

Accessibility to great local places: Understanding the promise of access-based planning for the Six Cities Region

Author:

Roper, Josephine; Pettit, Christopher

Publication details:

Commissioning Body: Greater Cities Commission

Publication Date:

2025-05-12

DOI:

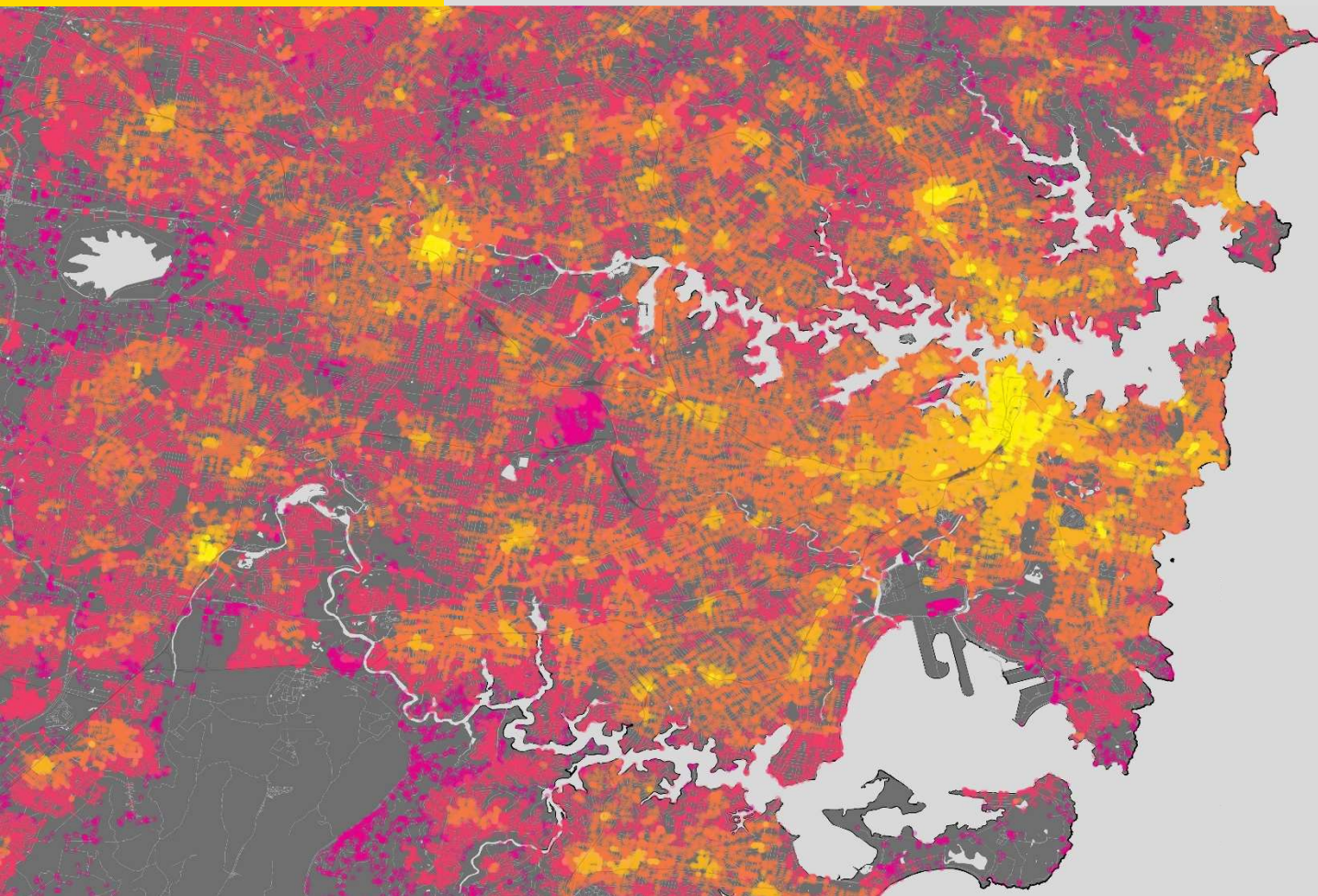
<https://doi.org/10.26190/unsworks/31115>

License:

<https://creativecommons.org/licenses/by-nd/4.0/>

Link to license to see what you are allowed to do with this resource.

Downloaded from <http://hdl.handle.net/1959.4/104845> in <https://unsworks.unsw.edu.au> on 2025-08-06



Accessibility to great local places: Understanding the promise of access-based planning for the Six Cities Region

Josephine Roper
Chris Pettit
April 2025



City Futures Research Centre, Faculty of Arts, Design and Architecture, UNSW Sydney
cityfutures.adfa.unsw.edu.au ©

City Futures Research Centre, UNSW Sydney, 2025.

This report is based on research commissioned by the Greater Cities Commission 2023 City Futures Fellowship Program.

Accessibility to great local places: Understanding the promise of access-based planning for the Six Cities Region

Josephine Roper*, Christopher Pettit

* Corresponding author: j.roper@unsw.edu.au

Key highlights

- Time-based access goals such as ‘15 minute cities’ have recently proliferated in urban planning documents world wide, including the Six Cities Region of NSW, Australia
- This report summarises recent developments and outlines a framework for flexible yet robust use of such goals in NSW, incorporating: target-setting with the community, measurement methods and ongoing monitoring
- Key data sources are needed and priorities for improved measurement and data sharing are outlined

Abstract

Appealing chrono-urbanist concepts such as ‘15 minute cities’ have recently sparked discussion across the world, but there is no international agreement on optimal measurement practice nor consensus on the most productive approaches to implementation. Time-based access goals have also begun appearing in Australian planning documents and can provide a way to crystallise visions of socially and environmentally sustainable access that creates vibrant local places. This report summarises recent developments and suggests opportunities to optimise time-based access goal use, specifically in the Six Cities Region of New South Wales, Australia.

Firstly, a summary of time-based access goals in current NSW planning documents is provided, and an introduction to the concept of access-based planning. Secondly, review of the academic and policy literature reveals that the x-minute city is a problematic concept as it is used as a label for a diverse mix of goals and actions. Nevertheless, its popularity points to the unmet need for methods to quantify and prioritise local, active transport-based access, and the importance of being able to explain how making changes could benefit residents in terms of time saved and increased access to opportunities.

In the third part of the paper, discussion of the difficulty of turning goals into action in this area is followed by review of approaches that have been taken to target setting, and an outline of feasible options for local access measurement (including opportunities for data enhancement and long-term monitoring).

Major conclusions are that targets need to be developed with local communities; international models are not fit for the Six Cities geographic and social context and stakeholder buy-in involved in target setting is also essential for implementation. In terms of measurement, while a plethora of data sources have been identified, currently there is no accepted ‘off the shelf’ or even best practice approach to measurement of time-based access goals. Thus, it is important to develop the skills of planners to program analyses using a range of data sources and tools.

Table of Contents

<i>Key highlights</i>	3
<i>Abstract</i>	3
<i>1. Introduction</i>	5
<i>2. Understanding the ‘15 minute city’ concept in planning policy</i>	7
<i>3. Approach</i>	8
<i>4. Turning goals into action.....</i>	8
4.1 Overcoming perceptions of potential negative consequences	9
4.2 Modern approaches to data sharing can encourage accountability	11
4.3 Suggestions for turning access goals into action	11
<i>5. Target Setting</i>	12
5.1 Access targets need to be place-specific.....	12
5.2 Selection of highly specific goals is important.....	13
5.3 Community consultation for target setting is crucial	15
5.4 Target setting suggestions for the Six Cities Region.....	15
<i>6. Measurement.....</i>	16
6.1 Tools for calculation	16
6.2 Data	17
6.3 Monitoring	21
6.4 Measurement suggestions for Six Cities Region:.....	21
<i>Conclusion and implications for the future</i>	22

Postscript

This report was written as a discussion paper for the NSW Government Greater Cities Commission, which was dissolved prior to publication of this report. UNSW has permission to publish this report in order to share the research undertaken. This report does not represent NSW government policy.

1. Introduction

This paper reviews recent uses of time-based access goals in urban planning and discusses how to optimise their use, specifically in the Six Cities Region of New South Wales (NSW), Australia.

The Six Cities Region is a mega-region consisting of the cities and surrounding areas of Newcastle, Wollongong, Gosford, and the three cities of Greater Sydney: the Eastern Harbour City, Central River City and Western Parkland City. The population of the region is around 6 million people and it follows New South Wales' east coast in a strip 350 kilometres long and 100 kilometres wide. The region forms a largely contiguous urbanised area which is economically interconnected, yet highly heterogeneous, ranging from dense urban centres to suburban and semi-rural land.

Planning for this region is complex, with transport and housing planning being carried out by both the state government and local governments – 44 local governments in total. The former Greater Cities Commission was established to co-ordinate planning across this region, in order to deliver the benefits of both global economic scale and local liveability. Developing more good jobs closer to where people live was also a central aim.

In the last 5 years, the concept of '15-minute cities', and adaptations of this concept, has spread rapidly through the planning world¹. Examples include Melbourne (20-minute neighbourhoods), Singapore (20 minute towns and a 45 minute city), Portland (20 minute neighbourhoods), Brussels (10 minutes), Paris (15 minute city), China (15 minute Community Life Circles), Ottawa (15 minute neighbourhoods), and Leeds (10 minute neighbourhoods). Going forward in this paper 'x-minute' will be sometimes used to indicate such time-based goals.

In NSW, time-based access goals have appeared in diverse ways in planning documents, which are summarised in Table 1 below. These access goals mention a variety of distances, modes of travel, destinations and can be either person focused (what a resident can reach around their home) or place focused (where housing is mentioned with reference to proximity to a centre). The documents are ordered roughly from least to most recent, although were generally prepared with public consultation periods over varying periods of time.

So far, these plans have not necessarily led to direct substantive action toward these aspirational goals. Thus, the aim of this discussion paper is to review recent and relevant literature which may provide guidance on implementation approaches, governance arrangements and measurement options for effective use of time-based access goals in planning.

Table 1: Time-based access goals in NSW planning documents

Document	Key wording/goal/s
Greater Sydney Commission - Greater Sydney Region Plan 2018	A 30-minute city is where most people can travel to their nearest metropolitan centre or cluster by public transport within 30 minutes; and where everyone can travel to their nearest strategic centre by public transport seven days a week to access jobs, shops and services.
Transport for NSW - Future Transport Strategy 2056 (published 2018-2020)	In Greater Sydney, the '30-minute city' will mean residents can access jobs and services in their nearest metropolitan or strategic centre within 30 minutes by public transport, walking and/or cycling, seven days a week.
Department of Planning and Environment (DPE) - Illawarra-Shoalhaven Regional Plan 2041	No specific time-based access goals.
DPE - Draft Central Coast and Hunter Regional Plan 2041	<ol style="list-style-type: none"> 1. most needs can be met within a 15-minute walk, bike or drive if you are in a rural area. 2. reasonably easy travel across communities and differing contexts by walking, cycling or public transport to less frequent, more specialised needs within 30-minutes
DPE - Central Coast and Hunter Plan 2041	<ol style="list-style-type: none"> 1. people can generally access most everyday needs within a 15-minute walk or cycle from where they live 2. In rural contexts [...] people to be able to access most needs within a 30-minute drive to a strategic centre 3. The 90-minute region will connect the [six cities of the Six Cities Region]. Fast rail will be essential to this vision.
Draft Design and Place State Environmental Planning Policy 2021 (not adopted) – Urban Design Guide	All homes are within 15 to 20 minutes walk of a collection of local shops, a primary school, public transport, a supermarket or grocery store.
Greater Cities Commission - Six Cities Region Discussion Paper 2022	<ol style="list-style-type: none"> 1. Everyone in the Six Cities Region lives in an inclusive and vibrant community that connects them to quality housing, services, jobs and amenities within a 15 minute walk or cycle in their local centre and neighbourhood, and 2. within 30 minutes by public transport to strategic centres, jobs and other key destinations including health and education. This may include 24/7 access in some areas.
TfNSW - Future Transport Strategy (published 2022)	<ol style="list-style-type: none"> 1. Key destinations (strategic centres, major health precincts, tertiary education precincts and cultural or leisure destinations) are accessible 24/7 within 30 minutes by public transport. 2. 15-minute neighbourhoods support local communities and healthy lifestyles by prioritising place making, walking, cycling, micromobility and last mile freight. Thriving 15-minute neighbourhoods feature shops, transport and facilities easily accessible by walking or cycling. They have tree canopy cover and shade, quality public spaces, well-designed roads and pathways with safe speeds, and a concentration of activities that bring people onto streets.

2. Understanding the ‘15 minute city’ concept in planning policy

The 15-minute city has been described as a ‘slippery ideal’² – simple on the surface but difficult to define in detail. This review confirmed this, finding a lack of consensus on the purpose behind these measures, methods of measurement and approaches to monitoring that can support improvement.

In the reviewed literature time-based access goals function in one (or more) of four main ways. The first is as a utopian planning vision in the tradition of garden cities³. This can be in the context of designing a 15 minute city from scratch, or the retrofitting of current cities. The second is as a promise to residents to fix problems – chiefly providing greater access and saving time. The third is a way to pursue goals that may be a city’s goals but not its residents’, such as mode shift for sustainability reasons. And finally, many cities appear to have added 15-minute city goals as a catchphrase or label for all kinds of ‘good’ in a city, but without any particular actions attributable to them^{1,3}.

It is often not clear what problems 15-minute city visions are trying to solve – or alternately they are sold (by some proponents) as solving every problem of city life. In NSW, goals underlying the descriptions provided in Table 1 include both the economic health of local centres and improved access - to more services in less time and a modal shift to walking, cycling and public transport.

What is access-based planning?

Access-based planning is the approach of enhancing people’s lives via more access to places and opportunities, rather than via more mobility. This can also be known as proximity-based planning, especially when considering access by short-distance modes such as walking, which relies heavily on proximity. Actions towards ‘15-minute cities’ can sometimes involve increased mobility (especially for longer distance goals such as ‘30 minutes by public transport’) but often there is the implication that cities will need to densify to bring destinations within walking or cycling distance of residents – using proximity to improve access while maintaining or reducing mobility. The ‘mobility versus accessibility debate’ has so far primarily taken place in the field of transport planning⁴, even though integrated land-use and transport planning is acknowledged as the key to improving access. Increased appearance of access thinking in non-transport planning departments, in the form of time-based access goals, is a welcome development, with the potential to help bridge the gap between land-use and transport planning.

Some jurisdictions have begun to move away from ‘15 minute city’ wording towards more actionable access goals – for example Leeds’ draft Local Plan has recently removed ‘20 minute neighbourhoods’ as a policy headline, although 20 minute neighbourhood wording is still present within the policy^{5–7}. The new title for the policy is ‘Achieving complete, compact and connected places in Leeds’, and at first glance, replacing vague chrono-urbanist wording with equally vague wording is not necessarily desirable. However, in fact Leeds has retained a measurement system based on the percentage of a defined set of destinations available within a 10-minute walk, and has implemented two key actions based on this. One is that accessibility maps will be kept online and updated annually, and the second, and more important, is that new residential development of 5 units or more may only take place where at least ‘good’ access by this measure is available. This is an example of a concrete, implementable policy emerging from x-minute city concepts, adapted to local priorities. The announcement of increased transit-orientated development in NSW⁸ shows a related complementary approach – encouraging housing in accessible areas rather than discouraging it in inaccessible areas.

Despite the difficulties of using an x-minute city concept, there are good reasons for its rapid rise in popularity. Firstly, it points out a gap due to the paucity of quantitative methods and goals for local, active-transport access. Second, planners' desire for positive, people-centric planning – to be able to design a more convenient, liveable future for residents. Finally, the almost self-explanatory simplicity of the surface level of the concept, which meets needs for communication with citizens, policy-makers and politicians.

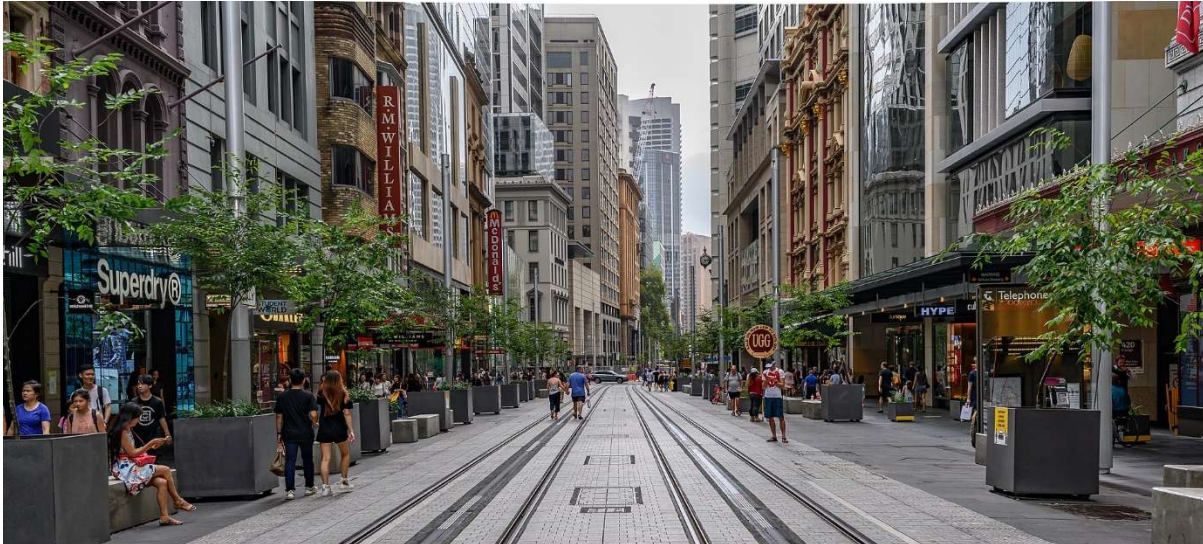


Figure 1: The pedestrianisation of George St is an example that can fit the 15-minute city utopian vision: improving effective access by foot and public transport while boosting the local economy. (Image © [Bengt Nyman](#), [George Street, Sydney CBD in Feb 2019](#), CC BY 2.0)

3. Approach

To date, most discussion of chrono-urbanist goals has been in city planning documents¹, followed more recently by an increase in academic publications⁹. The field is evolving rapidly, and comprehensive recent reviews (2023) have been undertaken on both government planning documents^{1,10} and the measurement-focused academic literature⁹. Thus, this discussion paper rather than duplicating such work has built on it with a specific focus on academic and grey literature that could provide guidance on practical implementation of time-based access planning in NSW.

Following a comprehensive search, 17 key documents were identified, 13 in the peer reviewed planning literature^{1,10–20} and 4 important government or grey literature publications^{21–24}. Many other academic papers were identified^{9,25–31}, but were primarily measurement exercises and while sometimes interesting, were not linked to policy goals and practical city planning.

The results and discussion that follows is structured in four sections, focused on overall policy implementation, target setting, measurement and monitoring.

4. Turning goals into action

While an elegant example is underway in Leeds (described above), unfortunately Gower and Grodach's recent review of 33 cities' planning documents, found "a general lack of implementation with [neither] measurability nor statutory policy weight to support planners to enact the concept in practice"¹. Other reviews and the investigation reported in this discussion paper found little

improvement on this situation in the intervening year¹⁰. Thus, there is disappointingly little guidance available on how to effectively plan for these goals and facilitate effective implementation.

Two more recent documents were found to be of relevance to the options available to the DPHI. In Scotland, suggestions recently published for discussion by the Scottish Town Planning Institute include incorporating 20-minute neighbourhood outcomes into development application assessment, planning authority performance assessment frameworks, and transport appraisals²². In Melbourne, a State government commissioned report includes recommendations to strengthen the Victoria Planning Provisions, develop guidelines and resources and continue a program of 'pilot neighbourhoods' that are being used to test and monitor 20 minute neighbourhood projects²⁴. There is a lack of precision in some of the documentation provided and it will be interesting to see formal evaluations of the pilots.

Major barriers to implementation in both the Six Cities and other jurisdictions include the multiple types and numbers of agencies necessarily involved (and lobby and special interest groups, such as business chambers, motorist and cyclist lobby groups) and the fact that changes may disadvantage some groups³². Additionally, there is often a lack of clarity about the purpose of proposed accessibility goals and they may be insufficiently detailed (this will be discussed further in Section 6, 'Target Setting'). Finally, regular monitoring with publicly available results is uncommon.

4.1 Overcoming perceptions of potential negative consequences

Conspiracy theories about 15 minute neighbourhoods arose around the time of COVID neighbourhood lockdowns when some governments placed geographical restrictions on where people could travel³³, and are frequently based on misinformation about being 'locked in' to a small area^{34,35}. While not literally true, this perhaps resonates with an understandable fear of reduced access to rich and varied opportunities across a city. Within the limitations of space and time in urban areas, improving local access may sometimes be a trade-off against longer distance access. Something as simple as a zebra crossing reallocates time from drivers (who may have to wait a few seconds) to pedestrians (who no longer have to wait for a gap to cross). If both are going to the same local centre, this results in the intended and usually uncontroversial outcome of making active transport the easiest option. But some car journeys are longer, to destinations outside a walking or cycling radius, and the cumulative effect of many changes to crossing timings across a city could extend already long car journeys.

One solution for maintaining longer distance access involves grade separation of longer distance transport – such as train and motorway tunnels and bridges. But all private vehicle journeys involve some surface component, and buses on surface roads are a vital part of the public transport network.

Because the price of housing is generally positively correlated with access^{36,37}, increasing access inequality can potentially worsen social disadvantage^{38,39}. This could be the case if '15 minute neighbourhoods' result in the most accessible areas experiencing improved local accessibility, while areas already suffering from infrastructure disadvantage experience reduced access to more distant destinations¹⁸. A suggested solution is for access-based planning to focus on achieving a sufficient level of access for all, supported by clearly defined targets⁴⁰.



Figure 2: Infrastructure such as pedestrian crossings is often evaluated in terms of safety for pedestrians versus delay for drivers. Accurately measuring local access goals means reduced delay for pedestrians also needs to be considered. (Image © Friends of Erskineville, X, 28/11/2022)

In the Six Cities region, developing a combination of local access goals and longer-range goals such as ‘30 minute access to strategic centres’ (see Figure 4 on page 16 for example), and the ‘90 minute region’ can help ensure (and reassure) that opportunities to reach more distant destinations are always provided for. This will make it more likely that goals can be developed that are accepted by both the community and the many involved agencies.

In fact, Transport for NSW’s ‘Movement and Place’ concept can be seen as a way to balance local access (place) against longer distance access (movement), but the associated guidance is most developed at the level of individual segments (streets, paths and plazas)ⁱ. Policies such as the Road User Space Allocation Policy and Procedure present a method for implementation starting at the network level, but the difficulty of reconciling the strong intent of its hierarchy with network mobility priorities hinders effectiveness to date. In general, these policies seem to be used assuming current levels of movement by different modes need to be maintained, and not as a way to encourage modal shift. Greater use of access-based planning may assist in resolving these conflicts by showing the access benefits of more imaginative changes, compared to mobility-based transport planning which attempts to fulfill predicted travel demand based on current patterns.

Another important approach to reducing opposition to access goals is to ensure that they are place-based – appropriate for diverse communities in a region and these communities need to be consulted³². This is discussed further in Section 6 ‘Target Setting’.

In most cities, disparate agencies with separate funding are responsible for achieving mobility by different modes. Funding bases are often largely historical and this entrenched situation may limit funding for new approaches.

ⁱ <https://www.movementandplace.nsw.gov.au/>

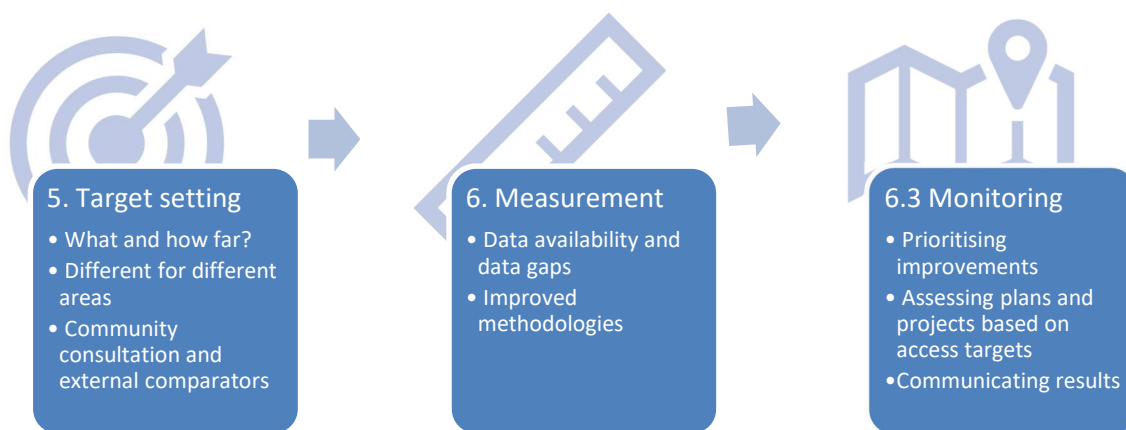
4.2 Modern approaches to data sharing can encourage accountability

Access monitoring should include provision of results on open platforms (for example, TfNSW with PTALⁱⁱ). The free release and sharing of urban information can have far more value, economically and socially, than paywalling or restricting data⁴¹. A key benefit of modern data sharing approaches that should be capitalised on is the ability for frequent updates and timely release of data. The release of live public transport data through APIs using the GTFS format is a good example of this. Technically, there is no reason that a public transport access index on an open platform could not be updated live every time the underlying timetables are updated. Certainly, updating of access calculations should not be restricted to the multi-year timeframes of typical strategic planning processes.

4.3 Suggestions for turning access goals into action

- The diverse communities of the Six Cities Region require a flexible approach to planning for access. Communities must be consulted and engaged in setting targets for their local areas.
- A staged approach should be taken to implementation, with small pilots to test that goals are feasible and acceptable and then successes built on across the wider region.
- Transport planning and funding should be based on how to best achieve access goals rather than directed to particular modes of transport.
- Mechanisms for balancing shorter distance active transport access versus long distance access by public transport and cars need to be clear and agreed upon.
- All transport projects should include modelling as to their effects on short-distance access and/or walking and cycling mode share, of at least equal effort and sophistication as any modelling undertaken for car and public transport effects.
- Access monitoring should include provision of results on open platforms.

4. Overall policy vision: turning goals into action



ⁱⁱ <https://www.movementandplace.nsw.gov.au/place-and-network/built-environment-indicators/public-transport-accessibility#metricsindetail>

5. Target Setting

This section covers principles and methods for deciding on accessibility goals, for example 20 minute neighbourhood or 30 minute city.

Jurisdictions need to closely examine the underlying reasons for wanting to introduce proximity/access-based planning concepts. The difficulty of using indicators to drive change is well documented^{42,43}. A broad 15, 20, or 30 minute vision cannot function as a target driving change – there are too many possible actions and too many agencies to coordinate. It can however potentially be decomposed into more specific targets, which will be locally variable and can take either a person-centred or a place-centred approach. Developing such precise and actionable goals is important, and best practice for measuring them is covered in the following section.

5.1 Access targets need to be place-specific

The '15 minute city' concept originates from Paris⁴⁴ where a dense, fine-grained urban form with few natural barriers allows the ambitious vision of 15 minute access to every aspect of life, including employment – in the context of predominantly service and commercial industries, with very few industrial or manufacturing jobs within the City of Paris. Across the Six Cities Region, the same target is not necessarily possible or desirable, while the measurement of access by public transport to more distant locations is also important.

The Six Cities Region is around 22,000km², with cities ranging in area from 930km² to 8000km². The cities are interconnected, with the Central River City having the lowest trip containment at 51%⁴⁵, meaning half the trips from this subcity end in one of the other cities. Apart from the Eastern and Central cities, all cities contain extensive low-density greenfield development⁴⁵, with 70% of dwellings overall being free-standing houses⁴⁶, which presents a challenge to using active and public transport. In very low-density suburban and semi-rural areas, only car travel may offer meaningful access within 30 minutes, never mind 15 minutes¹⁸.

The oldest sections of the Eastern Harbour City are still the densest overall, but they are clustered around Sydney Harbour, a drowned river valley. As a result, long peninsulas are features of the harbour and beachside suburbs, further limiting opportunities for proximity compared to a more continuous topography. The three cities of Sydney exhibit a mixture of transit-oriented development with high-density mixed-use suburbs around branches of the radial rail network but low-density, car-centred development elsewhere, while the other three cities have very limited rail services and rely on buses for public transport. 84% of households own at least one car⁴⁷.



Figure 3: Rue Milton in Paris, part of the "Rues aux ecoles" program - pedestrianisation of streets around primary schools. (Image © Guillaume Bontemps/Ville de Paris)

5.2 Selection of highly specific goals is important

Most current plans do not express their goals in the degree of detail necessary to enable measurement and implementation. There may sometimes be confusion with accessibility for disability and with promotion of walking for health – both important in themselves but actions to promote these may be minimal contributors toward ‘x-minute’ city goals. The characteristics of places that drive walking for transport/access versus walking for recreation/exercise are not the same^{48,49}, although both these walking purposes, and their supportive environmental features, can sometimes overlap.

Centre-based and person-based goals are very different and need to be kept separate. An example of a person-based goal would be to ‘Ensure every person in this LGA has 15-minute walking access to a primary school’. A possible centre-based goal, with the school as the centre is to ‘Ensure that each primary school is accessible by 15 minutes safe and pleasant walking from anywhere in its catchment’.

For a centre, there are always some number of people who live in walking distance, so the goals can be one or more of the following:

- to increase the number living in walking distance by increasing residential density
- encouraging a mode shift so that more of those people use active transport to get there, by improving walking and cycling routes in the area
- creating a destination shift – attract people who are currently preferring other centres – via enhanced route quality or destination improvement

Some European studies find that many urban areas are already 15, or even 10 or 5 minute cities by their measures^{21,28}. Yet this proximity to goods and services, the most easily measured components, has not resulted in the utopian dream of ubiquitous active transport use, social equity and sustainable economic development. In cases like this, a centre-based approach may reveal why

residents are travelling to more distant centres rather than utilising the closest services.

Then, agencies can develop a method to determine their local priorities for improvement, e.g. for a centre are: access, route quality and density of people living nearby major priorities, or perhaps it's the services and activities in the centre that are lacking. If it's the latter, solutions may include imposing requirements on commercial developers or much more specific approaches to zoning and commercial approvals. The loss of hardware stores, post offices and pharmacies can have a big effect on local centres.

Comparison of real mobility with potential mobility is a currently developing area of research thanks to the increased availability of detailed mobility data from mobile phone usage. Previously, knowledge of real mobility across cities was only possible by expensive and small-scale household travel surveys or by measuring traffic on major roads and public transport usage (depending on the ticketing system) then modelling origin and destination demand to match observed flows. The details of local access by active modes, and where exactly people go after parking the car or disembarking public transport, have been largely unknown.

Comparing real mobility with potential mobility

Zhang et al have demonstrated a method for comparing real mobility patterns with 'optimal' mobility patterns where people utilise the closest opportunities³¹, in the city of Nanjing, the capital city of Jiangsu province, China. Phone data was collected for a month. If an individual stayed at one location for more than 30 minutes, the location was considered as an activity point. The residential location was deemed to be the activity point an individual visited the most during the period of 9pm to 8am and the work location is the activity point an individual visited the most during 9am to 5pm. Point of interest (POI) data was added from a Chinese web map provider. Results demonstrated multiple subcities, with some being described as being 'imbalanced'. For instance, residents of the busy Xijiekou CBD district have abundant urban amenities (such as high-end shopping) but may not accommodate local residents' daily needs who are forced to travel for some services. This kind of methodology allows for data collection that would be highly sensitive to changes in access – e.g. the effect of a new cycleway or rail line or of a sudden expansion in the use of grocery delivery services.

Other research has approached this idea through the lens of 'excess commuting'⁵⁰ (compared to an optimal job-resident match) or by completely redesigning a city (Coimbra, Portugal) as a 'garden city' and comparing current mobility patterns with mobility in the new design¹⁶. In this study, employment is assumed to be distributed across the 3 sub-cities with no attempt to match jobs and residents, yet average travel distance to jobs drops by 30% thanks to the overall denser layout. Distances to other destinations drop by 70% with most other trips staying contained within one of 3 sub-cities. But this result assumes that residents will (wish to) visit the closest urban facility of each type available to them – this is an assumption that limits the application of learnings from idealised models to real cities. Providing opportunities to visit closer destinations does not mean every person will necessarily want to use them, and fears that this will be 'forced' underlie some of the x-minute city controversies. Nevertheless, comparing real mobility with potential mobility can at least provide insights into why people travel further than a minimised scenario, whether out of choice or lack of opportunities nearby.

5.3 Community consultation for target setting is crucial

In some areas, negative public reactions to '15-minute city' plans have shown the need for greater public communication and consultation in the process of implementing this approach³⁵. Often, time-based access goals have been added rapidly as an 'obvious good thing' without buy-in from the community, resulting in backlash even where the underlying planning has not substantially changed. Combating misinformation with more detail on what will actually be done in the name of these goals is crucial. The best way to do this is to set locally meaningful targets in consultation with communities.

The recent academic literature presents several methods for local target-setting:

- Surveys³¹: Zhang et al. in Nanjing, China surveyed 1561 residents and asked them to weight the top 3 categories of points of interest (out of a set of 'living, business, recreation, sports, culture, education, healthcare and transport'). They then measured 1.5km radius access, so residents do not give input on distance/time threshold. Similarly, city governments in Ottawa, Edmondson and Surrey consulted residents on important destinations, but not times¹⁰.
- Face-to-face workshops and public meetings: Capasso Da Silva in Tempe, Arizona¹² base their destination list on 'public meetings where residents were able to point out which non-work destinations they considered important for a good living'.
- Structured interviews with stakeholders: Moreno et al. in France²³ have released a multi-dimensional 'High Quality of Societal Life' indicator based on "Specific survey methods, including participatory workshops and structured interviews with various stakeholders led to the understanding and mapping out of daily activities and individual routines along the 6 social functions model."

Such methods are time-consuming and expensive. It is hard to make the groups representative and lobby groups can easily dominate. There is however opportunity to use small group work to develop an online survey that can be used to reach thousands of residents and repeated over time.

5.4 Target setting suggestions for the Six Cities Region

- A restricted number of targets should be initially set.
- Centre-based approaches are prioritised as they are arguably easier to develop and it is easier to find organisations who will be 'champions' for improvement.
- Communities are involved in choosing destinations for x- minute neighbourhood' measures.
- Government agencies assists 1-3 areas (centres) to pilot an approach using workshops to develop an online survey that integrates destinations, travel time and modes. For example, residents will be asked if they do or do not visit a particular local centre, what mode they use, and what improvements would be needed for them to choose a sustainable mode. Centre businesses and other stakeholders can also be consulted, for example on the number of residents needed in a catchment for particular services to be viable there.
- A trial of involving Six Cities Region communities in developing time targets should be undertaken. For example, consultation could ask 'how far are you willing to walk to X? How far would you prefer to walk? How far would you let your child walk to school alone?' This would be an innovative addition to the current global conversation on chrono-urbanism.

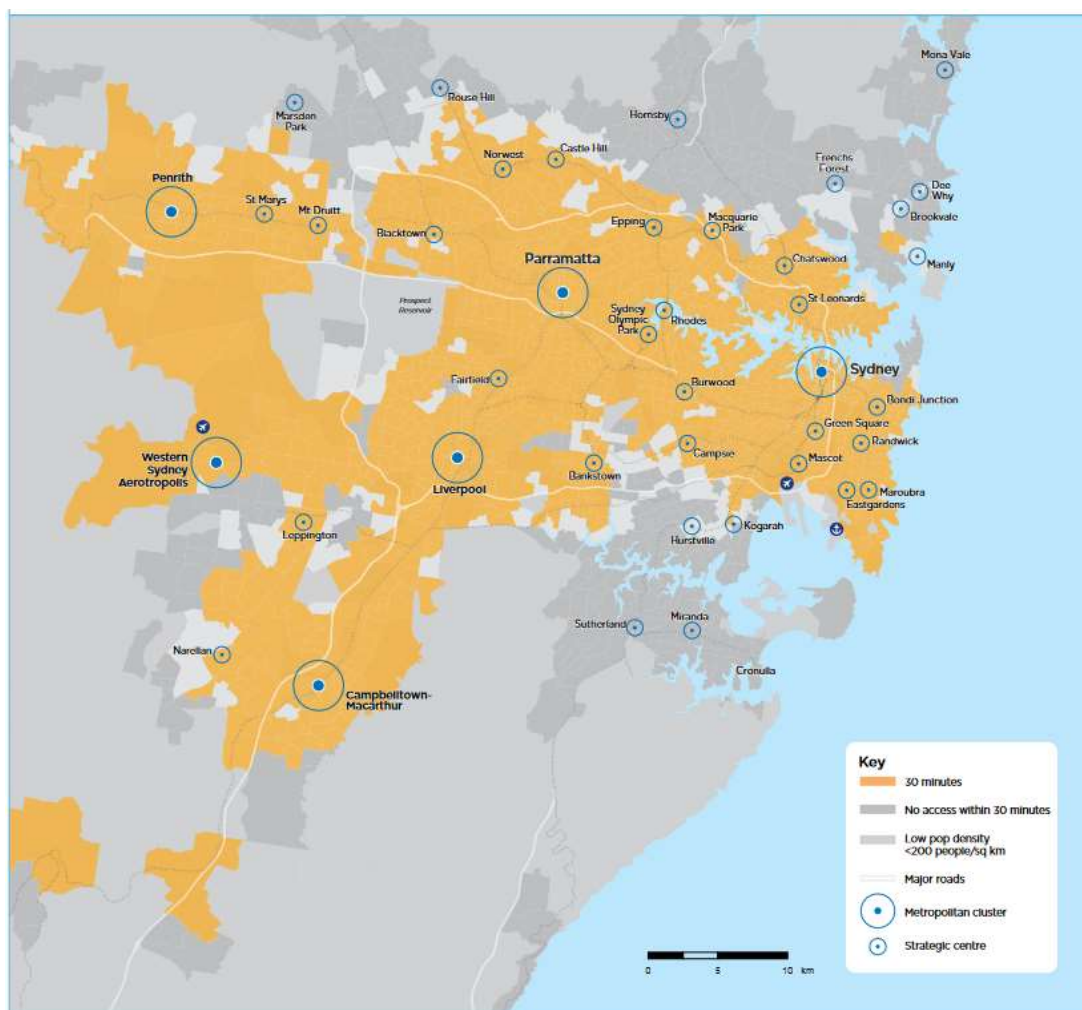


Figure 4: An example of longer distance targets: Projected 30 minute public transport access to metropolitan clusters, from the NSW Future Transport Strategy 2056

6. Measurement

This section covers methods for measuring the current status towards accessibility goals. Measurement requires calculation tools and data and needs to be designed so that regular monitoring can be undertaken.

6.1 Tools for calculation

Tools for measuring local access fall on a spectrum from pre-prepared indicators, though limited flexibility GUI tools, to flexible and powerful approaches requiring programming skills. Examples of pre-prepared indicators include existing walkability indices presented online such as WalkScore, AURIN, or WalkTHERE on Colouring Australia^{51,52}, and public transport indices such as PTAL. Directly using these pre-calculated indices can give some insights into x-minute city progress but does not allow customisation for specific targets.

A number of access calculation tools are available onlineⁱⁱⁱ. There are many free and easy to use tools for simple isochrone calculations^{iv}, but these generally do not have the customisability to

ⁱⁱⁱ <https://www.accessibilityplanning.eu/>

^{iv} <https://app.traveltime.com/>, <https://commutetimemap.com/>

implement the exact targets determined by cities, calculate many points at once, incorporate hypothetical transport and land-use changes, or additional data sources that were not available to the tool-builders.

Other tools are more sophisticated but require a licence, such as GOAT^v, TRACC^{vi} and Conveyal^{vii}. The most flexible option is for planners to be equipped with the skills to run these analyses programmatically. The major tools in use for this are: ArcGIS Network Analyst, Python based packages such as Pandana and UrbanAccess⁵³, and R-based packages⁵⁴.

Programming network analyses also opens the door for measuring path prioritisation – which segments of the network are most important for pedestrians and thus are priorities for walking environment quality improvement.

Person-centred approaches to access ideally would incorporate trip-chaining effects, as at least 30% of trips have multiple destinations and thus the proximity of destinations relative to each other has an impact on the convenience of using active or public transport to access them^{55,56}. However, methods for measuring these effects are currently under-developed^{57,58}. Measuring access to local centres and the ‘completeness’ of those centres can be an easier way to capture the additional opportunity presented by convenient multi-destination trips.

6.2 Data

There are three critical components for measurement of any access metric: population distribution, destinations (locations and attributes) and generalised cost of travel. Data can be expensive and generalised cost in particular potentially requires extensive data, so prioritisation is necessary. The time thresholds determined via a target-setting process inform what data is required, as shorter time thresholds and smaller geographical scales can benefit from more detailed data. Population distribution and demographic data is well supplied via the Census in Australia, at a suitably fine level of detail for walking distance analysis in urban areas.

The destination locations are the most important data. Destinations can be simplified by grouping them into local and strategic centres, but with some loss of fidelity as to exactly what amenities are available and to walking distances. For example, TfNSW define ‘local centre’ as “centres that provide services such as shopping, dining, health and personal services to meet the daily and weekly needs of the local community.”⁵⁹ This leaves considerable room for variation and potential inequity – must a local centre have a dentist or a GP, or does a pharmacy suffice for ‘health services’? Some local centres might have fresh food while others might only have a small supermarket or convenience store.

Generalised cost of travel can incorporate multiple factors beyond time or distance. People may be willing or able to walk further on a green and shaded route⁶⁰ and less far on a route with steep hills and heavy traffic. Although phrased as a ‘cost’, the positive aspects of ‘generalised cost of travel’ are factors that make walking and cycling attractive: tree canopy cover, natural views, interesting streetscapes, quality surfaces, and welcoming and useful street furniture. A simple way to represent generalised travel cost that maintains communicability is as ‘adjusted travel time’. So, a target could be set in terms of 10 minutes of adjusted travel time, not direct travel time. For example, research shows that waiting at traffic signals is perceived as more onerous than walking for the same length of time^{61,62}, so adjusted travel times would increase more rapidly with increasing delay at signals.

Across the type of roads found in the Six Cities Region the generalised cost of travel varies more for

^v <https://plan4better.de/en/goat/>

^{vi} <https://basemap.co.uk/tracc>

^{vii} <https://conveyal.com/>

cycling than for walking. This is because many segments are unusable for most current or potential cyclists. A common approach in literature is to use only a 'low stress network' to calculate cycling travel times. Although there are different approaches to defining and weighting this network^{63–65}, any published method is an improvement on using the full cyclable network. Novel approaches underway include current work at UNSW using a virtual reality cycling simulator to quantify the perceived safety of different road designs^{viii}.

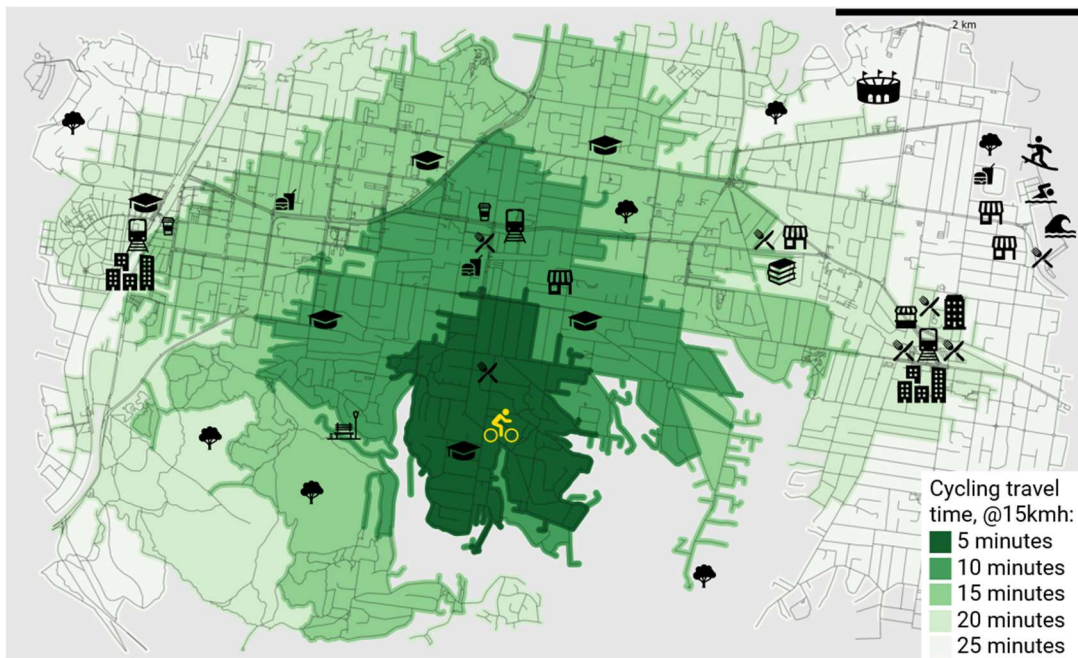


Figure 5: Isochrones of cycling access using the full road network (above) versus a low-stress network (below) showing the importance of considering cycling conditions



^{viii} <https://imoveaustralia.com/project/safer-cycling-and-street-design-a-guide-for-policymakers/>

Overall, there are some excellent data sources available in NSW to use for time-based access measures. They are listed and their strengths and weaknesses briefly discussed in Table 2 (below).

Table 2: Data sources for local access measures

Data type	Options	Cost	Currency	Comment
High priority				
Destination locations and category				
	Google Places	Proprietary	Continuously updated	
	OpenStreetMap	Free	Continuously updated, not as complete	
	Local government data			The Open Data NSW platform should be used as much as possible to share such data.
	NSW Survey data	Free	Limited range of destinations	
Walkable network (as a binary – walkable/non-walkable)	Geoscape Australia	Free	Frequently updated yet not as complete as OSM	
	OpenStreetMap	Free	Continuously updated	
	Google	Proprietary	Continuously updated	
Total cycling network	OpenStreetMap			
	TfNSW Open Data			
Low-stress cycling network	TfNSW Open Data + processing			
Public transport schedule	TfNSW Open Data			
Population characteristics	Census	Free	~4 yearly	
Medium priority				
Walking conditions	Conventional audits	Expensive	Occasional at best	
	Footpath widths		Some councils maintain this data	OSM enrichment projects ⁶⁶

Data type	Options	Cost	Currency	Comment
	AI & robot supported audits		Very new technology, but potential for frequent updates	For example https://footpath.ai/
	Participatory mapping	Potentially expensive to get large samples		Can be used to gather holistic data on walking conditions, without necessarily needing to define every input ⁵¹⁶⁷
	Gradient - survey data			
	Canopy cover – aerial imagery	Commercially available		Needs analysis with image identification software
Refining walking & cycling times	Traffic signal data	Expensive		Should be made free as in Victoria
	Google Maps API	Proprietary		
	Local audits eg using tracking devices	Expensive		
Detailed destination attributes – size/capacity, opening hours	Google Places		Continuously updated	
	OpenStreetMap		Continuously updated	
	Localised audits			
	State government data (eg, on school enrolments)			Often available through data.nsw.gov.au
Public transport reliability & perceived reliability	TfNSW realtime APIs	Expensive to work with		Perceived reliability affects how much buffer time people allow for public transport journeys, and thus influences true door-to-door travel times

6.3 Monitoring

Measurement and monitoring must form a continuous loop, with access assessment against targets able to be easily and quickly redone. This facilitates checking the effect on local access of anything from a single traffic signal timing change to different designs for a large development site⁶⁸.

Access monitoring should include providing the results on open platforms as described in section 4.2. Developing and maintaining access measurement and visualisation skills in government will be required to use these methods broadly.

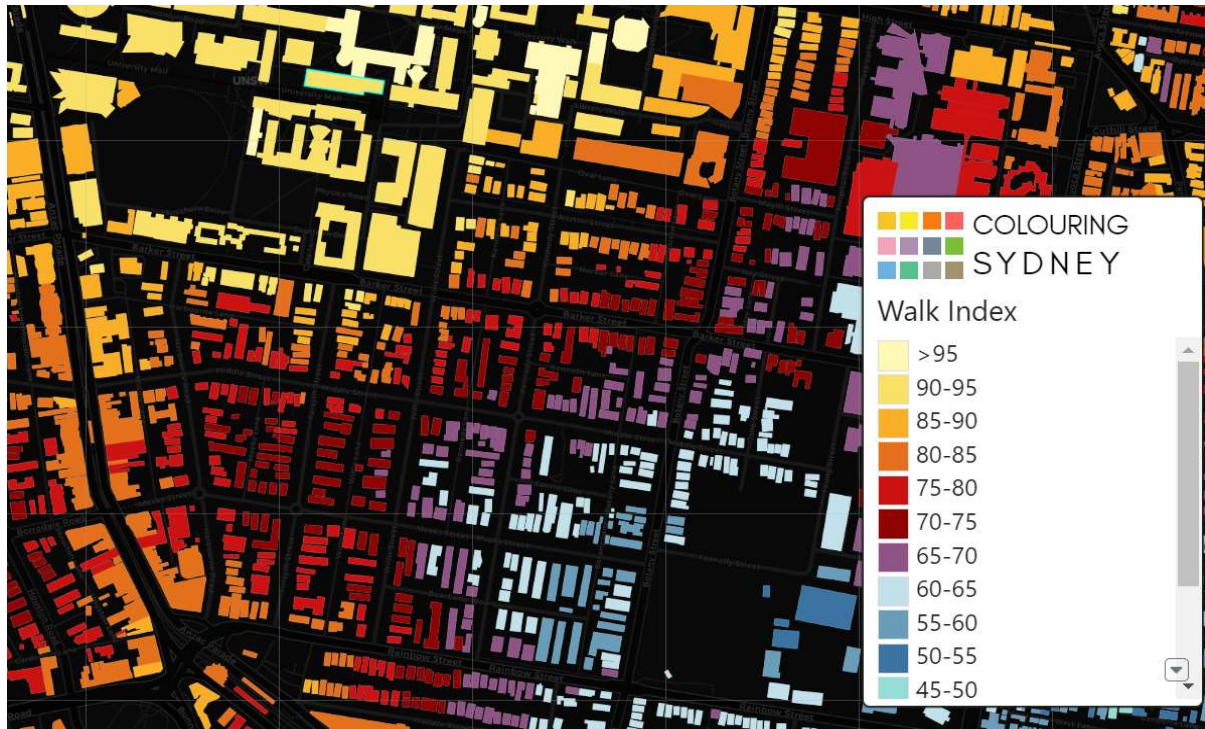


Figure 6: Example of a walkability index displayed on an open platform, Colouring Australia⁵¹. Data can be downloaded and full calculation details are available⁵².

6.4 Measurement suggestions for Six Cities Region

- Provision of on-going training for planners in using and measuring access goals
- Continued investment in release of open data and in data.nsw.gov.au
- Public transport times be measured door to door including walking and waiting time and ideally incorporate uncertainty around reliability in the quantification of generalised cost
- Cycling times use a low-stress cycling network
- Walking times account for varied walking speeds in the population⁶⁹ and do not use an inappropriately high average speed^{9,21}
- Walking times explicitly incorporate delay due to traffic signals, with data to be made freely available from TfNSW to facilitate this
- Consider supporting research into incorporating trip chaining considerations in access measures

Conclusion and implications for the future

The idea of a '15 minute city' including employment is a promise of convenience and liveability which would require radical changes to land use and transport to truly achieve. '15 minute neighbourhoods' and other targets proposed in NSW are less demanding, yet still make a substantial promise to the community. Where these promises are made, they need to be supported by all agencies involved, not treated as window-dressing, 'city branding'¹ or a vague commitment to increasing walking and cycling that falters in the face of the inevitable trade-offs involved. Few, if any cities provide a solid story of achievement, however the literature provides clues about approaches most likely to be successful. The recommendations are summarised in Table 3 (below).

The Six Cities region is a complex situation for integrated land use and transport planning, with functions devolved across different bodies at multiple levels of government. The geography of the region, its diverse high and low-density housing, long distances for public transport and low uptake of transport cycling create further difficulties. However, there is an impressive range of data available for measurement and monitoring against agreed targets. This together with dedicated skilled planners and strong community consultation offers promise for the use of time-based goals and improvement in the liveability of the Six Cities region.

Table 1: Suggestions for the Six Cities Region

Suggestions for turning access goals into action

- The diverse communities of the Six Cities Region require a flexible approach to planning for access. Communities must be consulted and engaged in setting targets for their local areas.
- A staged approach should be taken to implementation, with small pilots to test that goals are feasible and acceptable and then successes built on across the wider region.
- Transport planning and funding should be based on how to best achieve access goals rather than directed to particular modes of transport.
- Mechanisms for balancing shorter distance active transport access versus long distance access by public transport and cars need to be clear and agreed upon.
- All transport projects should include modelling as to their effects on short-distance access and/or walking and cycling mode share, of at least equal effort and sophistication as any modelling undertaken for car and public transport effects.
- Access monitoring should include provision of results on open platforms.

Suggestions for target setting

- A restricted number of targets should be initially set.
- Centre-based approaches are prioritised as they are arguably easier to develop and it is easier to find organisations who will be 'champions' for improvement.
- Communities are involved in choosing destinations for x- minute neighbourhood' measures.
- Government agencies assists 1-3 areas (centres) to pilot an approach using workshops to develop an online survey that integrates destinations, travel time and modes. For example, residents will be asked if they do or do not visit a particular local centre, what mode they use, and what improvements would be needed for them to choose a sustainable mode. Centre businesses and other stakeholders

can also be consulted, for example on the number of residents needed in a catchment for particular services to be viable there.

- A trial of involving Six Cities Region communities in developing time targets should be undertaken. For example, consultation could ask 'how far are you willing to walk to X? How far would you prefer to walk? How far would you let your child walk to school alone?' This would be an innovative addition to the current global conversation on chrono-urbanism.

Suggestions for best practice in measurement

- Provision of on-going training for planners in using and measuring access goals
- Continued investment in release of open data and in data.nsw.gov.au
- Public transport times be measured door to door including walking and waiting time and ideally incorporate uncertainty around reliability in the quantification of generalised cost
- Cycling times use a low-stress cycling network
- Walking times account for varied walking speeds in the population and do not use an inappropriately high average speed
- Walking times explicitly incorporate delay due to traffic signals, with data to be made freely available from TfNSW to facilitate this
- Consider supporting research into incorporating trip chaining considerations in access measures

References

1. Gower A, Grodach C. Planning Innovation or City Branding? Exploring How Cities Operationalise the 20-Minute Neighbourhood Concept. *Urban Policy and Research*. 2022;40(1):36-52. doi:10.1080/08111146.2021.2019701
2. Duany A, Steuteville R. Defining the 15-minute city. *Public Square*. Published online February 8, 2021. <https://www.cnu.org/publicsquare/2021/02/08/defining-15-minute-city>
3. Marchigiani E, Bonfantini B. Urban Transition and the Return of Neighbourhood Planning. Questioning the Proximity Syndrome and the 15-Minute City. *Sustainability*. 2022;14(9):5468. doi:10.3390/su14095468
4. Ferreira A, Papa E. Re-enacting the mobility versus accessibility debate: Moving towards collaborative synergies among experts. *Case Studies on Transport Policy*. Published online April 2020:S2213624X1930094X. doi:10.1016/j.cstp.2020.04.006
5. Leeds City Council. Introduction and have your say - FAQ section. Local Plan Update. October 30, 2023. <https://www.leeds.gov.uk/planning/planning-policy/local-plan-update/introduction-summary-and-have-your-say>
6. Leeds City Council. *Tracked Changed Version of Local Plan Update Pre-Submission Draft Changes*.; 2023. <https://www.leeds.gov.uk/Local%20Plans/LPU%20Pre-Submission%20Oct%202023/02%20LPU-PSC%20Tracked%20Changed%20version%20of%20Local%20Plan%20Update%20Pre-Submission%20Policies.pdf>
7. Leeds City Council. *Leeds Local Plan Update Pre-Submission Changes - Placemaking Background Paper*. Leeds City Council; 2023. <https://www.leeds.gov.uk/Local%20Plans/LPU%20Pre-Submission%20Oct%202023/LPU-PSC%20Placemaking%20Background%20Paper.pdf>
8. Department of Planning and Environment. A Shared Responsibility: The plan to begin addressing the housing crisis in NSW | NSW Government. NSW Government. December 7, 2023. Accessed December 16, 2023. <https://www.nsw.gov.au/media-releases/addressing-housing-crisis-nsw>
9. Papadopoulos E, Sdoukopoulos A, Politis I. Measuring compliance with the 15-minute city concept: State-of-the-art, major components and further requirements. *Sustainable Cities and Society*. 2023;99:104875. doi:10.1016/j.scs.2023.104875
10. Lu M, Diab E. Understanding the determinants of x-minute city policies: A review of the North American and Australian cities' planning documents. *Journal of Urban Mobility*. 2023;3:100040. doi:10.1016/j.urbmob.2022.100040
11. Allam Z, Chabaud D, Gall C, Pratlong F, Moreno C. On proximity-based dimensions and urban planning: historical precepts to the 15-minute city. In: *Resilient and Sustainable Cities*. Elsevier; 2023:107-119. doi:10.1016/B978-0-323-91718-6.00005-0
12. Capasso Da Silva D, King DA, Lemar S. Accessibility in Practice: 20-Minute City as a Sustainability Planning Goal. *Sustainability*. 2019;12(1):129. doi:10.3390/su12010129
13. Capolongo S, Rebecchi A. The city of proximity as an Urban Health strategy for the post pandemic neighborhood's needs. In: *European Journal of Public Health*. Vol 31. ; 2021:ckab164.495. doi:10.1093/eurpub/ckab164.495
14. Gurr JM. From the "Garden City" to the "Smart City": Literary Urban Studies, Policy Mobility Research and Travelling Urban Models. In: *Charting Literary Urban Studies: Texts as Models of and for the City*. Routledge; 2021.
15. Khavarian-Garmsir AR, Sharifi A, Sadeghi A. The 15-minute city: Urban planning and design efforts toward creating sustainable neighborhoods. *Cities*. 2023;132:104101. doi:10.1016/j.cities.2022.104101
16. Monteiro J, Sousa N, Natividade-Jesus E, Coutinho-Rodrigues J. Benchmarking City Layouts—A Methodological Approach and an Accessibility Comparison between a Real City and the Garden City. *Sustainability*. 2022;14(9):5029. doi:10.3390/su14095029
17. Moreno C, Allam Z, Chabaud D, Gall C, Pratlong F. Introducing the "15-Minute City": Sustainability, Resilience and Place Identity in Future Post-Pandemic Cities. *Smart Cities*. 2021;4(1):93-111. doi:10.3390/smartcities4010006

18. Poorthuis A, Zook M. Moving the 15-minute city beyond the urban core: The role of accessibility and public transport in the Netherlands. *Journal of Transport Geography*. 2023;110:103629. doi:10.1016/j.jtrangeo.2023.103629
19. Pozoukidou G, Chatziyiannaki Z. 15-Minute City: Decomposing the New Urban Planning Eutopia. *Sustainability*. 2021;13(2):928. doi:10.3390/su13020928
20. Rebecchi A, Crespi F, Capolongo S. (Re)thinking the city of proximity for Salutogenic purposes. In: *15th European Public Health Conference 2022*. ; 2022.
21. Büttner B, Seisenberger S, Baquero Larriva MT, et al. *±15-Minute City: Human-Centred Planning in Action*. EIT Urban Mobility, TUM; 2022.
22. Calvert R. *20 Minute Neighbourhoods: Implementing 20 Minute Neighbourhoods in Planning Policy and Practice*. Royal Town Planning Institute; 2021.
23. Moreno C, Gall C, Chabaud D, Garnier M, Illian M, Pratlong F. *The 15-Minute City Model: An Innovative Approach to Measuring the Quality of Life in Urban Settings (30-Minute Territory Model in Low-Density Areas)*. Université Paris 1 Panthéon Sorbonne; 2023. <https://hal.science/hal-04065455>
24. Victoria State Government. *20-Minute Neighbourhoods: Creating a More Liveable Melbourne*. Department of Environment, Land, Water and Planning; 2019:100773. Accessed November 15, 2023. <https://linkinghub.elsevier.com/retrieve/pii/S221414051930547X>
25. Birkenfeld C, Victoriano-Habit R, Alousi-Jones M, Soliz A, El-Geneidy A. Who is living a local lifestyle? Towards a better understanding of the 15-minute-city and 30-minute-city concepts from a behavioural perspective in Montréal, Canada. *Journal of Urban Mobility*. 2023;3:100048. doi:10.1016/j.urbmob.2023.100048
26. Ferrer-Ortiz C, Marquet O, Mojica L, Vich G. Barcelona under the 15-Minute City Lens: Mapping the Accessibility and Proximity Potential Based on Pedestrian Travel Times. *Smart Cities*. 2022;5(1):146-161. doi:10.3390/smartcities5010010
27. Olsen JR, Thornton L, Tregonning G, Mitchell R. Nationwide equity assessment of the 20-min neighbourhood in the scottish context: A socio-spatial proximity analysis of residential locations. *Social Science & Medicine*. 2022;315:115502. doi:10.1016/j.socscimed.2022.115502
28. Staricco L. 15-, 10- or 5-minute city? A focus on accessibility to services in Turin, Italy. *Journal of Urban Mobility*. 2022;2:100030. doi:10.1016/j.urbmob.2022.100030
29. Thornton LE, Schroers RD, Lamb KE, et al. Operationalising the 20-minute neighbourhood. *Int J Behav Nutr Phys Act*. 2022;19(1):15. doi:10.1186/s12966-021-01243-3
30. Weng M, Ding N, Li J, et al. The 15-minute walkable neighborhoods: Measurement, social inequalities and implications for building healthy communities in urban China. *Journal of Transport & Health*. 2019;13:259-273. doi:10.1016/j.jth.2019.05.005
31. Zhang S, Zhen F, Kong Y, Lobsang T, Zou S. Towards a 15-minute city: A network-based evaluation framework. *Environment and Planning B: Urban Analytics and City Science*. 2023;50(2):500-514. doi:10.1177/23998083221118570
32. Emery T, Thrift J. *20-Minute Neighbourhoods: Creating Healthier, Active, Prosperous Communities An Introduction for Council Planners in England*. Town and Country Planning Association; 2021.
33. Rescorigio A. What's a 15-minute city? Liveable urban space or climate lockdown? *Thomson Reuters Foundation Newsroom*. <https://www.context.news/green-cities/whats-a-15-minute-city-liveable-urban-space-or-climate-lockdown>. November 11, 2023.
34. Addley E. 'This is political expediency': how the Tories turned on 15-minute cities. *The Guardian*. <https://www.theguardian.com/cities/2023/oct/07/15-minute-cities-rishi-sunak-tories-conspiracy-theory>. October 7, 2023. Accessed January 24, 2024.
35. Nurse A, Calafiore A, Dunning R. 15-minute cities: how to separate the reality from the conspiracy theory. *The Conversation*. <https://theconversation.com/15-minute-cities-how-to-separate-the-reality-from-the-conspiracy-theory-200111>. February 18, 2023.
36. Abelson P, Joyeux R, Mahuteau S. Modelling House Prices across Sydney. *Australian Economic Review*. 2013;46(3):269-285. doi:10.1111/j.1467-8462.2013.12013.x
37. Herath S, Jayasekare AS. City proximity, travel modes and house prices: the three cities in Sydney. *Journal of Housing and the Built Environment*. Published online March 2, 2021:25.

38. Gunn LD, Saghapour T, Giles-Corti B, Turrell G. Exploring inequities in housing affordability through an analysis of walkability and house prices by neighbourhood socioeconomic disadvantage. *Cities & Health*. Published online June 1, 2022;1-19. doi:10.1080/23748834.2022.2072058
39. Ng MKM, Roper J, Lee CL, Pettit C. The Reflection of Income Segregation and Accessibility Cleavages in Sydney's House Prices. *IJGI*. 2022;11(7):413. doi:10.3390/ijgi11070413
40. Ryan J, Martens K. Defining and implementing a sufficient level of accessibility: What's stopping us? *Transportation Research Part A: Policy and Practice*. 2023;175:103792. doi:10.1016/j.tra.2023.103792
41. Hawken S, Han H, Pettit C. Introduction: Open Data and the Generation of Urban Value. In: Hawken S, Han H, Pettit C, eds. *Open Cities | Open Data*. Springer Nature Singapore; 2020:1-25. doi:10.1007/978-981-13-6605-5_1
42. Kent JL, Harris P, Thompson S. What gets measured does not always get done. *The Lancet Global Health*. 2022;10(9):e1235. doi:10.1016/S2214-109X(22)00321-7
43. Lowe M, Whitzman C, Badland H, et al. Planning Healthy, Liveable and Sustainable Cities: How Can Indicators Inform Policy? *Urban Policy and Research*. 2015;33(2):131-144. doi:10.1080/08111146.2014.1002606
44. Moreno C. La ville du quart d'heure : pour un nouveau chrono-urbanisme. *La Tribune*. May 10, 2016.
45. Transport for New South Wales. *Directions for On-Street Transit*. NSW Government; 2023. https://ehq-production-australia.s3.ap-southeast-2.amazonaws.com/78ed816287c31ab081595d842e5bab0ac063e620/original/1698109018/35676654a98a058a18b4aab87fa7a516_CST237_On_Street_Transit_Strategy_White_Paper_Single_pages_nocrops.pdf
46. Greater Cities Commission. *The Six Cities Region: Delivery Global Competitiveness and Local Liveability*. NSW Government; 2022.
47. Australian Bureau of Statistics. Census of Population and Housing: Mesh Block Counts, Australia, 2016. Published online 2016. <https://www.abs.gov.au/ausstats/abs@.nsf/mf/2074.0>
48. Forsyth A. What is a walkable place? The walkability debate in urban design. *Urban Des Int*. 2015;20(4):274-292. doi:10.1057/udi.2015.22
49. Shuvo FK, Mazumdar S, Labib SM. Walkability and Greenness Do Not Walk Together: Investigating Associations between Greenness and Walkability in a Large Metropolitan City Context. *IJERPH*. 2021;18(9):4429. doi:10.3390/ijerph18094429
50. Zhou J, Murphy E. Day-to-day variation in excess commuting: An exploratory study of Brisbane, Australia. *Journal of Transport Geography*. 2019;74:223-232. doi:10.1016/j.jtrangeo.2018.11.014
51. Roper J, Hudson P, Petersen H, Pettit C, Russell T, Ng M. Colouring Australia: a participatory open data platform. *ISPRS Ann Photogramm Remote Sens Spatial Inf Sci*. 2022;X-4/W3-2022:229-235. doi:10.5194/isprs-annals-X-4-W3-2022-229-2022
52. Roper J, Ng M, Pettit C. Incorporating diminishing returns to opportunities in access: Development of an open-source walkability index based on multi-activity accessibility. *JTLU*. 2023;16(1):361-387. doi:10.5198/jtlu.2023.2308
53. Foti F, Waddell P, Luxen D. A Generalized Computational Framework for Accessibility: From the Pedestrian to the Metropolitan Scale. In: *Proceedings of the 4th TRB Conference on Innovations in Travel Modeling*. Transportation Research Board; 2012.
54. Pereira RHM, Saraiva M, Herszenhut D, Braga CKV, Conway MW. r5r: Rapid Realistic Routing on Multimodal Transport Networks with R⁵ in R. *Findings*. Published online March 4, 2021. doi:10.32866/001c.21262
55. Greed C. Planning for sustainable transport or for people's needs. *Proceedings of the Institution of Civil Engineers - Urban Design and Planning*. 2012;165(4):219-229. doi:10.1680/udap.10.00033
56. Ye X, Pendyala RM, Gottardi G. An exploration of the relationship between mode choice and complexity of trip chaining patterns. *Transportation Research Part B: Methodological*. 2007;41(1):96-113. doi:10.1016/j.trb.2006.03.004

57. Bernardin VL, Koppelman F, Boyce D. Enhanced Destination Choice Models Incorporating Agglomeration Related to Trip Chaining While Controlling for Spatial Competition. *Transportation Research Record*. 2009;2132(1):143-151. doi:10.3141/2132-16
58. Salih SH, Lee J (Brian). Measuring transit accessibility: A dispersion factor to recognise the spatial distribution of accessible opportunities. *Journal of Transport Geography*. 2022;98:103238. doi:10.1016/j.jtrangeo.2021.103238
59. Transport for New South Wales. Future Transport Strategy: Our vision for transport in NSW. Published online 2022.
60. Quercia D, Schifanella R, Aiello LM. The shortest path to happiness: recommending beautiful, quiet, and happy routes in the city. In: *Proceedings of the 25th ACM Conference on Hypertext and Social Media*. ACM; 2014:116-125. doi:10.1145/2631775.2631799
61. Vallyon C, Turner S. *Reducing Pedestrian Delay at Traffic Signals*. NZ Transport Agency; 2011.
62. Wardman M. Public transport values of time. *Transport Policy*. 2004;11(4):363-377. doi:10.1016/j.tranpol.2004.05.001
63. Gehrke SR, Akhavan A, Furth PG, Wang Q, Reardon TG. A cycling-focused accessibility tool to support regional bike network connectivity. *Transportation Research Part D: Transport and Environment*. 2020;85:102388. doi:10.1016/j.trd.2020.102388
64. Lowry MB, Furth P, Hadden-Loh T. Prioritizing new bicycle facilities to improve low-stress network connectivity. *Transportation Research Part A: Policy and Practice*. 2016;86:124-140. doi:10.1016/j.tra.2016.02.003
65. Mekuria MC, Furth PG, Nixon H. *Low-Stress Bicycling and Network Connectivity*. Mineta Transportation Institute; 2012:84.
66. Rhoads D, Rames C, Solé-Ribalta A, González MC, Szell M, Borge-Holthoefer J. Sidewalk networks: Review and outlook. *Computers, Environment and Urban Systems*. 2023;106:102031. doi:10.1016/j.compenvurbsys.2023.102031
67. Roper J, Ng M, Huck J, Pettit C. A participatory mapping approach to capturing perceived walkability. Published online Upcoming.
68. Aultman-Hall L, Roorda M, Baetz BW. Using GIS for Evaluation of Neighborhood Pedestrian Accessibility. *Journal of Urban Planning and Development*. 1997;123(1):10-17. doi:10.1061/(ASCE)0733-9488(1997)123:1(10)
69. Willberg E, Fink C, Toivonen T. The 15-minute city for all? – Measuring individual and temporal variations in walking accessibility. *Journal of Transport Geography*. 2023;106:103521. doi:10.1016/j.jtrangeo.2022.103521