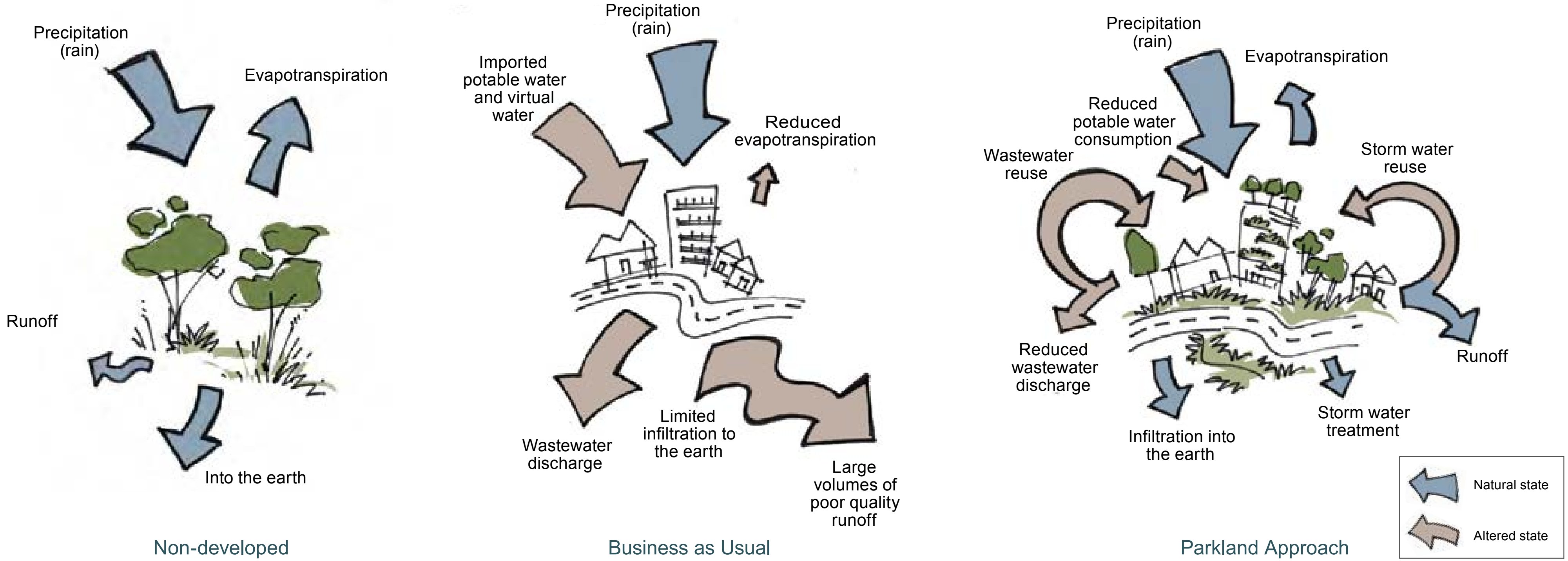
Waterway health – why is it important?

The waterways of Wianamatta South Creek are essential for the realisation of the Western Parkland City and provide the main landscape feature to orientate the urban form, narrative and identity. Along with the green bankside corridors, the creeklines provide the linking of local destinations, alignment of recreational activities and the ecological core of the natural environment.

The waterways of Wianamatta South Creek currently have a range of ecological values. Populations of native birds, fish, turtles, reptiles and mammals still thrive within parts of the catchment. Existing residential communities identify with the creeks and their values.

The projected urbanisation of the catchment will drastically increase the flow of stormwater into the waterways of Wianamatta South Creek. In the long term, this will destabilise the creeklines causing ongoing erosion, degrading waterway health. In a business-as-usual urban development scenario, the creeks will become drains stabilised by concrete or other hard structures, losing much of their ecological and landscape values.

Without these core natural features, the government's vision for a cool, green parkland city will not be realised.



Water sensitive urban design (WSUD) water balance. Trees can positively impact the water balance in an urbanised context

The risk-based framework for waterway health

In 2017, the NSW Government released *The Risk Based Framework for Considering Waterway Health Outcomes in Strategic Land Use Planning Decisions* (the Risk Based Framework) to improve the management of waterways across the state.

The Wianamatta South Creek catchment is a long, ephemeral waterway system, where the flow volume reaching the waterways is critical to their long term health. Reducing the flow of stormwater into these delicate systems will also effectively reduce pollutant loads and improve water quality.

The Department of Planning, Industry and Environment (DPIE) is finalising waterway health objectives and targets for the Wianamatta South Creek catchment which will detail a combination of flow and water quality elements. Maintaining the flow of water into the Wianamatta South Creek system close to existing conditions, would ensure the form and ecological function of the waterway is retained.

To maintain the same conditions, development would need to achieve a runoff volume of around 0.9 megalitres per hectare per annum. This is a reduction of approximately 75% of typical urban runoff and requires innovative approaches to urban form and stormwater management infrastructure. The urban typologies provide planning solutions that help stakeholders consider how best to achieve flow reduction.

Tools for urban stormwater management

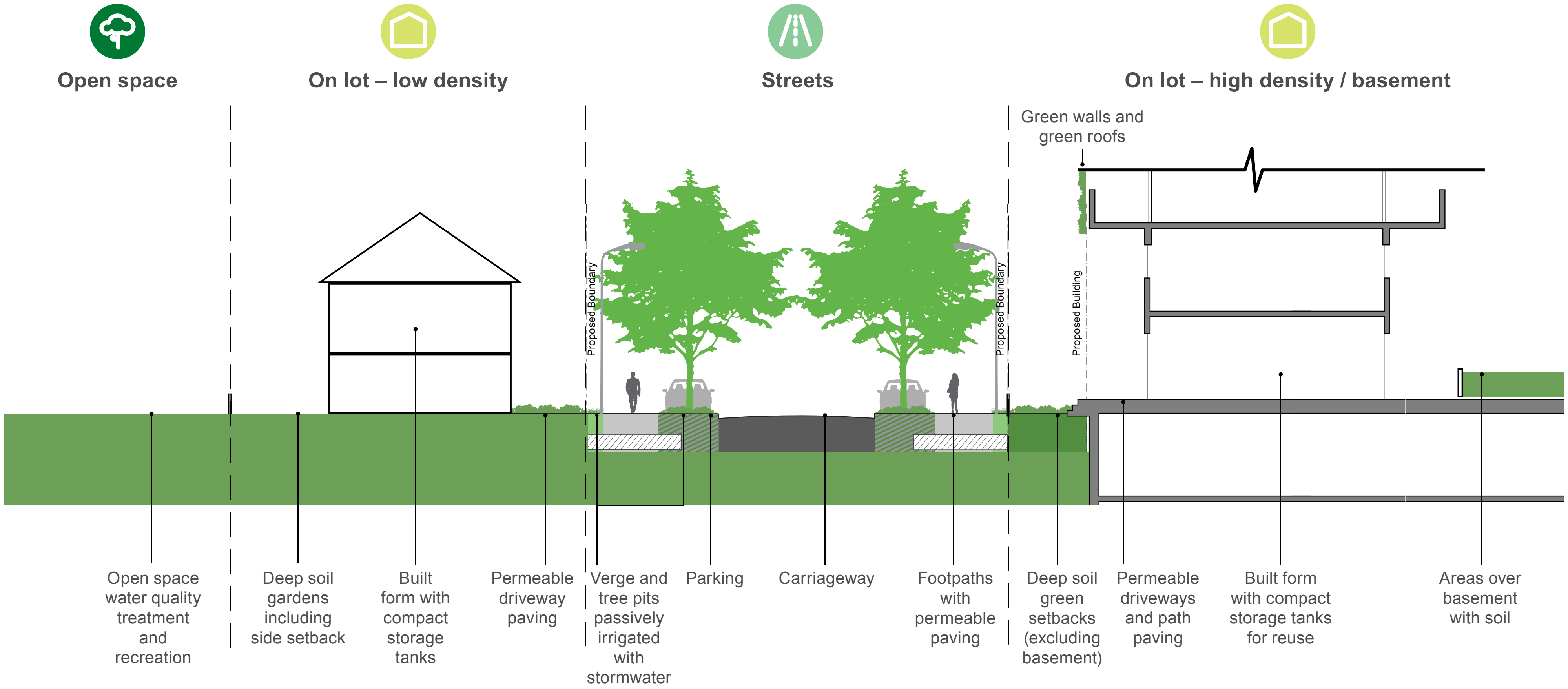
In the Wianamatta South Creek catchment, stormwater management solutions must not only slow down stormwater flow but also capture and prevent it from reaching the waterway system. The solutions are relatively simple:

- On lots – compact construction, deep soil areas, downpipe diverters, storage tanks, permeable pavements, green walls and roofs.
- On streets – street trees connected to stormwater drainage for passive irrigation and bioretention systems.
- Open spaces – bioretention, trees and wetlands.

Applicable locations for stormwater strategies

		Lots	Streets	Open space
1	Preserve and maintain waterways and riparian areas	X		
2	Urban design/housing design	X		X
3	Erosion and sediment control			X
4	Permeable paving	X		
5	Rainwater tanks	X		
6	Downpipe diverters	X		
7	Green roofs	X		
8	Street sweeping		X	
9	Litter control		X	
10	Gully baskets		X	X
11	Vegetated swales			X
12	Gross pollutant traps			X
13	Wetlands			X
14	Floating wetlands			X
15	Bioretention (raingardens)	X	X	X
16	Wianamatta Street Trees		X	X
17	Proprietary filtration devices	X	X	X

To mitigate the impacts of stormwater runoff, several measures can be combined to provide an effective solution. Harvesting stormwater can be used for both landscape and internal uses reducing the demand on potable water sources.



The importance of street trees

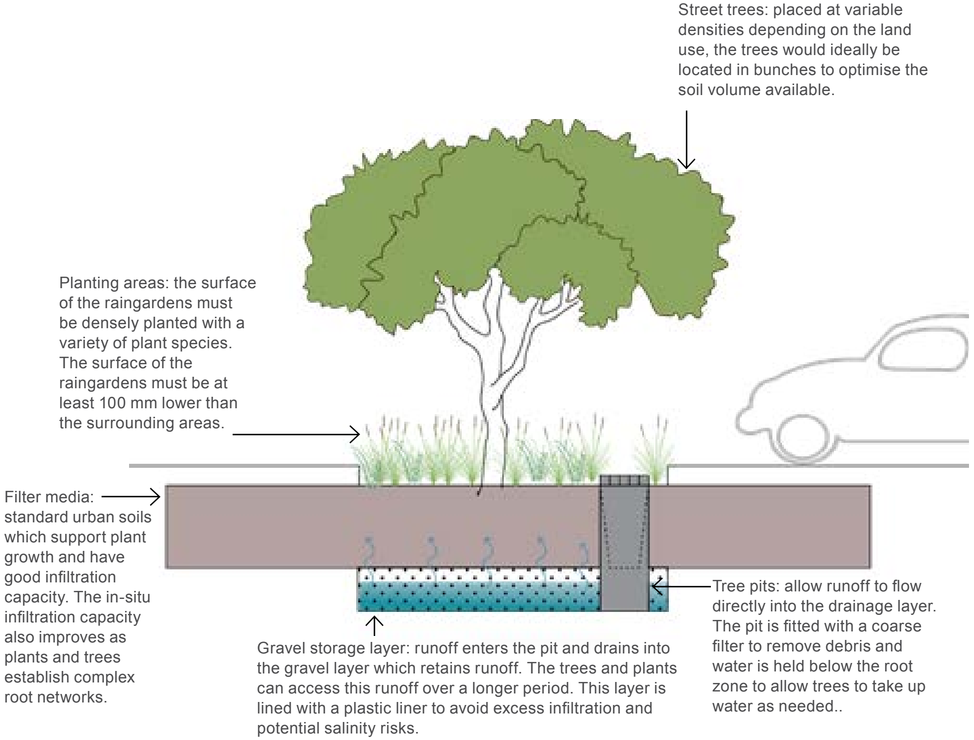
Street trees have multiple purposes in the urban form including greening, cooling and habitat. However, the value they can add to stormwater management systems is often understated.

Traditional street trees, particularly in Western Sydney, are often heat-stressed, have limited access to nutrients and water and sustain root damage due to construction and service trenches which can limit their uptake of water. A more sustainable solution to achieve healthy street trees is passive irrigation through connection to the stormwater drainage system. If a recycled water network is also available, design can incorporate connection to the street drainage system for irrigation of street trees during periods of low rainfall or drought.

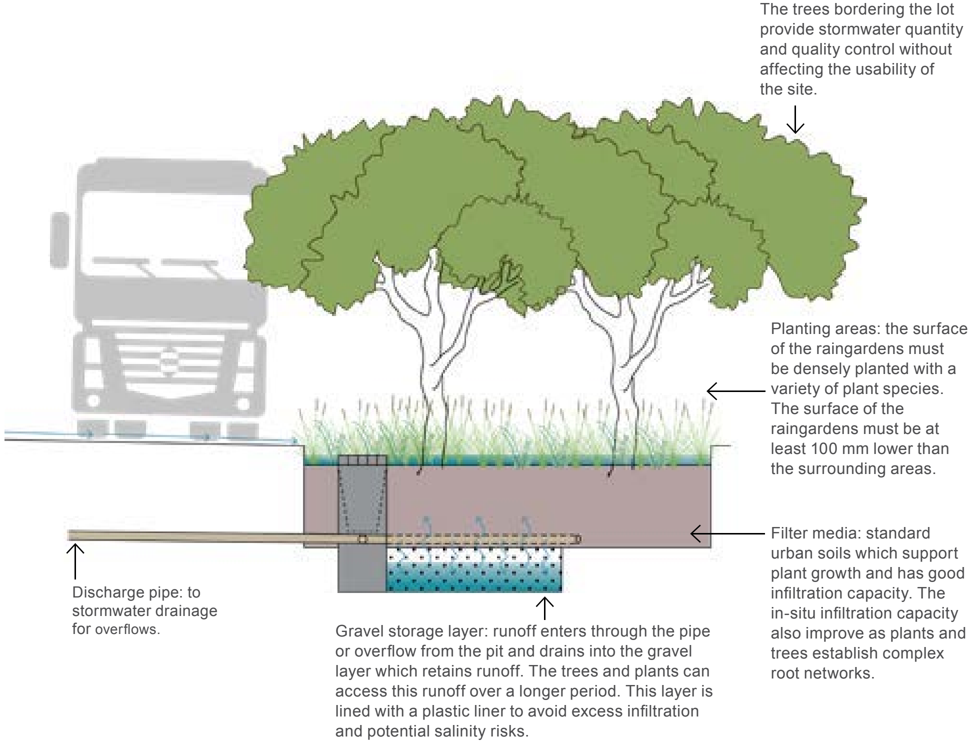
This approach not only provides a source of water for healthy street trees, but allows nutrients in stormwater to be sequestered by the trees, rather than discharged to waterways.

Wianamatta Street Trees

A street tree designed specifically for Western Sydney is required to respond to the unique landscape characteristics and address objectives for water management, greening and cooling. The Wianamatta Street Tree is connected to the stormwater system to allow for passive irrigation, optimising tree health and capturing urban stormwater for reuse and nutrient take up. The trees are planted within pits with gravel beds and lining to ensure minimal subsurface infiltration as shown in the residential and employment area figures below. The additional cost of the gravel bed and pit components have been estimated at $2,000 per lot. Cost-efficiencies could also be created if several trees were planted within the same garden bed with a singular pit.



Wianamatta Street Tree – residential areas



Wianamatta Street Tree – employment areas

Wianamatta Street Trees artist impression, Bligh Tanner (2020)

Wianamatta Street Trees artist impression, Bligh Tanner (2020)

Urban salinity

Salinity occurs when salts naturally found in soil or groundwater mobilise, allowing capillary rise and evaporation to concentrate the salt at the ground's surface. Such movements are caused by changes in the natural water cycle. In these areas, activities, infrastructure and resources on and above the soil surface may be affected. Potentially, salinity in urban areas could also place additional stress on remnant natural areas such as bushland, wetlands, rivers and creeks.

Traditionally, infiltration and uncontrolled discharge of stormwater is not recommended practice in saline landscapes because it creates a mechanism for existing salts to be mobilised and transported to sensitive receptors.

However, the impact of urban stormwater on the hydrology of waterways is being increasingly recognised as a critical factor that can contribute to the degradation of their ecological values. In the context of Wianamatta South Creek, avoidance of any stormwater infiltration is highly likely to result in poor waterway health outcomes.

Salinity has been a key consideration in the development of the typologies with several responses incorporated into the urban form and street tree design to mitigate salinity risk. With consideration of local conditions and constraints through the strategic planning process, practical and effective solutions can be developed to manage salinity across the catchment whilst still addressing stormwater management and waterway health objectives.

Strategic planning offers a valuable opportunity to develop evidence based, landscape scale strategies for adequately managing salinity. Site and landscape specific evidence can be used to develop meaningful and measurable controls to ensure salinity risk is effectively managed as urbanisation occurs in the Wianamatta South Creek catchment.

Urban typologies

To explore the extent to which the urban environment can retain stormwater towards the waterway health targets, a series of urban typologies have been developed depicting roads, open space, subdivision pattern and built form at a block scale. Seven different land uses were modelled in the typologies to reflect the likely range of development that could occur across the Wianamatta South Creek catchment.

The typologies show the:

- interactions between planning, design and development processes and water cycle management
- design impacts of the measures needed to achieve the waterway health target
- extent to which changes and innovations are required to current development practice
- planning and policy opportunities and barriers to delivering a new model of integrated urban development and stormwater management.

The key outputs of the urban typologies and stormwater management work include:

- an evidence base for an alternative approach to urban stormwater management which integrates urban form and water management to optimise waterway health outcomes in the context of the *Risk Based Framework*
- principles and assumptions for use in modelling and water service planning for the Western Parkland City that are consistent with the *Western Sydney Street Design Guidelines*, Western Sydney Planning Partnership (WSPP), 2020.
- scaleable planning tools which can be applied through strategic planning processes to ensure urban waterways are protected, water is used efficiently and streets are green and cool
- recommended planning and development controls to facilitate delivery of the required water management outcomes.

The typologies cover a range of commercial, industrial and residential development and are intended to be used as tools in the strategic planning of new development in the Western Parkland City.

Employment typologies

Commercial office

Development in the Wianamatta South Creek catchment will need to accommodate a range of businesses in contemporary formats, from small offices to larger floorplate and multi-storey building typologies accommodating national and international businesses with large workforces. Strategies have been applied to commercial office development to retain and reuse stormwater and contribute to broader greening and cooling objectives.

Strategy 1: business park – increased deep soil setbacks and planting

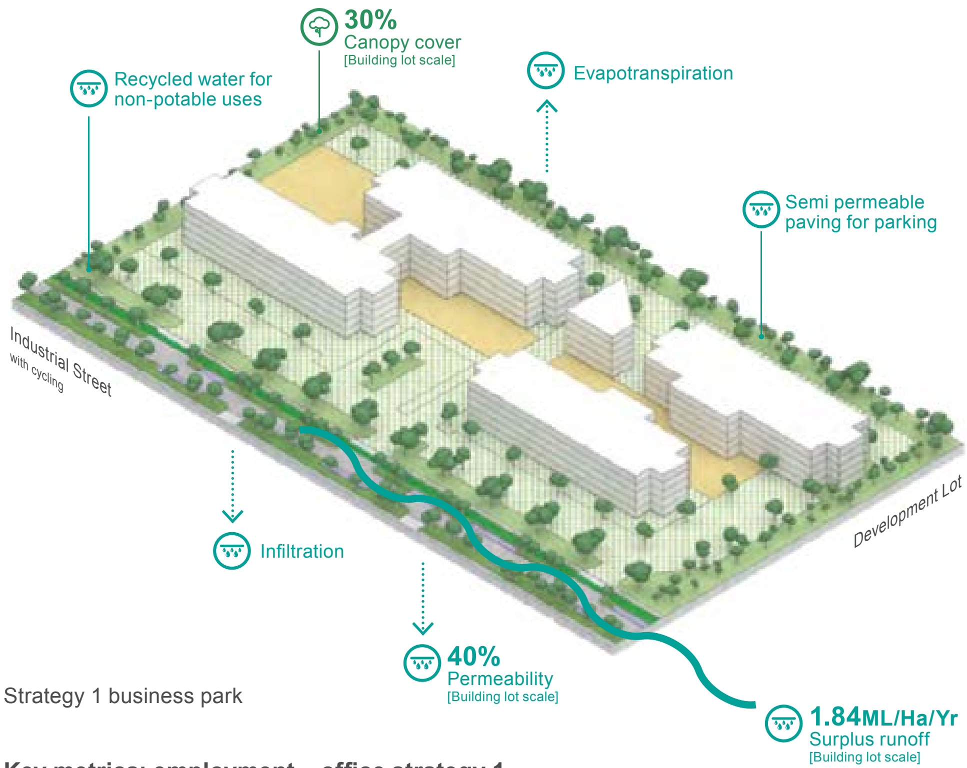
Use of deep soil and substantial trees to add greening and canopy cover as well as permeability.

Typology overview:

- Large floor plate commercial office campus
- Internal road + parking network
- On grade + basement car parking
- Hardstand areas including loading areas and parking (50% permeable assumed)
- Opportunity to use green walls and/or roofs to provide greening and water capture/loss.

Blocks + streets

Stormwater management strategies



Strategy 1 business park

Key metrics: employment – office strategy 1

Lot size	Approx. GFA	Approx. FSR
40,652m²	48,816m²	1.20:1

Permeable surfaces	Permeability	Area
Deep soil	100%	8000m² (20%)
Parking hardstand	50%	13350m² (33%)
Service hardstand	50%	3027m² (7%)
Building site coverage	0%	10170m² (25%)
Non building hardstand	0%	6105m² (15%)
	Total	40652m²

Key metrics

Density	1.20	FSR (x:1) [Building lot scale]
	0.88	FSR (x:1) [Urban typology scale]
Green	37	% canopy cover [Block+street scale]
Water	40	% permeability [Block+street scale]
	1.84	ML/Ha/Yr surplus runoff [Block+street scale]
	40	kL rainwater tank [per building lot]
	12	% sponge area [per building lot]
	37	Wianamatta Street Trees [per building lot]

Precedent

Macquarie Business Park, Macquarie Park

Aerial view

Courtyard elevation

Strategy 2: urban office – deep soil setbacks and planting

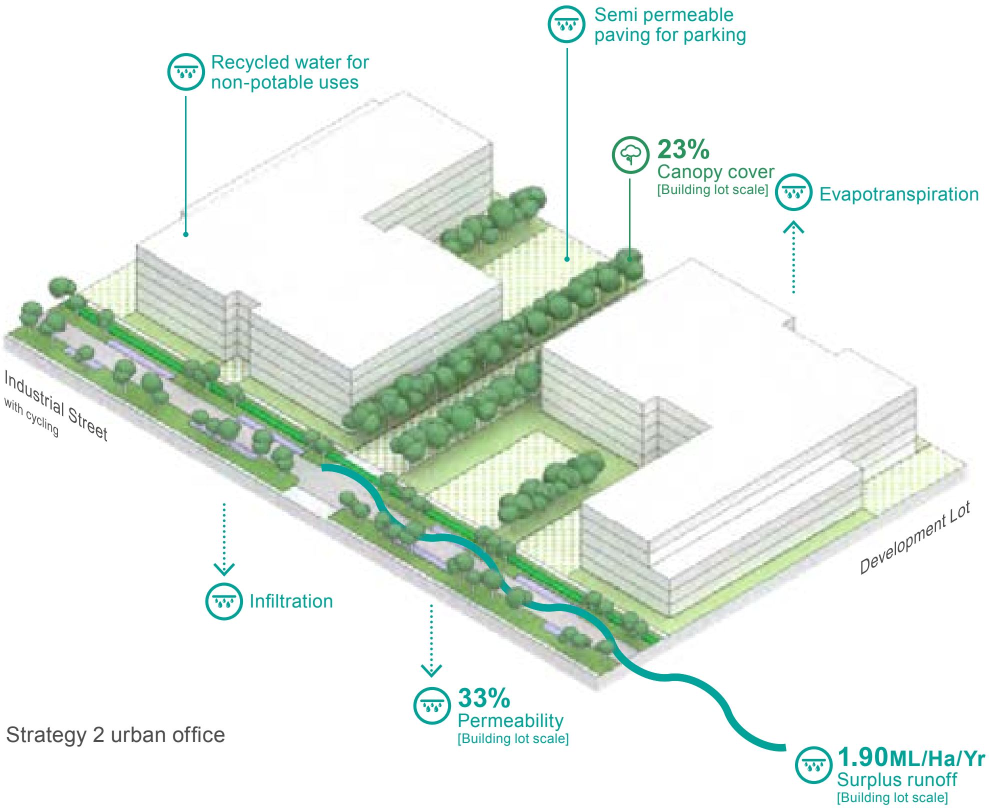
Low rise, large floorplate campus style buildings on a single site, with no at grade parking.

Typology overview:

- Low-rise, large floorplate campus style buildings
- Suitable for academic, commercial and research purposes
- Typically no taller than five storeys
- Underground parking/loading
- Extremely deep floorplates up to 30m (acceptable to technology/ laboratory uses)
- Supersized 200mx100m lots
- Opportunity to use green walls and/or roofs for greening and water capture/loss.

Blocks + streets

Stormwater management strategies



Strategy 2 urban office

Key metrics

Density	2.01	FSR (x:1) [Building lot scale]
	1.48	FSR (x:1) [Urban typology scale]
Green	31	% canopy cover [Block+street scale]
Water	34	% permeability [Block+street scale]
	1.90	ML/Ha/Yr surplus runoff [Block+street scale]
	40	kL rainwater tank [per building lot]
	12	% sponge area [per building lot]
	36	Wianamatta Street Trees [per building lot]

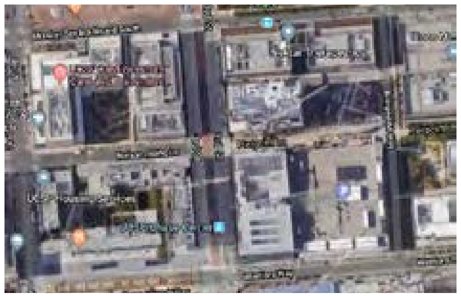
Key metrics: employment – office strategy 2

Lot size	Approx. GFA	Approx. FSR
20,000m²	40,168m²	2.01:1

Permeable surfaces	Permeability	Area
Deep soil	100%	4,003m² (20%)
Parking hardstand	50%	5,121m² (26%)
Service hardstand	50%	0m² (0%)
Building site coverage	0%	10,876m² (54%)
	Total	20,000m²

Precedent

Mission Bay, San Francisco



Aerial view

Street view

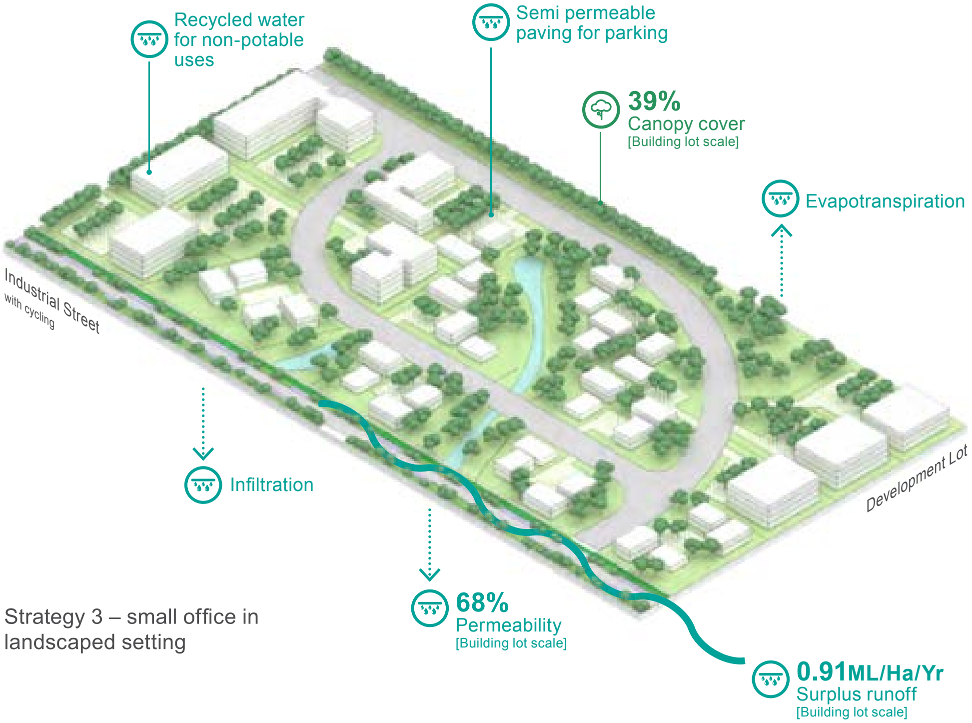
Strategy 3: small office in landscaped setting

A high amenity setting for small businesses with large areas of open space and permeable on grade car parking.

Typology overview:

- Variable size commercial office spaces including small footprint domestic scale buildings in landscape setting, including riparian zones
- Assumed 18m wide street (WSPP, 2020)
- Building heights ranging from 1-5 storeys
- On grade car parking for small buildings, larger buildings could incorporate basement car parking
- Hardstand areas including loading areas and parking (50% permeable assumed)
- Opportunity to use green walls and/or roofs for greening and water capture/loss.

Blocks + streets
Stormwater management strategies



Strategy 3 – small office in landscaped setting

Key metrics		
Density	0.47	FSR (x:1) [Building lot scale]
	0.35	FSR (x:1) [Urban typology scale]
Green	44	% canopy cover [Block+street scale]
Water	62	% permeability [Block+street scale]
	0.91	ML/Ha/Yr surplus runoff [Block+street scale]
	40	kL rainwater tank [per building lot]
	6	% sponge area [per building lot]
	80	Wianamatta Street Trees [per building lot]

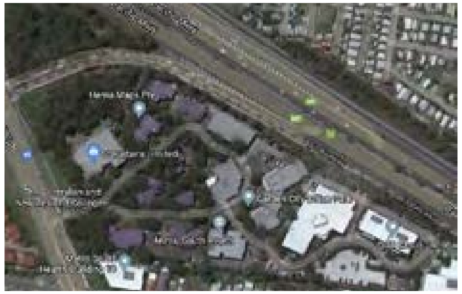
Key metrics: employment – office strategy 2

Lot size	Approx. GFA	Approx. FSR
81,572m²	38,535m²	0.47:1

Permeable surfaces	Permeability	Area
Deep soil	100%	47,191m² (58%)
Parking hardstand	50%	17,208m² (21%)
Service hardstand	50%	0m² (0%)
Building site coverage	0%	17,173m² (21%)
	Total	81,572m²

Precedent

Garden City Office Park, QLD



Aerial view

Street view

Industrial

Strategy 1: large floorplate warehousing

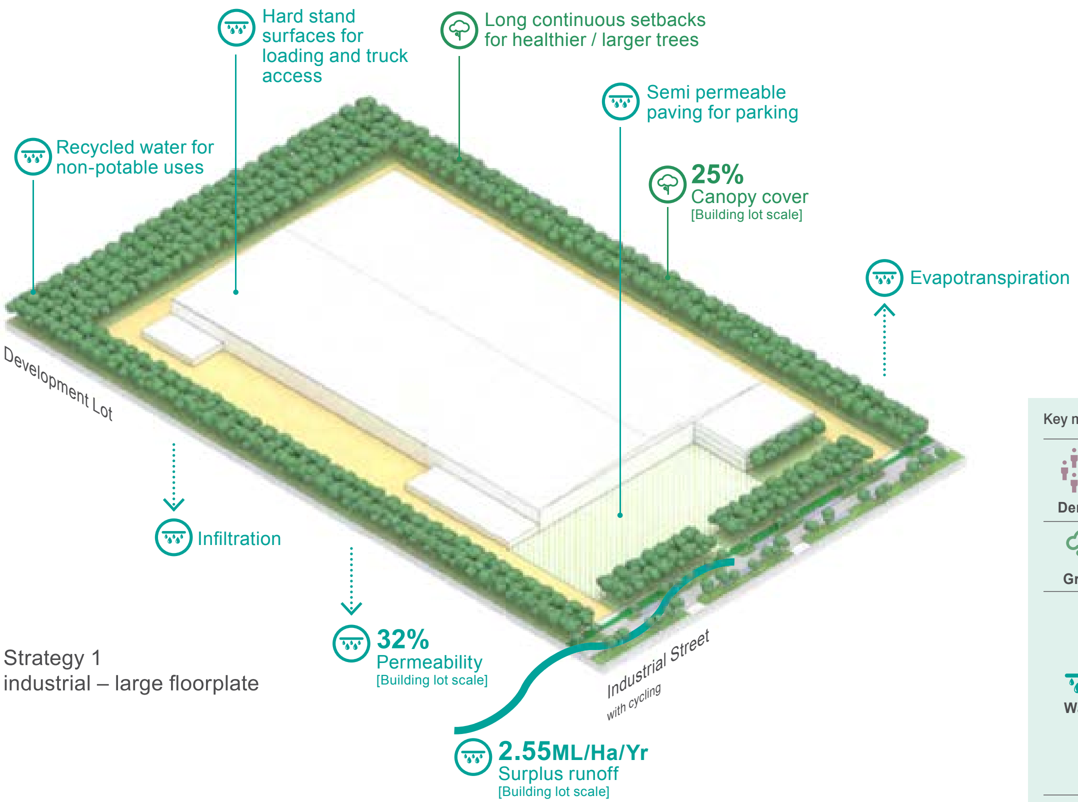
Increasing the permeability of typical large format uses through permeable paving and asphalt and boundary vegetation.

Typology overview:

- Single storey factory/warehouse with upper storey office
- Lightweight tilt-up + roof frame construction
- On grade car parking
- Hardstand areas including loading areas and parking (50% permeable assumed)
- Opportunity to use on site storage tanks to capture and release water on building roof to provide evaporative cooling and water loss to the atmosphere.

Blocks + streets

Stormwater management strategies



Strategy 1
industrial – large floorplate

Key metrics		
Density	0.61	FSR (x:1) [Building lot scale]
	0.47	FSR (x:1) [Urban typology scale]
Green	32	% canopy cover [Block+street scale]
Water	34	% permeability [Block+street scale]
	2.55	ML/Ha/Yr surplus runoff [Block+street scale]
	0	kL rainwater tank [per building lot]
	8	% sponge area [per building lot]
	53	Wianamatta Street Trees [per building lot]

Key metrics: employment – office strategy 2

Lot size	Approx. GFA	Approx. FSR
61,000m²	37124m²	0.61:1

Permeable surfaces	Permeability	Area
Deep soil	100%	9330m² (15%)
Parking hardstand	50%	6279m² (10%)
Service hardstand	50%	14446m² (24%)
Building site coverage	0%	30929m² (51%)
	Total	61000m²

Precedent

Warehouse, Marsden Park

Aerial view

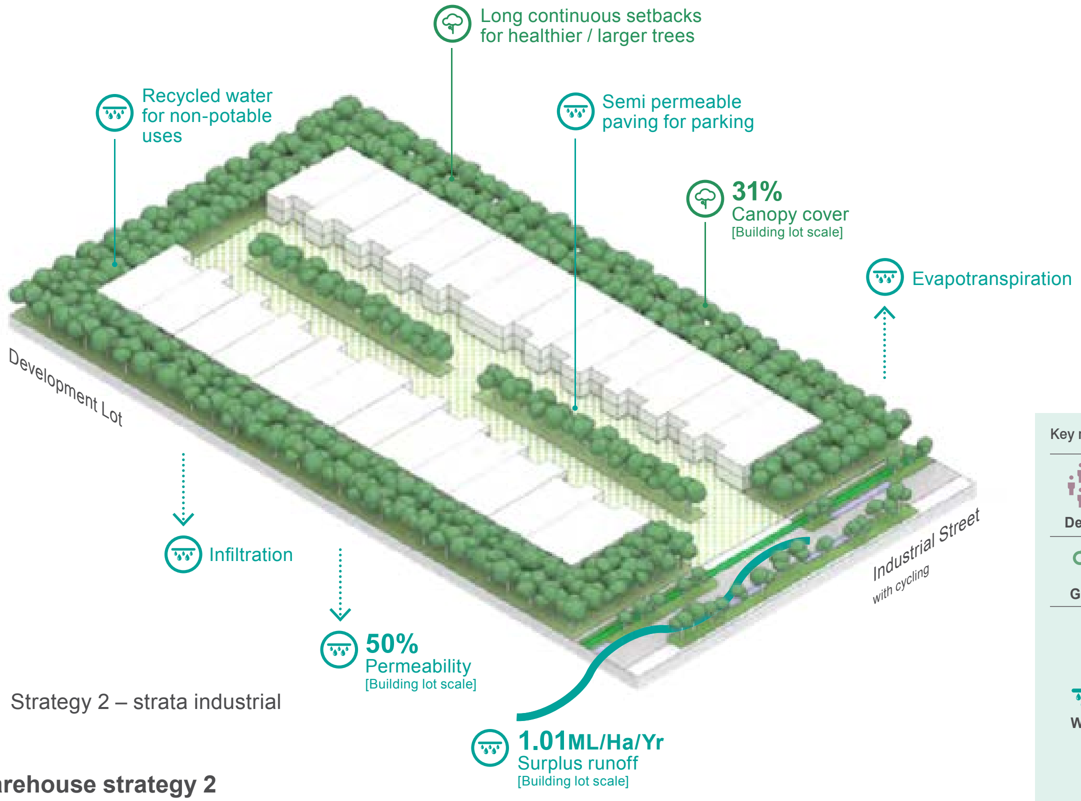
Street elevation

Strategy 2: strata industrial

Increasing permeability through perimeter planting and permeable paving.

Blocks + streets

Stormwater management strategies



Strategy 2 – strata industrial

Typology overview:

- One to two storey unit complexes for light industrial use
- Lightweight tilt-up + roof frame construction
- On grade car parking
- Hardstand areas including loading areas and parking (50% permeable assumed)
- Double row of planted tees to side boundaries.

Key metrics

Density	0.69	FSR (x:1) [Building lot scale]
	0.53	FSR (x:1) [Urban typology scale]
Green	37	% canopy cover [Block+street scale]
Water	48	% permeability [Block+street scale]
	1.01	ML/Ha/Yr surplus runoff [Block+street scale]
	0	kL rainwater tank [per building lot]
	25	% sponge area [per building lot]
	73	Wianamatta Street Trees [per building lot]

Key metrics: employment – indusrial and warehouse strategy 2

Lot size	Approx. GFA	Approx. FSR
26,460m²	18,180m²	0.69:1

Permeable surfaces	Permeability	Area
Deep soil	100%	10,115m² (38%)
Parking hardstand	50%	6,242m² (24%)
Service hardstand	50%	0m² (0%)
Building site coverage	0%	10,103m² (38%)
	Total	26,460m²

Precedent

Newington, NSW

Aerial view

Street view

Apartments

There are two simple solutions for optimising perviousness and stormwater retention in apartment developments:

- Technology and greater soil depths within traditional typologies – increasing soil depth over basements (if provided), permeability and technologies around water retention and reuse beyond existing standard practice.
- Greater open space – large courtyards, setbacks or separate open space to maximise perviousness and deep soil presents significant benefits for tree canopy, amenity, long term flexibility without basements and improved building performance (potentially 50% more trees and configurations with almost 100% solar access and cross ventilation to apartments of around three to five storeys).

An alternative apartment typology consisting of small apartment blocks with parking courts (strategy 3), presents opportunities for the parkland city to offer a diversity of apartment style housing without the need for basement carparking. Separate parking structures or ground floor parking within buildings could also be accommodated in the typologies shown.

Strategy 1: courtyard deep soil zone

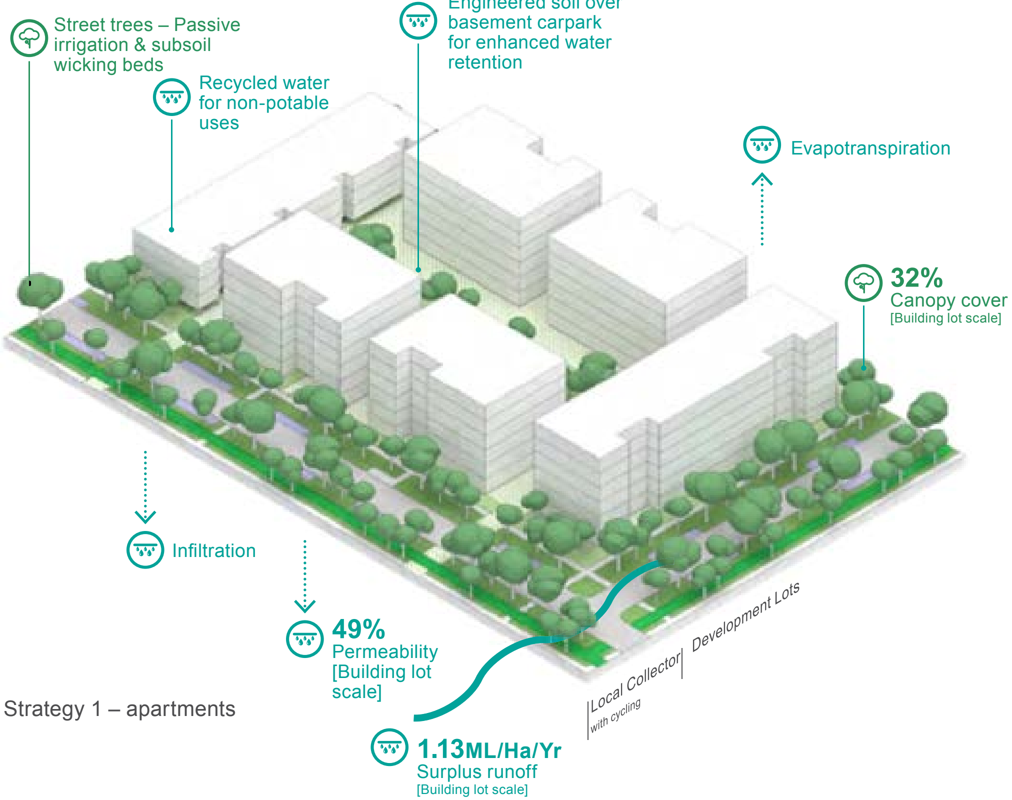
Central deep soil space at the heart of a block including large trees.

Typology overview:

- Three storey walk-up + 6 storey apartments
- Cottage construction + commercial construction
- Basement car parking below grade assumed in metrics. Parking within envelopes would improve permeability however would require increased building heights to achieve the same floorspace
- Mid-block through site link (7m)
- Through site link under community title (50% permeable assumed)
- Deep soil courtyard to achieve the *Apartment Design Guide* (2015) requirements
- Opportunity to use green walls and/or roofs for greening and water capture/loss.

Blocks + streets

Stormwater management strategies



Strategy 1 – apartments

Key metrics		
Density	109	Dwellings per hectare
	208	Residents per hectare [Urban typology scale]
	1.94	FSR (x:1) [Building lot scale]
	1.09	FSR (x:1) [Urban typology scale]
Green	27	m² of open space [per building lot]
	49	% canopy cover [Block+street scale]
Water	43	% permeability [Block+street scale]
	1.13	ML/Ha/Yr surplus runoff [Block+street scale]
Stormwater	80	kL rainwater tank [per building lot]
	x	m² sponge area [per building lot]
	27	Wianamatta Street Trees [per building lot]

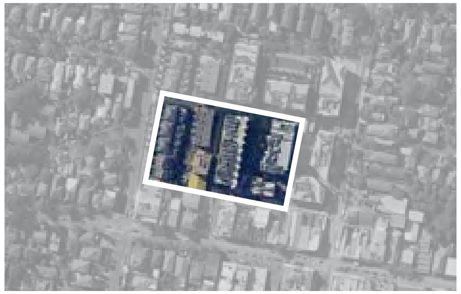
Key metrics: apartments – strategy 1

Lot size	Approx. GFA	Approx. FSR
8400m²	16,326m²	1.94:1

Permeable surfaces	Permeability	Area
Deep soil (<6m width)	100%	1138m² (15%)
Deep soil (>6m width)	100%	767m² (8%)
Non-dwelling surfaces	50%	2080m² (25%)
Dwelling site coverage	0%	3045m² (36%)
Elevated dwellings	100%	900m² (11%)
	Total	8400m²

Precedent

Balgowlah mixed use development



Aerial view

Courtyard elevation

Strategy 2: deep soil front setbacks

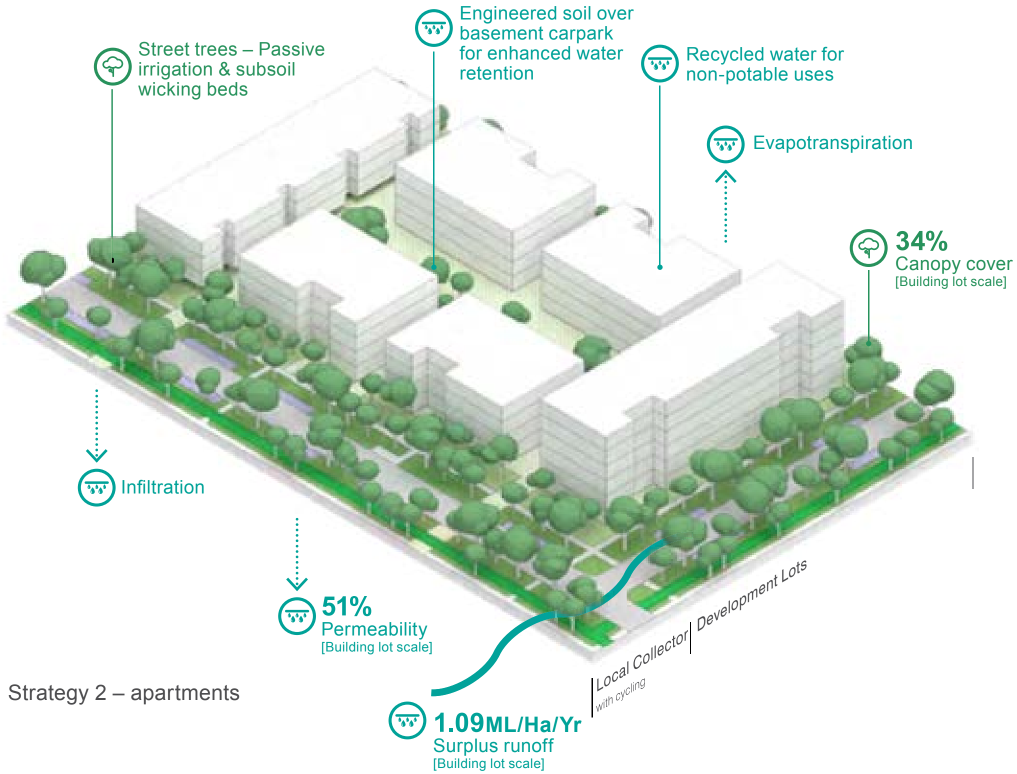
Six metre wide deep soil perimeter setback.

Typology overview:

- Three storey walk-up + 4-6 storey apartments
- Cottage construction + commercial construction
- Basement car parking below grade assumed for metrics. Higher permeability can be achieved with in-building parking
- Mid-block through site link (7m)
- Through site link under community title (50% permeable assumed)
- Six metre perimeter setback to achieve the *Apartment Design Guide* (2015) requirements
- Opportunity to use green walls and/or roofs for greening and water capture/loss.

Blocks + streets

Stormwater management strategies



Strategy 2 – apartments

Key metrics

Density	87	Dwellings per hectare
	165	Residents per hectare [Urban typology scale]
Green	1.54	FSR (x:1) [Building lot scale]
	0.87	FSR (x:1) [Urban typology scale]
	32	m² of open space [per building lot]
Water	45	% permeability [Block+street scale]
	1.09	ML/Ha/Yr surplus runoff [Block+street scale]
	80	kL rainwater tank [per building lot]
	308	m² sponge area [per building lot]
	27	Wianamatta Street Trees [per building lot]

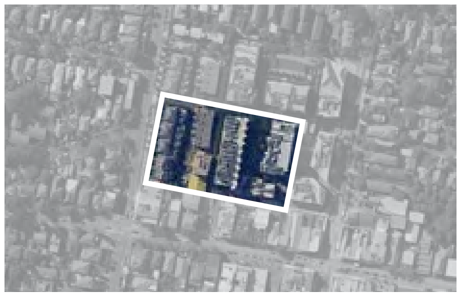
Key metrics: apartments – strategy 2

Lot size	Approx. GFA	Approx. FSR
8400m²	12,954m²	1.54:1

Permeable surfaces	Permeability	Area
Deep soil (<6m width)	100%	0m² (0%)
Deep soil (>6m width)	100%	1942m² (22%)
Non-dwelling surfaces	50%	2899m² (35%)
Dwelling site coverage	0%	2659m² (32%)
Elevated dwellings	100%	900m² (11%)
Total		8400m²

Precedent

Balgowlah mixed use development



Aerial view

Courtyard elevation

Strategy 3: parking courts

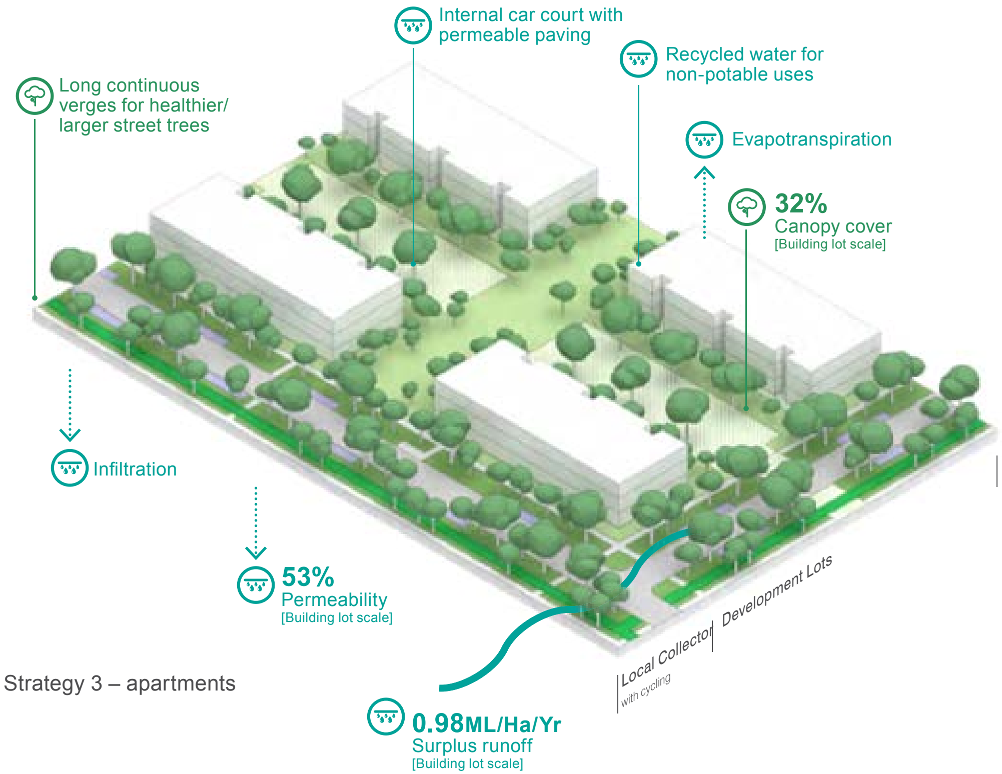
Use of permeable parking courts as both an aid to increasing permeability and reducing development costs associated with basement parking.

Typology overview:

- Three storey walk-up developments (no lifts)
- Domestic/ cottage construction
- Car court style parking located between buildings with permeable pavements
- Linear park located on a mid-block spine
- Community title linear park (100% permeable assumed) 10.5m width
- Opportunity to use green walls and/or roofs for greening and water capture/loss.

Blocks + streets

Stormwater management strategies



Strategy 3 – apartments

Key metrics		
Density	46	Dwellings per hectare
	87	Residents per hectare [Urban typology scale]
	0.81	FSR (x:1) [Building lot scale]
	0.46	FSR (x:1) [Urban typology scale]
Green	58	m² of open space [per building lot]
	49	% canopy cover [Block+street scale]
Water	46	% permeability [Block+street scale]
	0.98	ML/Ha/Yr surplus runoff [Block+street scale]
	80	kL rainwater tank [per building lot]
	308	m² sponge area [per building lot]
	27	Wianamatta Street Trees [per building lot]

Key metrics: apartments – strategy 3

Lot size	Approx. GFA	Approx. FSR
7665m²	6,840m²	0.81:1
735m² (community title)		

Permeable surfaces	Permeability	Area
Deep soil (<6m width)	100%	1370m² (18%)
Deep soil (>6m width)	100%	1370m² (18%)
Non-dwelling surfaces	50%	1950m² (25%)
Dwelling site coverage	0%	2975m² (39%)
	Total	7665m²

Precedent

Vikkii eco-housing, Finland

Aerial view

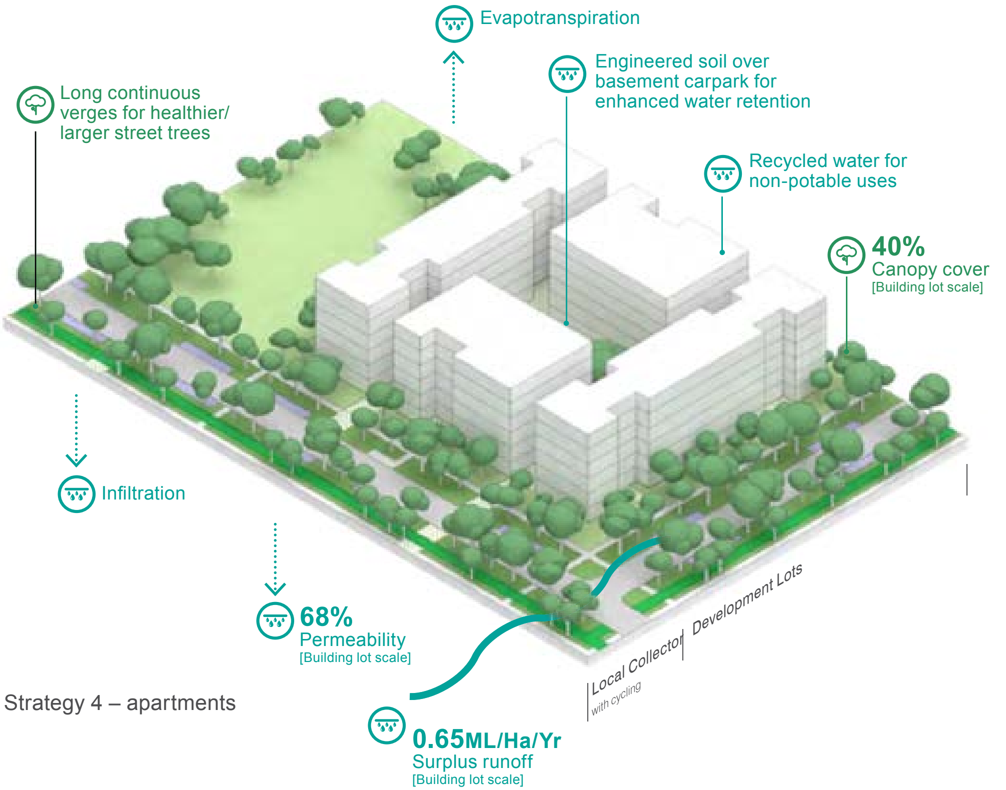
Street elevation

Strategy 4: apartments to public park

Use of a public open space to increase permeability and minimise the overall building footprint on the site.

Blocks + streets

Stormwater management strategies



Strategy 4 – apartments

Key metrics

Density	78	Dwellings per hectare
	149	Residents per hectare [Urban typology scale]
	1.40	FSR (x:1) [Building lot scale]
	0.78	FSR (x:1) [Urban typology scale]
Green	48	m² of open space [per building lot]
	54	% canopy cover [Block+street scale]
Water	55	% permeability [Block+street scale]
	0.65	ML/Ha/Yr surplus runoff [Block+street scale]
	80	kL rainwater tank [per building lot]
	308	m² sponge area [per building lot]
	27	Wianamatta Street Trees [per building lot]

Typology overview:

- Basement car parking below grade
- Linear park located on a mid-block spine 18m
- Central courtyard and perimeter with deep soil to maximise perviousness.

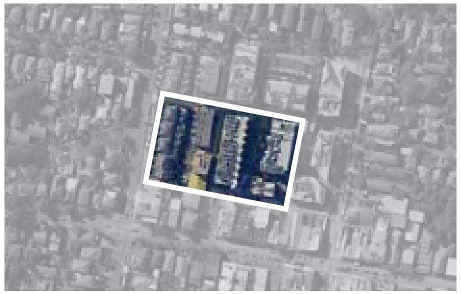
Key metrics: apartments – strategy 4

Lot size	Approx. GFA	Approx. FSR
5498m²	11727m²	1.40:1
2902m² (community title)		

Permeable surfaces	Permeability	Area
Deep soil (<6m width)	100%	1828m² (33%)
Deep soil (>6m width)	100%	0m² (0%)
Non-dwelling surfaces	50%	1250m² (23%)
Dwelling site coverage	0%	2420m² (44%)
	Total	5078m²

Precedent

Balgowlah mixed use development



Aerial view

Courtyard elevation

Mixed use

Strategy 1: high-density shop top housing

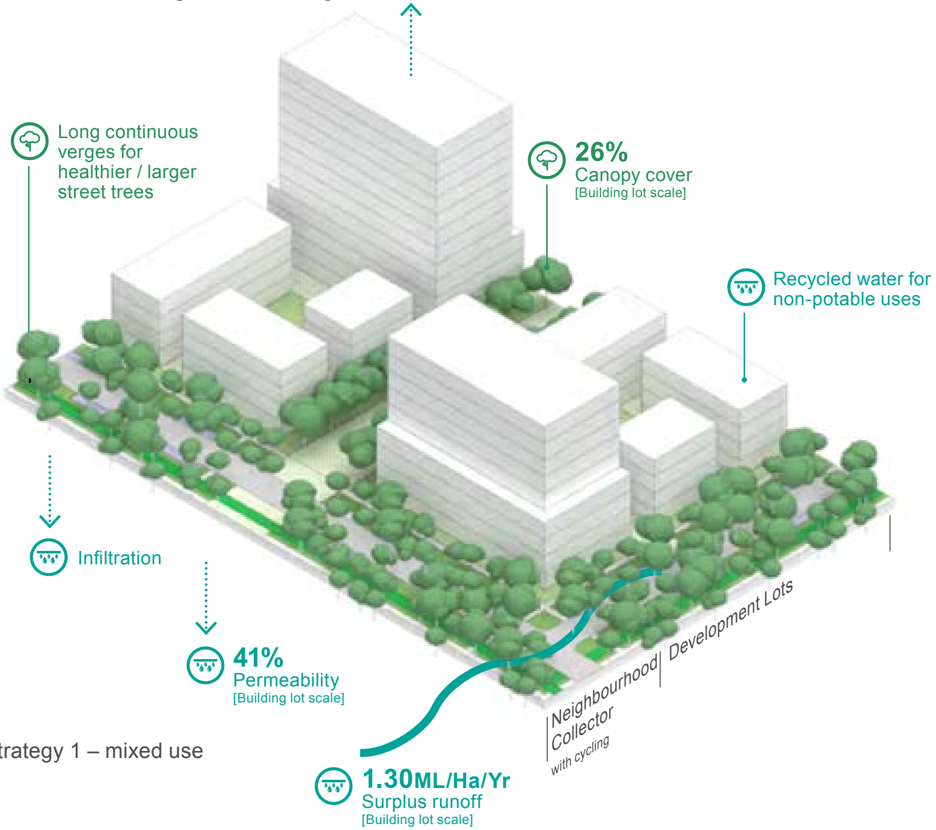
High-density housing scheme for use within centres and around transport nodes.

Typology overview:

- High-density shoptop housing up to 12 storeys, 4-6 storey podium
- Courtyard shape arrangement
- Private open space bisected with community title
- Basement parking assumed for metrics however higher outcomes achievable with decoupled parking or parking in building structures
- Typical building depths 15-20m
- Smaller buildings capable of supporting town/terrace houses.
- Opportunity for green walls and/or roofs to provide greening and water capture/loss.

Blocks + streets

Stormwater management strategies



Strategy 1 – mixed use

Key metrics

Density	152	Dwellings per hectare
	289	Residents per hectare [Urban typology scale]
	2.70	FSR (x:1) [Building lot scale]
	1.52	FSR (x:1) [Urban typology scale]
Green	19	m² of open space [per building lot]
	46	% canopy cover [Block+street scale]
Water	38	% permeability [Block+street scale]
	1.30	ML/Ha/Yr surplus runoff [Block+street scale]
	80	kL rainwater tank [per building lot]
	308	m² sponge area [per building lot]
	27	Wianamatta Street Trees [per building lot]

Key metrics: apartments – strategy 5

Lot size	Approx. GFA	Approx. FSR
8,400m²	22,702m²	2.7:1

Permeable surfaces	Permeability	Area
Deep soil	100%	2,435m² (29%)
Parking hardstand	50%	1,985m² (24%)
Service hardstand	50%	0m² (0%)
Building site coverage	0%	3,980m² (47%)
	Total	8,400m²

Precedent

Waterloo NSW

Aerial view

Street view

Attached housing

Attached dwellings have two basic forms driven by street access versus rear lane access:

- On small streets, rear lane access may be preferable as large front yards uninterrupted by driveways allow for large trees in the private domain, which improve the experience of the street.
- Rear laneways must address the complex issues of titling, appropriate runoff and service access, however, this approach also gives opportunity for secondary dwellings over garages which provide more diverse housing opportunities and surveillance and safety improvements. A rear-loaded terrace that addresses the street with a minimal front setback can create a positive street experience in an urban setting.
- Front access reduces the ability for good permeability and greening on streets, particularly at narrow lot frontages. This places an emphasis on the space between dwellings to be green, whether this be part of the lot (strategy 3) or in public/ communal ownership of some form (strategy 4).

Strategy 1: community laneways and narrow streets

Driving for greater site permeability can also get cars off streets and into green, permeable rear lanes.

Typology overview:

- Two storey development with compact footprint
- Large rear yards (11m)
- Rear loaded double garage
- Paved surfaces assumed as semi-permeable
- Lane + through site link (50% permeable assumed).

Blocks + streets

Stormwater management strategies

Strategy 1 – attached housing

Key metrics

Density	22	Dwellings per hectare
	70	Residents per hectare [Urban typology scale]
	0.54	FSR (x:1) [Building lot scale]
	0.28	FSR (x:1) [Urban typology scale]
Green	133	m² of open space [per building lot]
	50	% canopy cover [Block+street scale]
Water	41	% permeability [Block+street scale]
	1.05	ML/Ha/Yr surplus runoff [Block+street scale]
	5	kL rainwater tank [per building lot]
	10.35	m² sponge area [per building lot]
	0.75	Wianamatta Street Trees [per building lot]

Key metrics: attached housing – strategy 1

Lot size	Approx. GFA	Approx. FSR
236m²	128m²	0.54:1

Permeable surfaces	Permeability	Area
Rear yard	100%	94m² (40%)
Front yard	100%	10m² (4%)
Non-dwelling surfaces	50%	13m² (6%)
Dwelling site coverage	0%	82m² (35%)
Non-dwelling surfaces	0%	37m² (16%)
	Total	236m²

Precedent

Edmondson Park

Aerial view

Indicative street view

Strategy 2: living out front

Inverts the big backyard approach to create a space for a large tree in the front yard encouraging people to spend time out front, where they can connect to their community.

Typology overview:

- Two storey development with compact footprint
- Large front yards (9m)
- Double garage shown
- Paved surfaces assumed as semi-permeable
- Lane + through site link (50% permeable assumed).

Blocks + streets

Stormwater management strategies

Strategy 2 – attached housing

Key metrics

Density	22	Dwellings per hectare
	70	Residents per hectare [Urban typology scale]
	0.54	FSR (x:1) [Building lot scale]
	0.28	FSR (x:1) [Urban typology scale]
Green	135	m² of open space [per building lot]
	45	% canopy cover [Block+street scale]
	41	% permeability [Block+street scale]
Water	1.11	ML/Ha/Yr surplus runoff [Block+street scale]
	5	kL rainwater tank [per building lot]
	10.35	m² sponge area [per building lot]
	0.75	Wianamatta Street Trees [per building lot]

Key metrics: attached housing – strategy 2

Lot size	Approx. GFA	Approx. FSR
236m²	128m²	0.54:1

Permeable surfaces	Permeability	Area
Rear yard	100%	55m² (23%)
Front yard	100%	41m² (17%)
Non-dwelling surfaces	50%	23m² (10%)
Dwelling site coverage	0%	80m² (35%)
Non-dwelling surfaces	0%	37m² (16%)
	Total	236m² (30x7.5m)

Precedent

Edmondson Park/Crimson Hill

Aerial view

Street elevation

Strategy 3: large rear yards

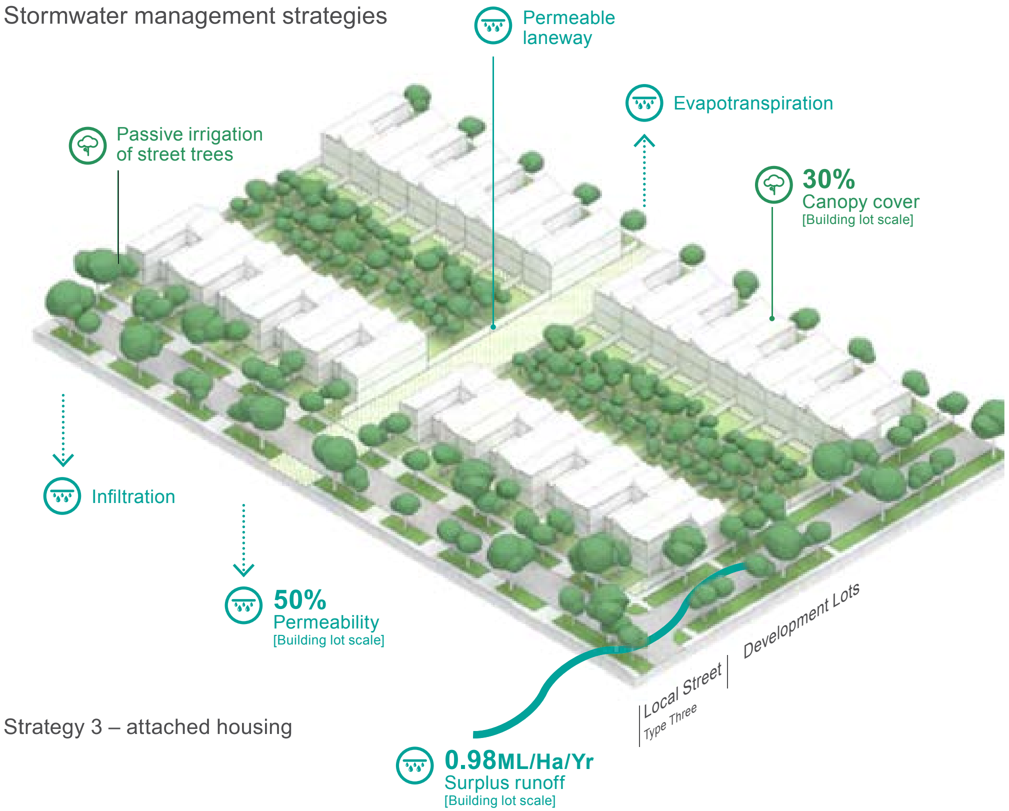
Optimises the benefits of large back yards for permeability and private amenity.

Typology overview:

- Large rear yards (14m) and front yards (5m)
- Front loaded tandem parking – opportunity to utilise permeable pavement
- Building footprint minimised to 45% of lot
- Through site link (50% permeable assumed).

Blocks + streets

Stormwater management strategies



Strategy 3 – attached housing

Key metrics		
Density	25	Dwellings per hectare
	80	Residents per hectare [Urban typology scale]
	0.58	FSR (x:1) [Building lot scale]
	0.33	FSR (x:1) [Urban typology scale]
Green	151	m² of open space [per building lot]
	46	% canopy cover [Block+street scale]
Water	43	% permeability [Block+street scale]
	0.98	ML/Ha/Yr surplus runoff [Block+street scale]
	5	kL rainwater tank [per building lot]
	8.97	m² sponge area [per building lot]
	0.65	Wianamatta Street Trees [per building lot]

Key metrics: attached housing – strategy 3

Lot size	Approx. GFA	Approx. FSR
228m²	132m²	0.58:1

Permeable surfaces	Permeability	Area
Rear yard	100%	77m² (34%)
Front yard	100%	20m² (9%)
Non-dwelling surfaces	50%	34m² (15%)
Dwelling site coverage	0%	82m² (36%)
Non-dwelling surfaces	0%	15m² (7%)
	Total	228m² (35x6.5m)

Precedent

Hudson Street, Thornton

Aerial view

Street elevation

Strategy 4: open space

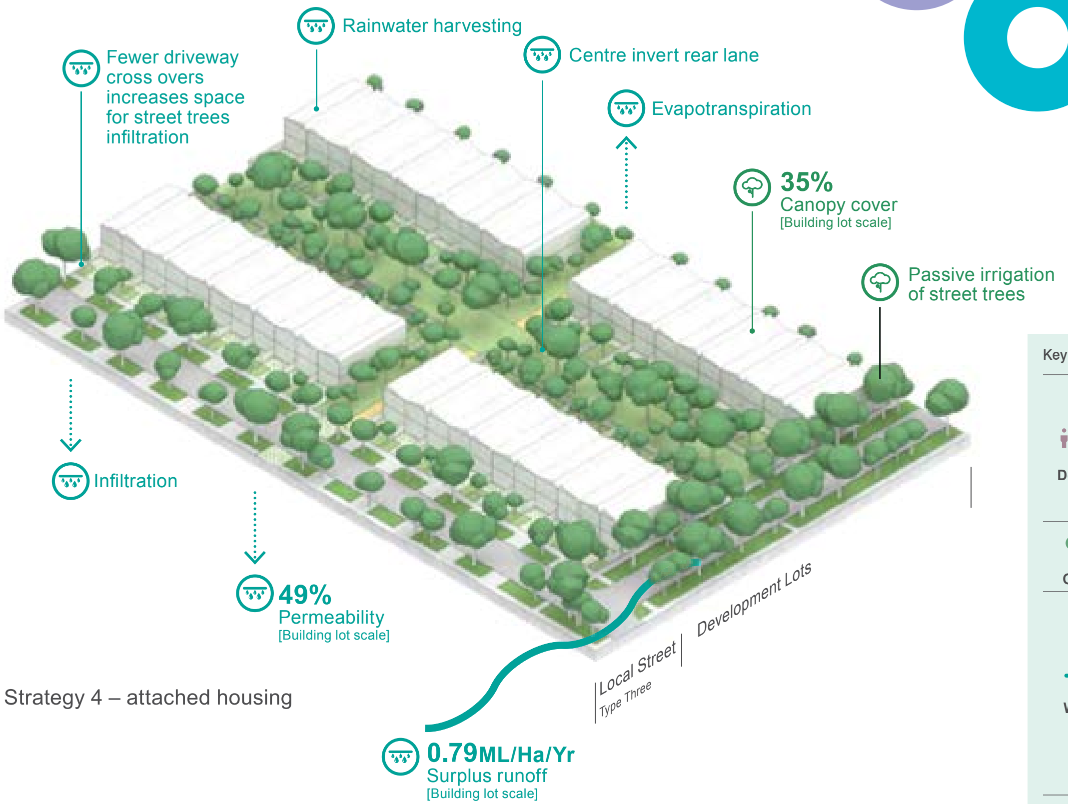
Utilises communal green links to augment the street network and private yards in providing communal amenity and increased permeability.

Typology overview:

- Two storey development
- Single on-grade parking – opportunity to use permeable pavement
- Large rear yards (10.5m)
- Large linear park (100% permeable assumed)
- Through site link (50% permeable assumed).

Blocks + streets

Stormwater management strategies



Strategy 4 – attached housing

Key metrics

Density	32	Dwellings per hectare
	103	Residents per hectare [Urban typology scale]
	0.72	FSR (x:1) [Building lot scale]
	0.37	FSR (x:1) [Urban typology scale]
Green	113	m² of open space [per building lot]
	49	% canopy cover [Block+street scale]
Water	42	% permeability [Block+street scale]
	0.79	ML/Ha/Yr surplus runoff [Block+street scale]
	5	kL rainwater tank [per building lot]
	6.9	m² sponge area [per building lot]
	0.5	Wianamatta Street Trees [per building lot]

Key metrics: attached housing – strategy 4

Lot size	Approx. GFA	Approx. FSR
160m²	115m²	0.72:1

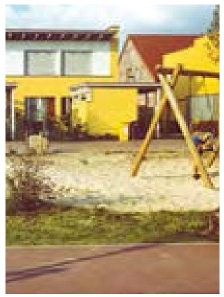
Permeable surfaces	Permeability	Area
Rear yard	100%	53m² (33%)
Front yard	100%	6m² (4%)
Non-dwelling surfaces	50%	23m² (14%)
Dwelling site coverage	0%	78m² (49%)
Non-dwelling surfaces	0%	0m² (0%)
	Total	160m²

Precedent

Turnberry Avenue, Magenta

Aerial view

Street elevation



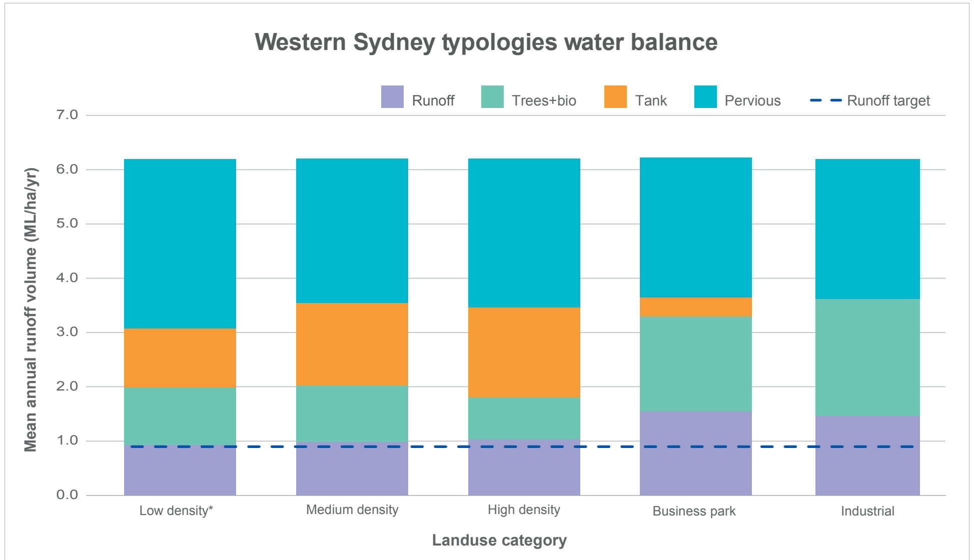
Communal open space (Sandkuhle Recklinghausen)

Water balance

Water balance analysis was undertaken on the urban typologies to determine their performance against waterway health objectives and targets. The results of the water balance analysis indicate the breakdown of rainfall and runoff conversion and mitigation. The modelled catchment rainfall of 6.19ML per hectare per annum represents the total inputs. The various outputs can be attributed to the mitigation strategies including permeability targets and various stormwater management approaches.

The runoff target can be achieved for most development types, except for business parks and industrial where runoff volumes are significantly higher and means of reducing runoff are more limited. Here, where there are few people using large buildings, consumptive water demands are much lower than residential land uses. However there are approaches that can be applied in these cases to assist with stormwater management, greening and cooling, including green roofs and walls and on site stormwater capture connected to rooftop sprinkler systems for evaporative cooling and water loss. Surplus runoff would be further reduced where these additional measures were applied.

With innovative application of the typologies and stormwater solutions, combined with some end of pipe infrastructure where required, the target of 0.9ML per hectare per annum is achievable within the catchment.



*These typologies are available in the full report.

What is landscape led design

Landscape led design changes the way urban design is typically undertaken by drawing on natural landscape features to drive the way in which urban development is planned. At a basic level, the design process starts with the blue (natural waterways and hydrology) and builds with the green (natural open spaces, green links and biodiversity) before responding with the 'grey' infrastructure such as roads, services and development lots. By adopting a landscape led design approach, liveability and amenity outcomes are maximised, infrastructure is more efficient and natural landscape features and ecosystems are preserved as the central defining factor of urban character and identity.

Precinct testing

The adoption of landscape led planning throughout the typologies maximise greenspace and irrigation to create shade, even in hot conditions.

To test the outcomes of application of the urban typologies at a wider scale, two case study sites were chosen within the Aerotropolis Growth Area and concept master plans were drawn using a combination of the urban typologies and a landscape led design approach.

Each precinct was then analysed based on a series of performance metrics to establish how well it aligned with waterway health, tree canopy and urban cooling objectives.

Mosaic Insights conducted urban heat modelling using the Air-temperature Response to Green/blue-infrastructure Evaluation Tool (TARGET)✦, to analyse the precinct testing masterplans and quantify the cooling benefit compared to business-as-usual (BAU) scenarios. Detail on the modelling, assumptions and results are in the *Draft Technical Report* (Mosaic Insights 2020).

The BAU residential precinct was based on a recent housing development at Oran Park, while the employment precinct was based on an existing business area in Erskine Park. Both followed the same master planned road and open space layouts.

Results show that both precincts were significantly cooler than BAU throughout the day in both current and future climates, when the urban typologies were applied. The cooling in the middle of the day is enough to offset the effects of climate change in both 2035 and 2055.

The 2055 scenario for the employment precinct showed the air temperature at 4:30pm on an extreme heat day was 4.6°C cooler than BAU. By retaining water in the landscape and repurposing it for irrigation, the cooling effects become significant in the current and future climate.

When considering the Universal Thermal Comfort Index, implementing the cooling actions (permeable surfaces, tree planting, vegetation and irrigation) in the precincts resulted in:

- the number of extreme, very strong and strong heat stress days per summer decreases dramatically from 47 to 19 days,
- the number of days with no thermal stress more than doubles.

It should be noted that the case studies presented are conceptual only and do not represent actual precinct planning which is being developed for greenfield growth areas in Western Sydney by the WSPP and DPIE. The precinct concepts are intended to demonstrate potential water, greening and cooling outcomes using integrated land use planning and water management at an illustrative level only.

✦ Broadbent AM, Coutts AM, Nice KA, Demuzere M, Krayenhoff S, Tapper NJ, Wouters H (2019) The Air-temperature Response to Green/blue-infrastructure Evaluation Tool (TARGET v1.0): an efficient and user friendly model of city cooling. Geoscientific Model Development12:785–803

Employment precinct

Opportunities

- Use creek corridor as an open space asset, for views and connectivity.
- Some existing trees may be considered for retention as focal assets.
- Connect north and south into surrounding communities. Large existing lot pattern provides opportunity for comprehensive and integrated masterplan.

Concept employment master plan

The following concept master plan has been developed in response to the opportunities and constraints identified in our initial analysis of the site. The plan provides emphasis on providing good, walkable connections to the edges of the creek which will become valuable places for recreation, as well as the commercial needs of a diverse range of employment.

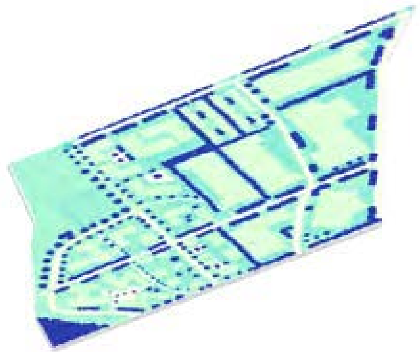
Key features include:

- Provision of a diverse mix of employment uses for employment generation and a robust collection of sites to accommodate different needs.
- Focus on amenity around the flood plain corridor with high quality open spaces and streets and highest density employment uses. This ensures attractive and well used frontages to the open space corridor and flood zone.
- Simple north-south as well as east-west road links built up from the existing street network, all with substantial greening. Use of street widths consistent with the WSPP street guidelines.
- A focus on creation of the 'green grid' with ecological connections across the site following lot boundaries and roads.
- Conceptualised public transport links, accessible to major employers.
- Retain existing trees and utilise them as a focal point for new development where possible.

Precinct summary

Total site area	989,092m²	Water [based on developable area only]	
Riparian / 1 in 100 flood zone (excluded)	32,550m²	Permeability % [Block+street scale]	35%
Net developable area	956,542m²	Surplus runoff	1.95ML/ha/yr
Local public open space	8% (72,429m²)	Total rainwater tank volume [per hectare]	3kL
Streets	20% (193,992m²)	Bioretention 'sponge area' [per hectare]	920m²
Development lots	72% (690,121m²)	Wianamatta Street Trees [per hectare]	43
Canopy cover	35%		

Employment precinct



Difference in maximum temperature between business-as-usual and master planned precincts over a 24 hour period.
Source: Mosaic Insights

- <-10°C
- -7.5°C
- -5°C
- -2.5°C
- >0°C

Illustrative employment precinct

This master plan is conceptual only and does not reflect precinct planning being developed by the WSPP and DPIE for Western Sydney. Its purpose is to demonstrate potential water, greening and cooling outcomes using an optimised integrated land use and water cycle management approach.

Employment precinct

Business-as-usual comparison – employment

<table>
<tr><th></th><th>BAU – business park</th><th>BAU – industrial</th><th>Parkland typologies</th></tr>
<tr><td>Development lots</td><td>80%</td><td>90%</td><td>72%</td></tr>
<tr><td>Streets</td><td>20%</td><td>10%</td><td>20%</td></tr>
<tr><td>Open space</td><td>0%</td><td>0%</td><td>8%</td></tr>
<tr><td>Detention basins</td><td>450-500m^3</td><td>450-500m^3</td><td>-20% (possibly up to -50%)</td></tr>
<tr><td>Perviousness (excl. streets)</td><td>30%</td><td>11%</td><td>58%</td></tr>
<tr><td>Canopy cover</td><td>10-15%</td><td><10%</td><td>35%</td></tr>
<tr><td>Surplus runoff</td><td>5-7ML/ha/annum</td><td>5-7ML/ha/annum</td><td>1.95ML/ha/annum</td></tr>
<tr><td>Extreme heat day average temp 2055</td><td colspan="2">30.6°C</td><td>28.7°C</td></tr>
<tr><td>Extreme heat day max temp 2055</td><td colspan="2">47.3°C</td><td>43.2°C</td></tr>
</table>

Residential precinct

Opportunities

- Existing drainage channel – the channel is part of a larger network of dams on the northern side of Fifteenth Avenue and supports a number of large trees. The channel should be kept to enable the retention of the existing trees.
- A large stand of trees is located off Ramsay Road and should be retained.
- The riparian corridor and flooding constraints extend into the site and will provide opportunities for re-vegetation and habitat creation. Connections to these edges should be considered when developing the access and movement network.

Concept residential master plan

The following concept master plan has been developed in response to the opportunities and constraints identified in our initial analysis of the site. The plan sets out a robust framework for a new residential precinct. It places emphasis on providing walkable connections to the edges of the creek which will become valuable places for recreation in the future. Existing vegetation on site such as the stands of trees have been retained and further enhanced by colocating them near new parks.

Key features of the plan include:

- Application of the 120m x 70m block framework as the basis of built form testing.
- A diverse mix of dwelling types and densities ranging from detached to attached-to-apartment dwellings.
- A north-south collector through-road to act as a new high street for the precinct, located along the existing irrigation channel and line of trees.
- An east-west road to provide a secondary point of access into the precinct.
- Secondary north-south green streets, with through connections, run to the southern edge of the creek to maximise access to the creek interface and active walking tracks.
- Reinforcement of park-to-park connections with east-west pedestrian connections across the precinct.
- Mix of urban and natural open spaces which include a 5000m² community title park off the new north-south high street and restored open space along the riparian corridor.

- Open space located around a stand of existing trees.
- Linear parks along east-west local streets provide additional open space and provide opportunities for deep soil planting and increased tree canopy.
- All street widths and designs are consistent with the WSPP Street Design Guidelines.

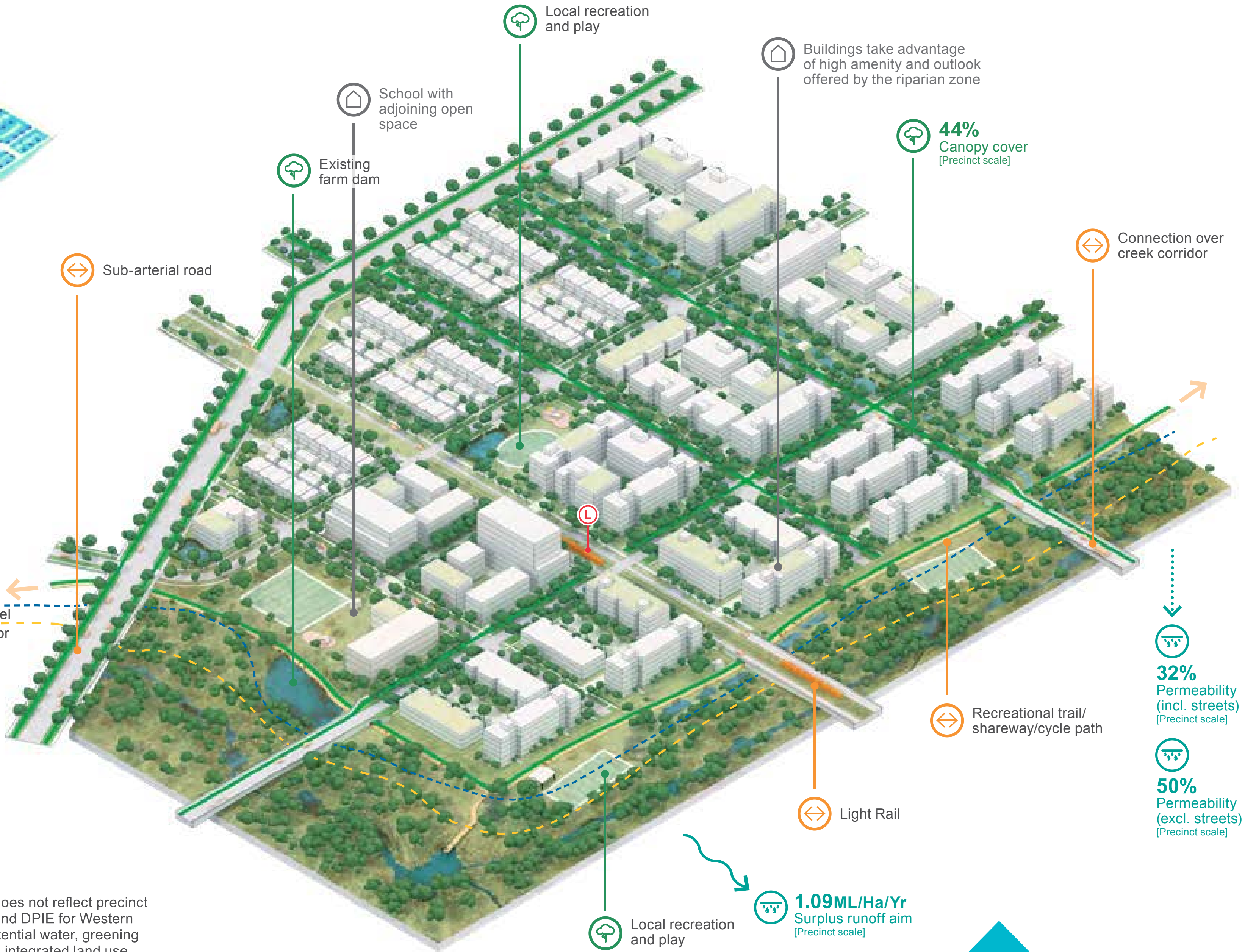
Precinct summary

Total site area	202,088m²	Water [based on developable area only]	
Riparian / 1 in 100 flood zone (excluded)	51,607m²	Permeability % [Block+street scale]	32%
Net developable area	150,481m²	Surplus runoff	1.09ML/ha/yr
Local public open space	14% (20,941m²)	Total rainwater tank volume [per hectare]	104kL
Streets	31% (46,681m²)	Bioretention 'sponge area' [per hectare]	324m²
Development lots	55% (82,859m²)	Wianamatta Street Trees [per hectare]	27
Canopy cover	44%		

Residential precinct

Difference in maximum temperature between business-as-usual and master planned precincts over a 24 hour period.
Source: Mosaic Insights

- <-10°C
- -7.5°C
- -5°C
- -2.5°C
- >0°C



Illustrative residential precinct

This master plan is conceptual only and does not reflect precinct planning being developed by the WSPP and DPIE for Western Sydney. Its purpose is to demonstrate potential water, greening and cooling outcomes using an optimised integrated land use and water cycle management approach.

PHOTO CREDIT: RAMESH SENEVIRATNE

Residential precinct

Business-as-usual comparison – residential

	Business-as-usual	Parkland typologies
Development lots	53%	55%
Streets	35%	31%
Open space	12%	14%
Detention basins	350-500m^3	-20% (possibly up to -50%)
Perviousness (excl. streets)	20%	50%
Canopy cover	10-20%	44%
Surplus runoff	4-5ML/ha/annum	1.09ML/ha/annum
Extreme heat day average temp 2055	30.5˚C	29.1˚C
Extreme heat day max temp 2055	46.6˚C	43.6˚C

Recommendations for implementation

In order to achieve the stormwater runoff benchmark adopted in this study – 0.9ML per hectare per annum, urban development and planning controls must respond in the following ways:

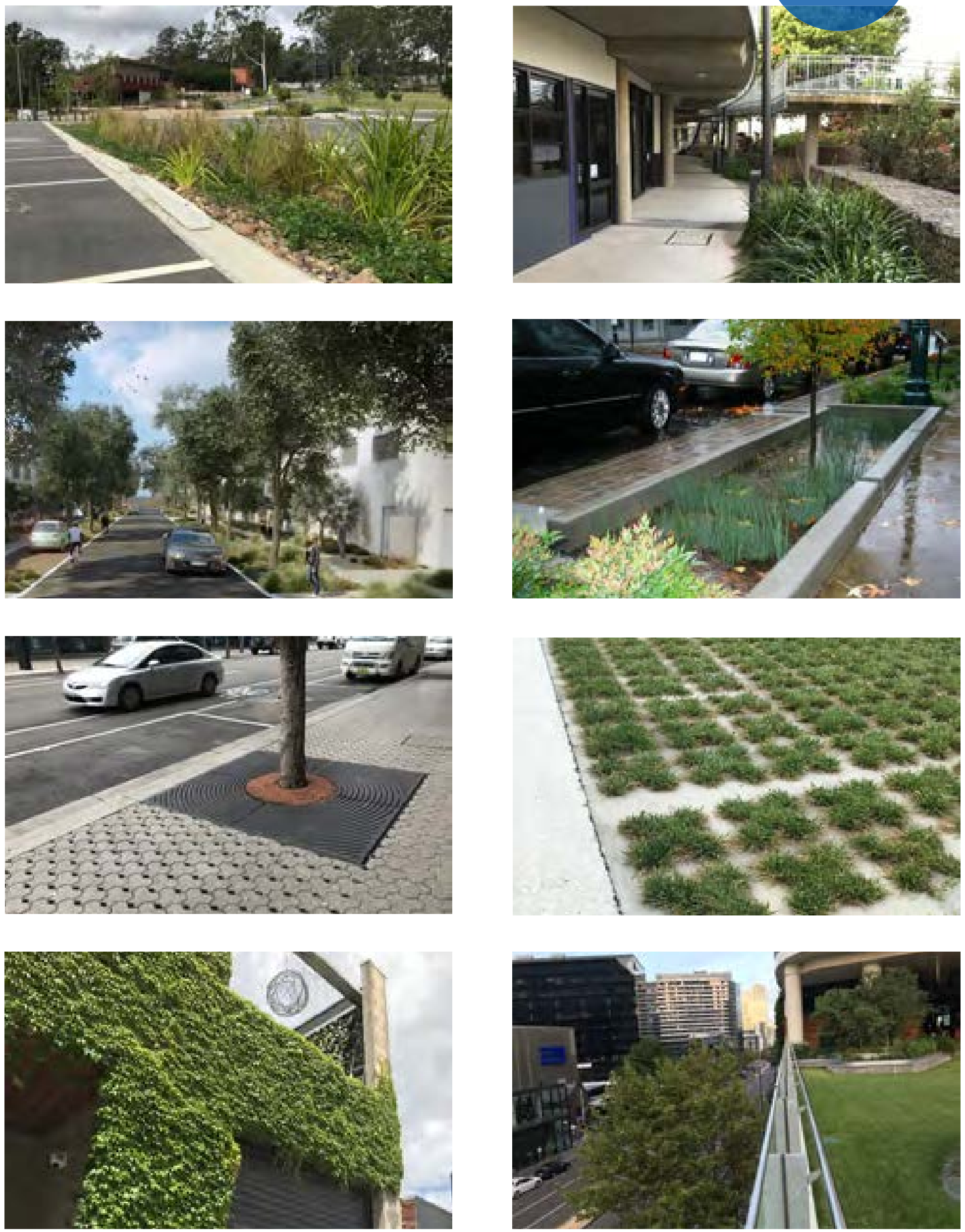
1. Clear requirements for open space, streets and trees in new development as shown in the table below.

Benchmarks for achieving the minimum permeability requirements

Land use	% of the development area comprising streets	% of the development area comprising open space (public local parks, linear parks and neighbourhood parks)	Wianamatta Street Trees canopy	Large trees and Wianamatta Street Trees (trees/ha)
Low density residential	30	10	33	25-30
Medium density residential	30	15	23	19
High density residential	30	25	28	7
Mixed use centre	30	25	28	25
Business	20	10	28	42
Industrial	20	5	37	19

2. Consistent application of four key technological solutions through precinct planning, master planning and development controls, being:

- Bioretention 'sponges' – raingardens that treat stormwater by vertical percolation through a soil filter media
- Water smart Wianamatta Street Trees
- Permeable pavements where feasible/practical
- Rainwater harvesting and reuse.



Examples of key technological solutions

3. Minimum water retention strategies as shown in the table below to be mandated through planning controls.

Minimum requirements for water retention strategies

Land use	Permeability of the development area 1	Water reuse on site	Trees and bioretention
Low density residential	50%	• 5,000L rainwater tank / dwelling • Rainwater for toilet flushing, laundry and hot water use and irrigation for at least half the on-lot green space	• 1 large tree on the private lot per dwelling • 13 Wianamatta Street Trees in the street per five dwellings
Medium density residential	50%	• 5,000L rainwater tank / dwelling • Rainwater for toilet flushing, laundry and hot water use and irrigation for at least half the on-lot green space	• 0.4 large tree on the private lot per dwelling • 4 Wianamatta Street Trees in the street per five dwellings
High density residential	50%	• 0.4ML of rainwater tank storage per five dwellings • Rainwater for toilet flushing, laundry and hot water use and irrigation for at least half the on-lot green space	• 0.16 large tree on the private lot per five dwellings • 1.6 Wianamatta Street Trees in the street per five dwellings
Mixed use centre	50%	• 0.4ML of rainwater tank storage per five dwellings • Rainwater for toilet flushing, laundry and hot water use and irrigation for at least half the on-lot green space	• 0.16 large tree on the private lot per five dwellings • 1.6 Wianamatta Street Trees in the street per five dwellings
Business	40%	• 20ML of rainwater tank storage per hectare • Rainwater for toilet flushing and irrigation for at least half the on-lot green space	• 46 Wianamatta Street Trees on the private lot per hectare • 34 Wianamatta Street Trees in the street per hectare
Industrial	40%	• Potential for use of rainwater tanks for storage and application to roofs for evaporative cooling	• 56 Wianamatta Street Trees on the private lot per hectare • 17 Wianamatta Street Trees in the street per hectare

Notes:

1. Development area is all land, excluding the blue-green grid, district open space and regional open space, but including streets, and all other types of open space.

2. To clarify, the 0.9ML / hectare / year limit for run-off is to be measured at the edge of the site, at precinct scale.

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