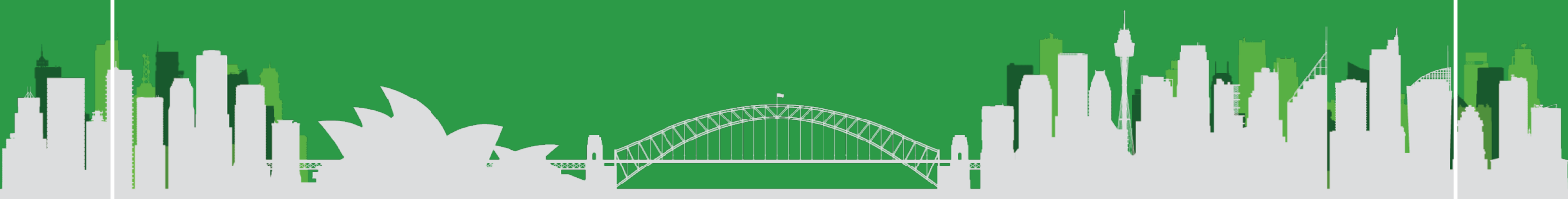
URBAN SYSTEMS TRANSFORMATION

GREATER WESTERN SYDNEY



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THE URBAN CHALLENGE

Future Earth Australia, hosted by the Australian Academy of Science, is leading a process to co-develop a national strategy for Australian sustainable cities.

Australia is already one of the most urbanised countries in the world, with 89% of the population living in urban areas (UNDESA, 2014) and 67% living in the capital cities. Australia's estimated resident population of 24.6 million people (June 2017) is projected to increase to between 37.4 and 49.2 million people by 2066 (ABS, 2018). All capital cities are projected to grow at a greater pace than the rest of their respective state or territory (ABS, 2018). Some are seeking to constrain growth; others, including many regional centres, are looking for extra or renewed growth.

Our urban environments are an interrelated system comprising social, economic, ecological and technical spheres. Urban systems transformation is needed to ensure that people can move around efficiently, live in safe and healthy homes, receive adequate education and medical care and enjoy lives of social equity in a healthy and biodiverse environment.

The metropolitan plans for most Australian capital cities include consistent sustainability planning and design principles such as containing urban sprawl, reducing car dependency and providing greater housing choices. However, in practice, urban decision-making is subject to numerous complex drivers—social, environmental, economic, institutional, technological—with the potential to create barriers to sustainable development.

The challenge lies in ensuring effective and consistent urban policy and decision-making in the complex urban institutional environment (across spatial scales and decision-making levels, and across sectors), with genuine stakeholder and community engagement that understands the many and varied underlying aspirations and values. In turn, this process needs to be guided by shared visioning of our urban futures, underpinned by approaches to co-produce, share and implement knowledge to inform decision-making. In this context all decision-makers and stakeholders are both providers and users of knowledge.

However, current urban development and decision-making is characterised by a lack of shared vision and excessive fragmentation in institutional arrangements and in relevant knowledge development, translation and use.

RESPONDING TO THE CHALLENGE

Future Earth Australia is working to improve the appreciation of the underlying barriers and enablers to sustainable urban development, and the supporting development, synthesis, translation, accessibility and application of relevant knowledge. Through a nationwide consultative process, it is co-developing a national strategy for the sustainable development of Australia's cities and communities over the coming decades.

Through a series of workshops in the capital cities, Future Earth Australia asked policymakers, practitioners, researchers, business and community stakeholders to contribute to the development of local and national strategies. Each workshop included a special focus on the specific city and the surrounding region, as well as implications for a national approach.

THE IMPORTANCE OF A NATIONAL STRATEGY

To be successful, transformational strategies will need to include shared urban visions of feasible and desirable futures, with a focus on:

- key systemic leverage opportunities
- collaborative and aligned urban governance integrated across systems, sectors and scales
- effective stakeholder and community engagement across multiple goals and diverse values
- co-produced knowledge development and use by policy and urban decision-makers.

These elements should all be supported by continuing learning and adaptive management. These are represented below as components of a national strategy.

A national strategy will provide governments, practitioners, businesses, communities and researchers with recommendations for cost-effective and integrated urban systems transformation.

To help us achieve these goals, workshop participants are asked to consider:

- current issues and future visions for their city and region
- how to improve engagement outcomes with stakeholder and community groups by policy and decision-makers
- actions that if taken locally (at state/territory level) and nationally would increase the sustainable development of the city/region
- how such actions might contribute to a national strategy for urban systems transformation.

A national strategy will also help Australia meet our commitments under the United Nations' Sustainable Development Goals (SDGs). SDG 11 is to 'make cities and human settlements inclusive, safe, resilient and sustainable', but transformation is underpinned by integration of all 17 of the goals.

Greater Western Sydney workshop

On 2 November 2018 Future Earth Australia held the first in a series of national workshops its project 'Urban systems transformation: sustainable cities'. The workshop was hosted by Western Sydney University at its Parramatta campus. Thirty stakeholders from state government, city councils, universities, local businesses, NGOs and research groups participated.

This document summarises discussions grouped under the following workshop themes: urban visioning initiatives and pathways; collaborative governance and decision-making; stakeholder and community engagement; and co-produced knowledge development, usage and learning.

A vision for Greater Western Sydney

Participants were asked to consider their current perceptions of the Greater Western Sydney (GWS) region and to use their devices to enter applicable words into an online poll to generate a word cloud. The most prominent word, with seven participant entries, was hot (word cloud 1). The point was made that even though Sydney as a whole is hot, GWS residents are furthest from the coast and most of the region suffers with comparatively low access to shade. Nevertheless, respondents did feel that there are good opportunities to make things better and to make the urban spaces in the region greener and cooler.

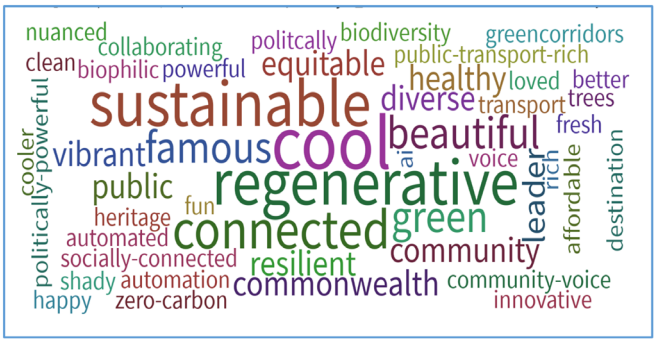
The critical issues that were identified included poor planning and infrastructure associated with urban sprawl (three entries) and the pressures associated with growth, such as congestion (four entries when car is included in the count) and lack of sustainability (three entries). Nevertheless, the region as a whole was seen as diverse (six entries) and having opportunities for social and economic development (five entries).

Word cloud: Current perception of GWS

Much of the vision for the future focused on greening of the built environment. When asked 'How do you want to be able to describe GWS by 2030 to 2050?' the words *sustainable* (five entries), *cool* (six entries), *regenerative* (five entries) and *green* (four entries) featured strongly in the answers (word cloud 2).

Participants identified specific programs that would contribute to greening the built environment, such as vegetation corridors, stormwater management projects and the 'Which Plant Where' initiative[1] —a five-year research program investigating how well current landscaping species will cope under more extreme climates that Australia's cities will one day face.

The comment was made that the people of GWS need to be able to decide their own future, to be involved in planning decisions and to be consulted in order to achieve their vision for sustainability.



Word cloud 2: Vision for GWS for 2030–2050

Next, participants were asked to discuss whether they could see unifying themes or contradictions in these visioning exercises. There was more surprise about

1. Which Plant Where is funded by the Hort Frontiers Green Cities Fund, with co-investment from Macquarie University, Western Sydney University and the NSW Office of Environment and Heritage and contributions from the Australian Government. www.whichplantwhere.com.au/about/nursery-paper-september-2018-integrating-green-life-into-buildings-and-infrastructure/

the words that were not included than those that were. For example, productivity did not appear, yet this is one of the main focuses of the planning documents for Western Sydney. To some this suggested a disconnect between government decisions and what people want from where they live. Migration and its impacts also did not appear in the word clouds but are prominent in government plans.

There was also no reference to the heritage of the region. GWS was once Sydney's food bowl, but urban development has replaced agricultural lands, diminishing this once important social and economic factor of the region. The group discussed the idea of the common wealth of GWS and how to build on the strengths of the resident population. The labour force needs more training and retraining in the context of declining manufacturing and an increase in the service economy. This should include details of how to get to a 'sustainability economy': a post-carbon, smart economy.

The word *connection* was prominent in the future vision, and participants agreed that it includes many layers of social connection and environmental connectedness, including the connection of the region to Sydney and Australia.

INITIATIVES AND PATHWAYS

Participants were asked to consider the specific knowledge that would be needed to achieve their vision for a sustainable Western Sydney Region (WSR). A series of initiatives were presented, detailed below.

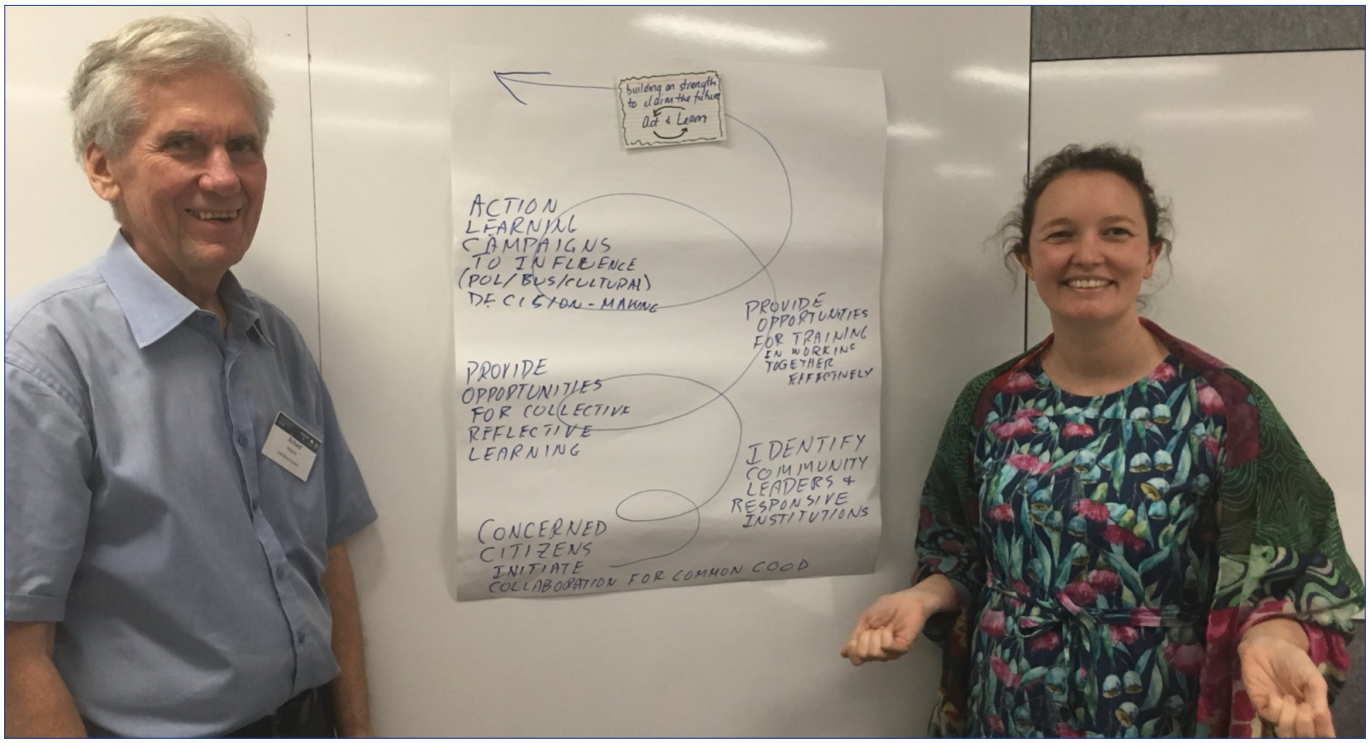
1. COMMUNITY LABS

It was proposed that a community urban action group, working towards the common good, could:

- identify community leaders and responsive institutions
- provide opportunities for both collective reflective learning and training in effectively working together
- engage with school leaders
- identify other leadership initiatives to work with.

Engaging local mayors and businesses with aligned values would expose the community to policy and industry. Campaigns and expos would carry the message to the extended community. The risk with this proposal is that change remains confined to concerned citizens but does not scale up.

Part of this could be a reality TV show. Community labs would present a chance for distributed democracy in action to prioritise key sustainability movements. It would be projective and current, including local science and evidence. It would be championed by major or a local CEO, but led by communities in each precinct with their local vision and flavour.



2. INFORMATION MAPPING HUB

To take effective and sustainable action on urban transformations, a long-term knowledge hub should be developed. Firstly, the following key repositories of urban sustainability data should be identified:

- bodies with policy intentions in the urban sustainability space at state, local and regional levels
- agencies and stakeholders including independent bodies and community groups.

Secondly, the information required should be categorised and collated. Good practice would include utilising case studies and peer-reviewed research.

The resources and initiatives required should be calculated at the start of the project. A timeframe of one to two years to define the network should be allowed, plus another one to two years for information mapping and the identification of barriers and opportunities.

3. PARTNERSHIP CENTRES

This group was connected by a desire to see a systems approach to urban transformations, particularly the need to break down silos between research institutes and local government areas (LGAs). Developing urban sustainability partnership centres would encourage institutions to work together on new planning, infrastructure, social and economic developments projects from inception.

Partnership centres would provide members with a voice in local decision-making. To be successful, partnership centres would have to fully engage with the local community. A partnership centre should develop status sufficient to support productive relationships with state and federal government agencies.

4. THE BIGGEST LOSER

There is currently either a lack of information regarding the living city or what exists is not implemented. Take water availability, for example. How much is for humans? How much is for trees? And carbon—how is this lost and how do companies and individuals reduce the amount they produce? How do researchers and policymakers find a balance?

This group proposed using technology to demonstrate these principles. User-friendly videos and apps would enable local WSR to understand these concepts at their

regional, local scale. For example, one possibility would be using an app or YouTube videos to design a challenge for users to measure carbon loss, and a competition about who can reduce their energy loss the most.

5. WESTERN SYDNEY 'SIMCITY'

This group also wanted to use technology to help educate the community about the sustainability of their urban system. A game could be developed to illustrate how different projects—such as environmental, transport and housing improvements—will affect the region.

This would be a highly effective way to engage the community. Importantly, it could be used to demonstrate the effects of predicted changes in climate, for example, how a mean two-degree increase in temperature in the WSR would really look.

COLLABORATIVE GOVERNANCE AND DECISION-MAKING

During the plenary discussion the group identified barriers to collaboration as a major problem in urban sustainability initiatives. Although urban researchers, policymakers and practitioners should be working collaboratively, funding for projects often comes with caveats and time restrictions. This can complicate attempts to initiate cross-discipline, cross-organisational projects.

Formulating a shared vision may be difficult—while policy setting may be focused on economics, growth and prosperity, end users are likely to also consider the environment and culture. In terms of communication, it was pointed out that different institutions and departments often use very different language.

A problem for local governments is the volume of information and data available—it can be hard to prioritise. Local governments often know what needs to be done, such as reducing carbon emissions. The problem is how to do it. It would be very helpful if research outputs were translated into easily adoptable actions.

STAKEHOLDER AND COMMUNITY ENGAGEMENT

Participants were adamant that to develop co-produced solutions to the pressures faced in GWS, community involvement at all levels would be paramount. The point was made that people need to experience what the future could be and that decision-makers, particularly the LGAs, need to understand what is happening in their communities. This should be filtered up to the state government.

The visioning exercise generated discussion about sharing existing urban knowledge and community engagement. To overcome community trust issues, a participant suggested involving young artists and filmmakers from Western Sydney in creating and broadcasting visions for urban transformation.

Education was identified as key to successful community participation. A school challenge to educate and raise awareness would engage young people and consequently their parents.

CO-PRODUCED KNOWLEDGE DEVELOPMENT, USAGE AND LEARNING

The workshop participants agreed that the current culture of competitiveness needs to be challenged for organisations to successfully work together. A comprehensive change in attitudes would be needed to break silos and repair fragmented systems.

Information sharing is an issue. Considerable high-quality planning and sustainability information already exists but it may be difficult to access, ipoorly or confusingly formatted or simply not being used.

Incentive programs may be needed to encourage collaboration. There is justification for a state-level official approach to mandating co-produced projects and collaborative frameworks, although this has apparently been pushed for years and not been successful.

IMPLICATIONS FOR A NATIONAL STRATEGY

The participants were enthusiastic about the potential for GWS to serve as a national inspiration, providing an example of successful community involvement. Citizen and business engagement would provide an example to the international community about how healthy green cities can develop anywhere and demonstrate the achievability of the housing equality and liveability for all. It would help Australia to be a legitimate contributor to the SDGs and provide the potential to reframe the right to the city in terms of environmental and social justice.

The group supported the creation of a single, powerful lobby group for sustainable city interventions, joining together universities, communities and businesses. A large, cross-disciplinary group would have a stronger voice, but harmonising those voices would be a challenge.

Young people should be involved as a key requirement in designing urban strategies, including engaging them in creative ways. Much current decision-making locks out young people, yet it is their future. Fresh ideas are needed, and it will be necessary to take risks.

There have been very successful approaches around the world made by creating networks of green and blue corridors. They help to achieve physical and mental health improvements, ecosystems and heat mitigation and offer a true urban systems approach to planning. The impact can be very high, but the input needed is also high.

There should be incentives for eco development. For example, six-star neighbourhood ratings could be linked to financial rewards for developers.

For a national strategy to work, education about sustainable development is needed, both in schools and in the community. Ongoing employment must be considered and a long-term commitment is needed. Cities should be solutions, not problems.

To finish the workshop, the group heard from two Future Earth Australia members about current urban initiatives in GWS.

ASSOCIATE PROFESSOR JUAN SALAZAR, SISTER HUB, WESTERN SYDNEY UNIVERSITY

The Sustainable Transitions Engaged Research (SISTER) Hub is seeking to create a collaborative platform with a cost-effective model and co-design approach. This is a partnerships platform that will bring members from across the GWS region together to work to address environmental challenges and sustainable transitions in ways that foster human and ecosystem wellbeing. As a multi-stakeholder space, it will enable members to co-produce new knowledge to advance urban sustainability transitions in GWS. The members will include research institutions, local government, the private sector and community organisations, each contributing knowledge, expertise, resources and assets where appropriate. It will recognise traditional owners and have strong integration with organisations belonging to and for Aboriginal and Torres Strait Islander people.

To bring this hub to life, the first steps will be to produce and share a strategy, generate membership, address resources and challenge capping and finalise governance. Participants will meet four to six times per year to form research and action partnerships. The aim is to co-produce projects with advocacy, industry, research and policy.

PROFESSOR MICHELLE LEISHMANN, CENTRE FOR SMART GREEN CITIES, MACQUARIE UNIVERSITY

The Centre for Smart Green Cities is a collaborative research hub connecting industry, researchers, government and the community to create liveable urban environments. It is multidisciplinary, with researches from many faculties: environmental science, climate science, biology, health, IT, economics, engineering, psychology and business.

The centre has three key themes: green infrastructure, smart technology and sustainable energy solutions. The 'smart' part of the title refers to the use of technologies such as the Internet of Things, tracking vehicles, energy meters and waste management tools.

The benefits of creating urban green spaces include reducing air and ground temperatures, mitigating air pollution and floods, providing habitats, increasing biodiversity and improving human health and wellbeing.

GREATER WESTERN SYDNEY

GWS runs from Windsor in the north to Campbelltown in the south and from Parramatta in the east to Penrith and the Blue Mountains in the west, comprising 14 local government areas.

North-West: Baulkham Hills, Blacktown, Blue Mountains, Hawkesbury, Penrith
South-West: Wollondilly, Camden, Campbelltown, Liverpool
West Central: Auburn, Bankstown, Fairfield, Holroyd, Parramatta

FACTS AND FIGURES

GWS encompasses a total land area of nearly 9000 square kilometres. The 2017 estimated resident population for the GWS is 2 288 554, with an average population density of 2.56 persons per hectare, which is much higher in urban areas (Deloitte, 2015). That equates to one in 11 Australians and three in 10 New South Wales (NSW) residents.

GWS residents come from more than 170 countries and speak over 100 languages (RCE-GWS, 2018). The region has the largest Aboriginal and Torres Strait Islander community in the country (RCE-GWS, 2018).

GWS has the third largest economy in Australia ($127 billion) and more than 240 000 local businesses.

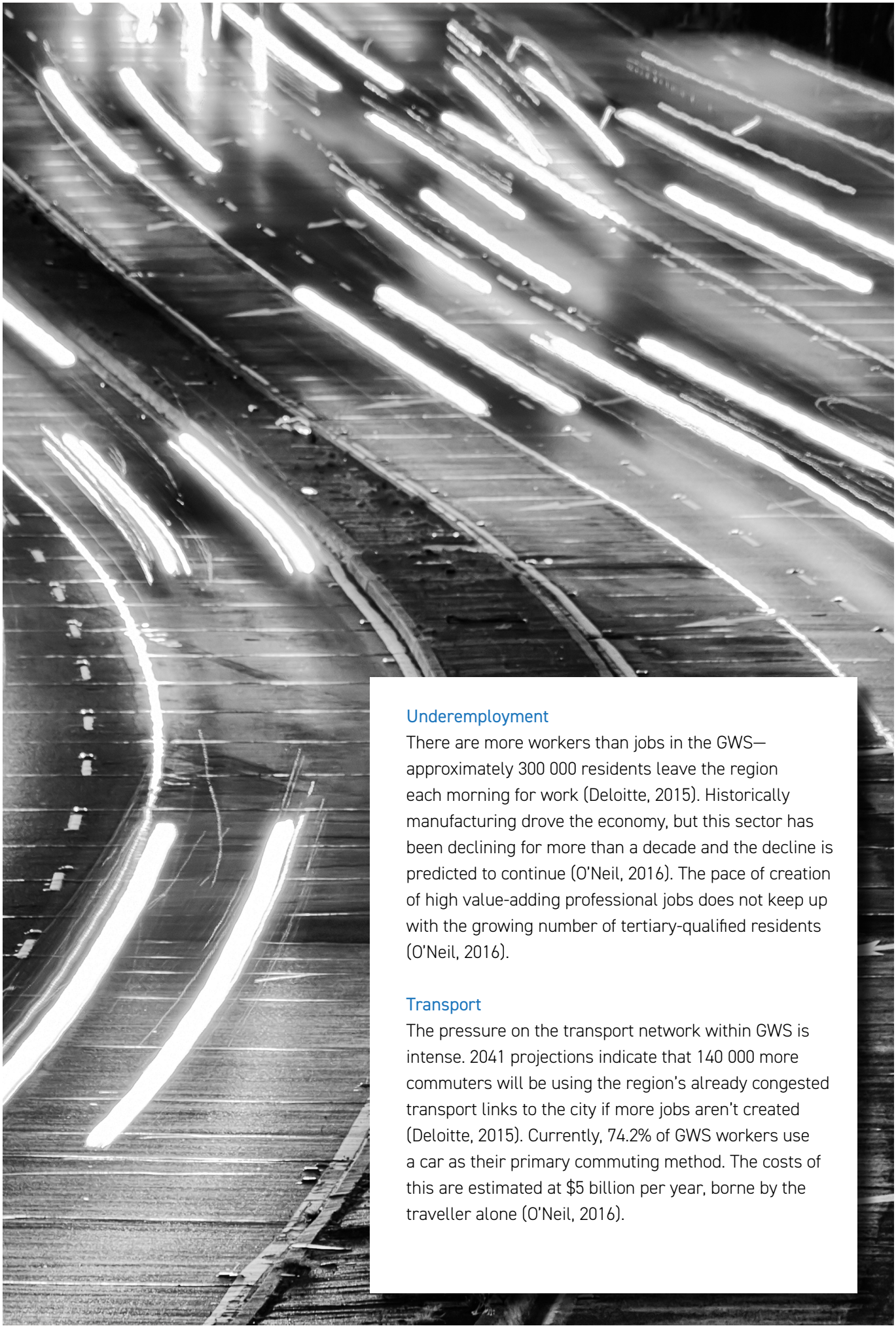
However, the region has higher than average unemployment and lower than average salary levels (RCE-GWS, 2018). Eight out of 10 of the most disadvantaged LGAs are found in the region. Transport infrastructure is poor and the region is heavily car dependent (RCE-GWS, 2018).

REGIONAL CHALLENGES

Rate of growth

The population of GWS is expected to grow from 2.2 million to 2.9 million and be home to more than 50% of the Greater Sydney region's population by 2036. Urban sprawl has already transformed once-rural regions into residential suburbs (The Urban Developer, 2018).

Figure 1: Aerial photographs of Penrith taken in 2009 (left) and 2018 (right); Box Hill in 2014 and 2018; Kellyville in 2013 and 2018; Spring Farm in 2009 and 2018 (images courtesy of nearmap and The Urban Developer)



Underemployment

There are more workers than jobs in the GWS—approximately 300 000 residents leave the region each morning for work (Deloitte, 2015). Historically manufacturing drove the economy, but this sector has been declining for more than a decade and the decline is predicted to continue (O'Neil, 2016). The pace of creation of high value-adding professional jobs does not keep up with the growing number of tertiary-qualified residents (O'Neil, 2016).

Transport

The pressure on the transport network within GWS is intense. 2041 projections indicate that 140 000 more commuters will be using the region's already congested transport links to the city if more jobs aren't created (Deloitte, 2015). Currently, 74.2% of GWS workers use a car as their primary commuting method. The costs of this are estimated at $5 billion per year, borne by the traveller alone (O'Neil, 2016).

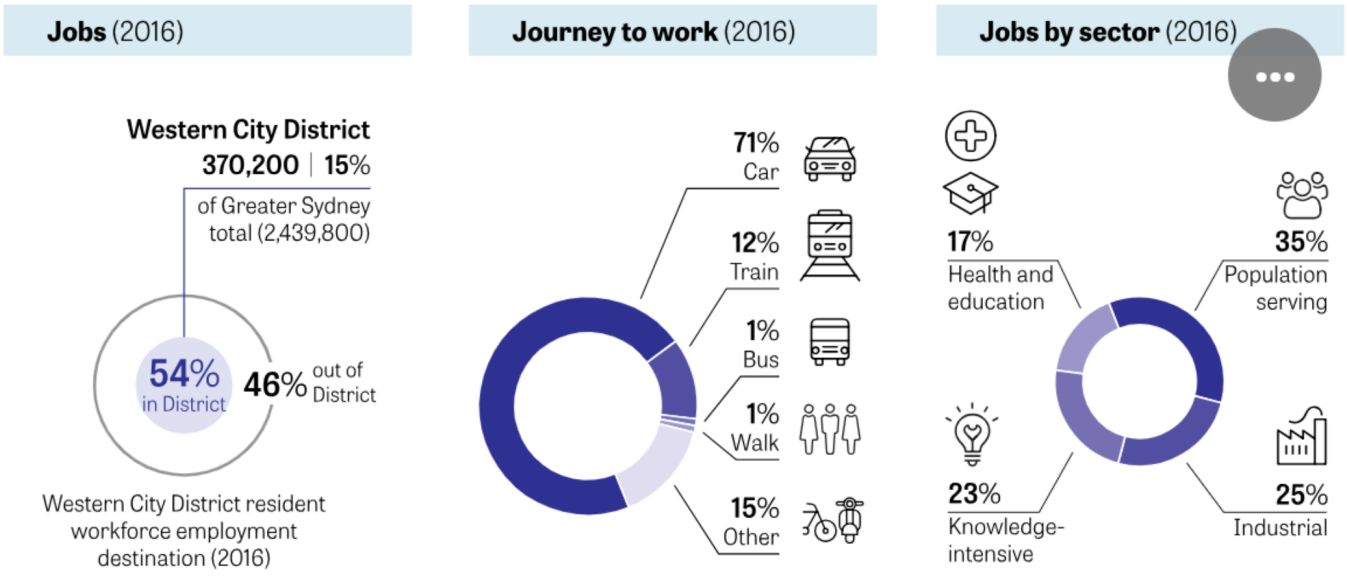


Figure 2: Western Sydney jobs and transport (Western City District Plan)

Social exclusion

The SEIFA Index of Disadvantage is a product developed by the ABS that ranks areas in Australia according to relative socio-economic advantage and disadvantage (ABS, 2011). The indexes are based on information from the five-yearly Census. The index is derived from attributes that reflect disadvantage, such as low income, low educational attainment, high unemployment rates and jobs in relatively unskilled occupations (.idcommunity, 2018). The SEIFA index shows that there has been a significant shift in the location of highly disadvantaged populations in Sydney towards the west of the city (Randolph and Tice, 2014).

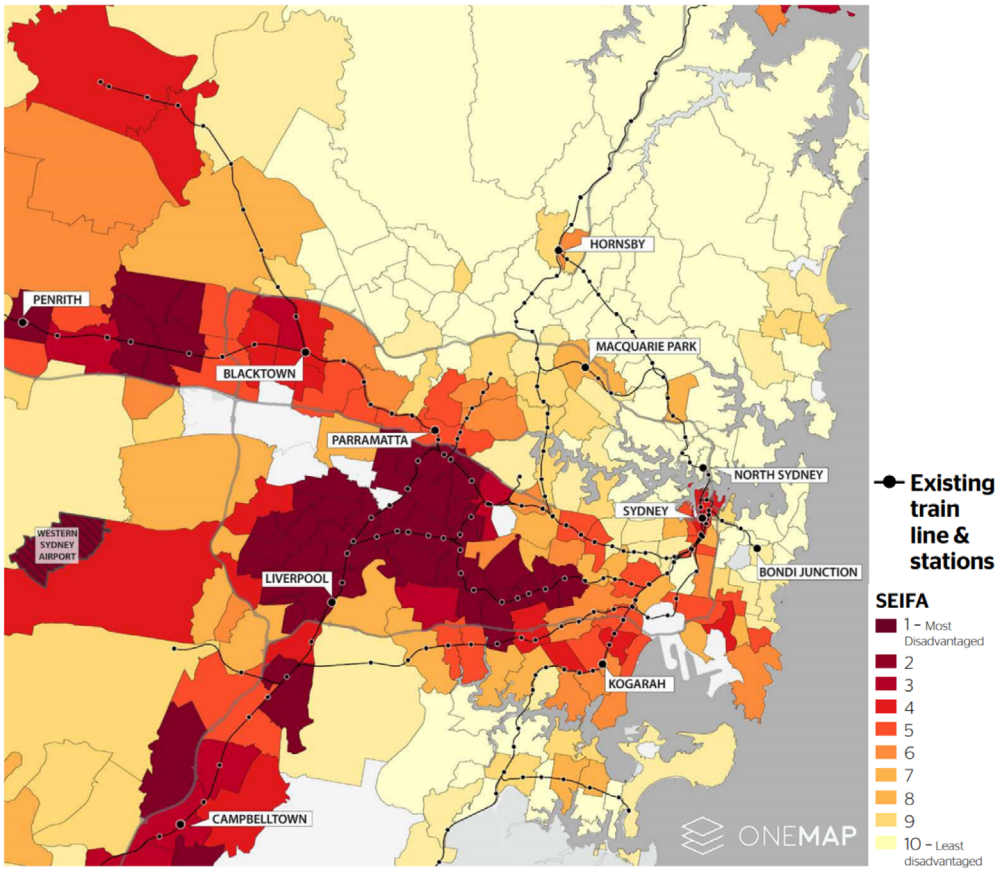


Figure 3: This map illustrates socioeconomic advantage and disadvantage, highlighting a strong spatial disparity (The Committee for Sydney, 2018b)

Urban heat

The urban heat island effect is pronounced in GWS. Its unique geography and lack of sea breeze means that the region experiences many more days over 35 degrees than the Sydney's eastern suburbs. In the region, temperatures can be up to six to 10 degrees higher during extreme events and there can be up to three times as many heat-related deaths (Sydney Water Corporation, 2017). As a result, the region uses twice as much energy for cooling purposes as eastern Sydney (Sydney Water Corporation, 2017).

The Western Sydney Regional Organisation of Councils' (WSROC) *Turn Down the Heat Strategy and Action Plan* was developed with stakeholders from health, infrastructure, academia, planning, utilities and non-profits to increase awareness and facilitate a broader and more coordinated response to the challenges of urban heat in Western Sydney (WSROC, 2018).

The plan proposes 16 strategic actions with implementation guided by a steering committee made up of representatives from WSROC, Western Sydney University, the Greater Sydney Commission, Resilient Sydney, NSW Health, the Office of Environment and Heritage and the NSW Government Architect's Office.

Environmental pressures

GWS contains agricultural land and native bushland, including intact remnants of the critically endangered native Cumberland Plain Woodland, a large proportion of which is situated on privately owned rural land. The region encompasses World Heritage-listed areas of the Blue Mountains, one of the largest and most intact tracts of protected bushland in Australia. Many of these areas are under pressure due to urban expansion.

The Hawkesbury-Nepean River system is Sydney's primary water source and has important ecological,

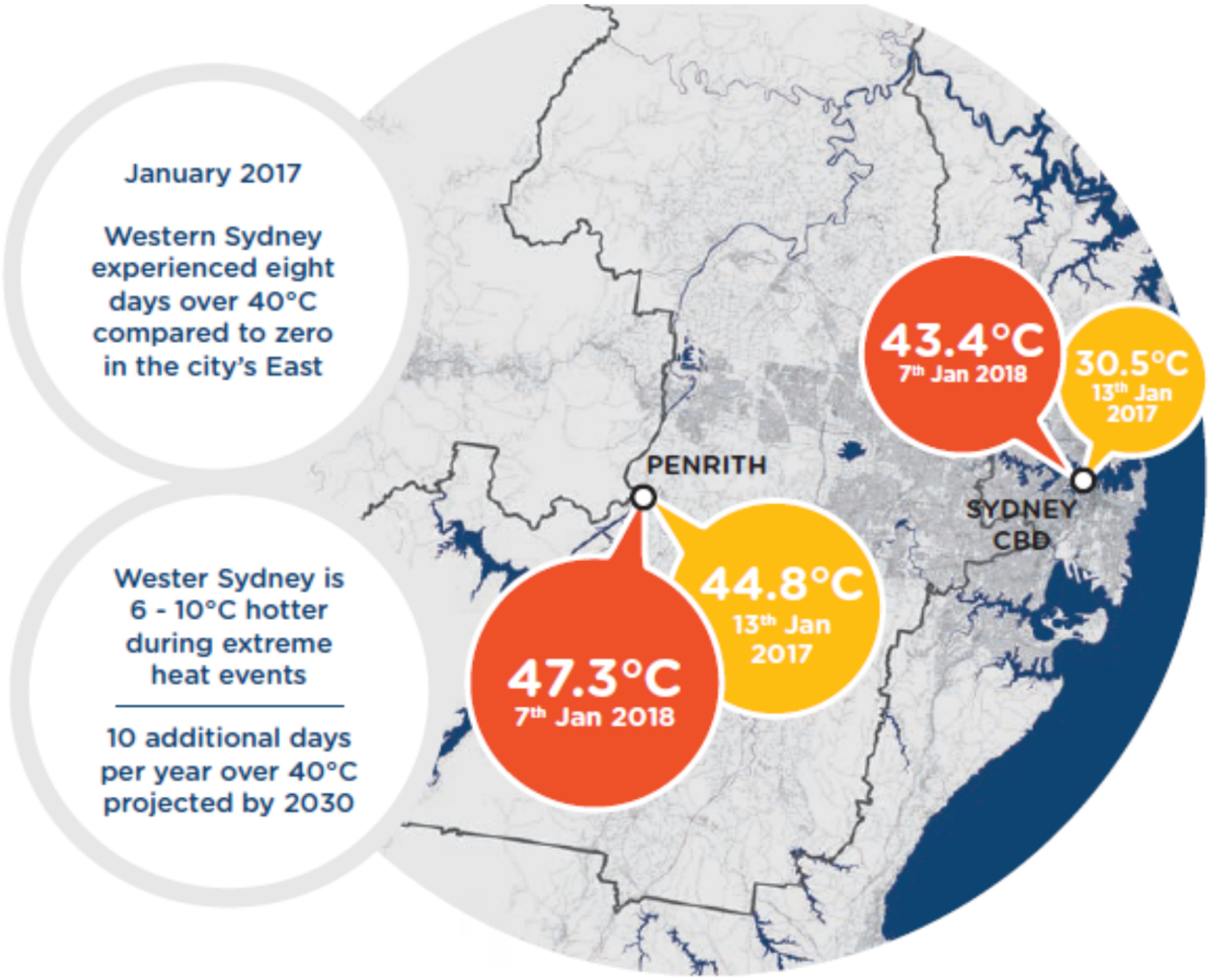


Figure 4: Heatwaves in Sydney (WSROC, 2018)

social and economic values. The river system is critical to the region's agricultural and fishing industries and is an important source of recreation for residents (RCE-GWS, 2018). But it is a threatened system; increasing development and population growth has resulted in poor water quality and a reduction in the river's environmental health.

MAJOR PLANNING DOCUMENTS

A Sydney of three cities?

The Greater Sydney Commission (GSC) was established by an Act of Parliament with specific roles and responsibilities for planning for Greater Sydney. *The Greater Sydney Region Plan: A metropolis of three cities* proposes a Sydney of three cities: Western Parkland City, Central River City and Eastern Harbour City (figure 5).

The plan was prepared concurrently with the NSW Government's *Future Transport Strategy 2056* and Infrastructure NSW's *State Infrastructure strategy 2018–2038*. It underpins five separate district plans: Western City, Central City, Eastern City, North and South districts. The district plans are designed to provide a link between regional and local planning efforts.

Western City District Plan

The district plan promises to build on the *Western Sydney City Deal* to transform the Western City District over the next 20 to 40 years by recognising natural and community assets and developing a more contained Western City District with a greater choice of jobs, transport and services aligned with growth. The plan prioritises infrastructure and collaboration, liveability, productivity, sustainability and implementation.

Figure 5: A Sydney of three cities

Western Sydney City Deal

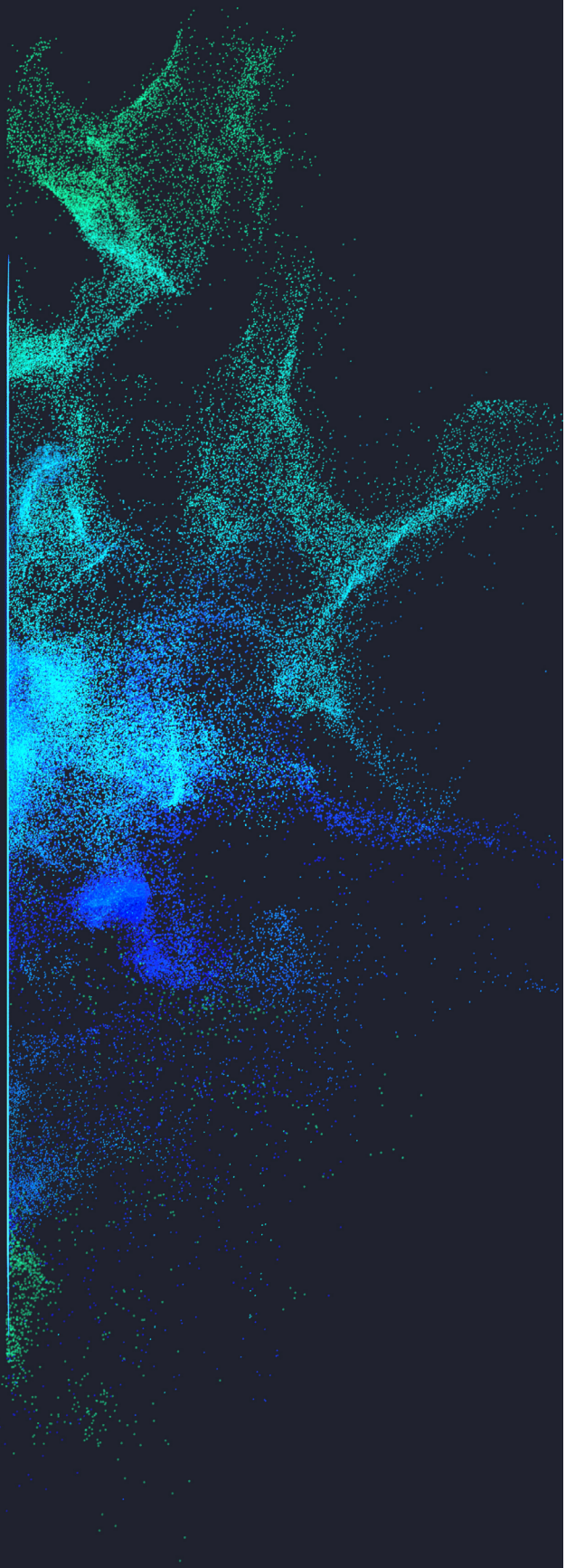
The *Western Sydney City Deal* (Department of Infrastructure, 2018) is a partnership between the Australian Government, the NSW Government and the local governments of the Blue Mountains, Camden, Campbelltown, Fairfield, Hawkesbury, Liverpool, Penrith and Wollondilly. The deal commits to:

- increasing connectivity by building a north–south rail link, rapid bus services and improving digital connectivity and smart technology
- creating 200 000 new jobs by building the Badgerys Creek Aerotropolis and establishing a Western Sydney Development Authority
- improving skills and education by creating an aerospace institute, STEM university and vet facility to upskill future workforces at the aerotropolis
- improving liveability and environment by supporting new community infrastructure and restoring and protecting the South Creek Corridor
- improving housing affordability by utilising a $30 million Western Parkland City housing package to ensure sustainable growth.

A Sydney mega-region?

In 2018 the Committee for Sydney (a think tank) produced a discussion paper about how to capitalise on the strengths of the three cities of Sydney, as well as the cities of Newcastle, Wollongong and the Central Coast (The Committee for Sydney, 2018a). In 2017 the region encompassed 70% of the NSW population and nearly 25% of the national population.

The document conceptualises a highly integrated mega-region with common housing and labour markets. The areas are currently not well connected and most people work in the place they live. Improving integration would require a transport rethink—the creation of a network of one hour or less rail connections.



REFERENCES

.IDCOMMUNITY 2018. .idcommunity demographic resource. https://profile.id.com.au/cws/seifa-disadvantage.

ABS. 2011. *Socio-Economic Indexes for Areas (SEIFA)* [Online]. Australian Bureau of Statistics,. Available: www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/22CEDA8038AF7A0DCA257B3B00116E34/$File/2033.0.55.001%20seifa%202011%20technical%20paper.pdf [Accessed 28/03/2019].

ABS. 2018. *Population Projections, Australia, 2017 (base) - 2066* [Online]. Australian Bureau of Statistics,. Available: www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3222.02017%20(base)%20-%202066?OpenDocument [Accessed 07/03/2019].

DELOITTE 2015. Shaping Future Cities. Designing Western Sydney. A blueprint for the economic transformation of Western Sydney. https://www2.deloitte.com/au/en/pages/future-of-cities/articles/designing-western-sydney.html.

DEPARTMENT OF INFRASTRUCTURE, R. D. A. C. 2018. Western Sydney City Deal. Sydney: Commonwealth of Australia.

O'NEIL, P. 2016. Addressing Western Sydney's Jobs Slide. www.westernsydney.edu.au/__data/assets/pdf_file/0019/1064701/JTW_report_complete_7April.pdf: Centre for Western Sydney, Western Sydney University.

RANDOLPH, B. & TICE, A. 2014. Suburbanizing Disadvantage in Australian Cities: Sociospatial Change in an Era of Neoliberalism. *Journal of Urban Affairs*, 36, 384-399.

RCE-GWS 2018. About Greater Western Sydney. www.westernsydney.edu.au/rcegws/rcegws/About/about_greater_western_sydney.

SYDNEY WATER CORPORATION 2017. Cooling Western Sydney. A strategic study on the role of water in mitigating urban heat in Western Sydney.

THE COMMITTEE FOR SYDNEY 2018a. The Sandstone Mega-region. Uniting Newcastle, the Central Coast, Sydney and Wollongong. www.sydney.org.au/wp-content/uploads/2015/10/Committee_The_Sandstone_Mega-region_Final_Web2.pdf.

THE COMMITTEE FOR SYDNEY 2018b. Seeing the City. Towards a data-driven Sydney. www.sydney.org.au/wp-content/uploads/2019/01/CfS_Seeing-the-City_2018.pdf.

THE URBAN DEVELOPER. 2018. How Western Sydney has transformed over the last decade. August 14.

UNDESA 2014. World urbanization prospects: The 2014 revision—highlights. Report by Department of Economic and Social Affairs, Population Division, United Nations, New York.

WSROC 2018. Turn Down the Heat. Strategy and Action Plan. Blacktown: WSROC.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