

ImagineSydney

Live | 2018

Appendices



Deloitte.

*Shaping
Future Cities*

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Appendix A: Methodology

Overview

We have developed a 30-Minute City Index to visualise the relative accessibility and liveability of the 312 statistical areas (ABS SA2 areas 2016) in Sydney.

Proximity to CBD can be considered a rough measure of accessibility, but this does not take into account 'local' accessibility. For instance, a local supermarket would increase accessibility of shopping for residents, even in areas further away from the CBD. Given that, the 30-Minute City Index needs to account for the accessibility provided by local facilities and employment hubs as well as the accessibility associated with the significantly higher number of employment opportunities in the current CBD.

Figure A.1 provides an overview of the components of our 30-Minute City Index, which comprises three elements: 1) Work accessibility, 2) Local accessibility and 3) Liveability. The data for the Index is sourced from Google Maps API data, the 2016 Domain Liveable City Index¹, and the Australian Bureau of Statistics.

Specifically, work accessibility measures the available employment opportunities within a 30-minute driving/transit and accessibility measures the number of essential facilities (e.g. schools, hospitals, etc.) in local areas within a 30-minute walking distance.

Liveability is based on the Domain Liveable Cities Index, to which Deloitte Access Economics was a contributor, which takes into account local accessibility along with other social statistics metrics such as crime rate and culture diversity. However, we further enhance this to introduce a definition of local and work accessibility focusing on the density of facilities rather than proximity.

Further detail on the key components of the 30-Minute City Index and a formal mathematical definition of the model is provided in the full Appendix available at www.shapingfuturecities.com.au.

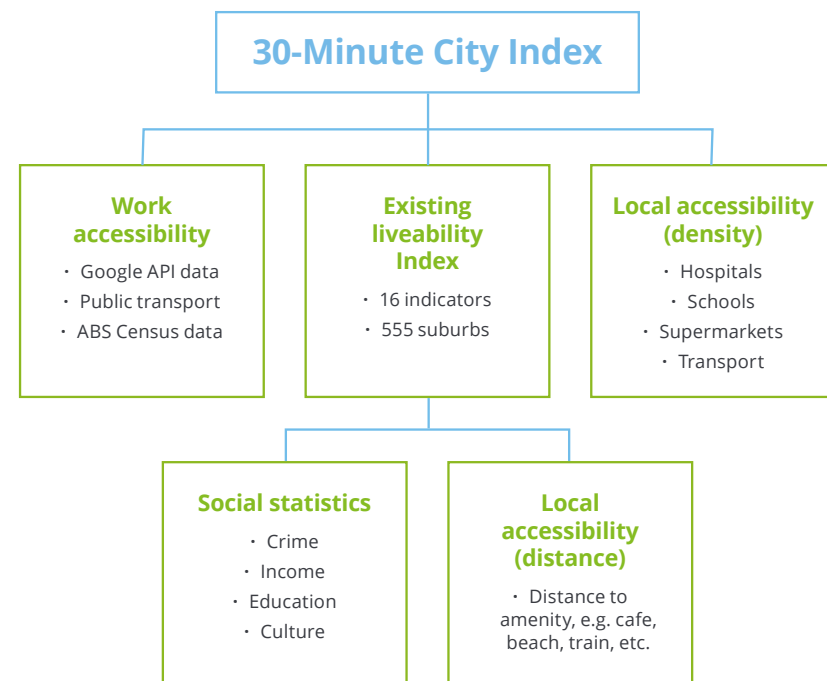


Figure A.1: Components of the 30-Minute City Index

¹ Authored by Tract Consultants and Deloitte Access Economics



Definition of accessibility

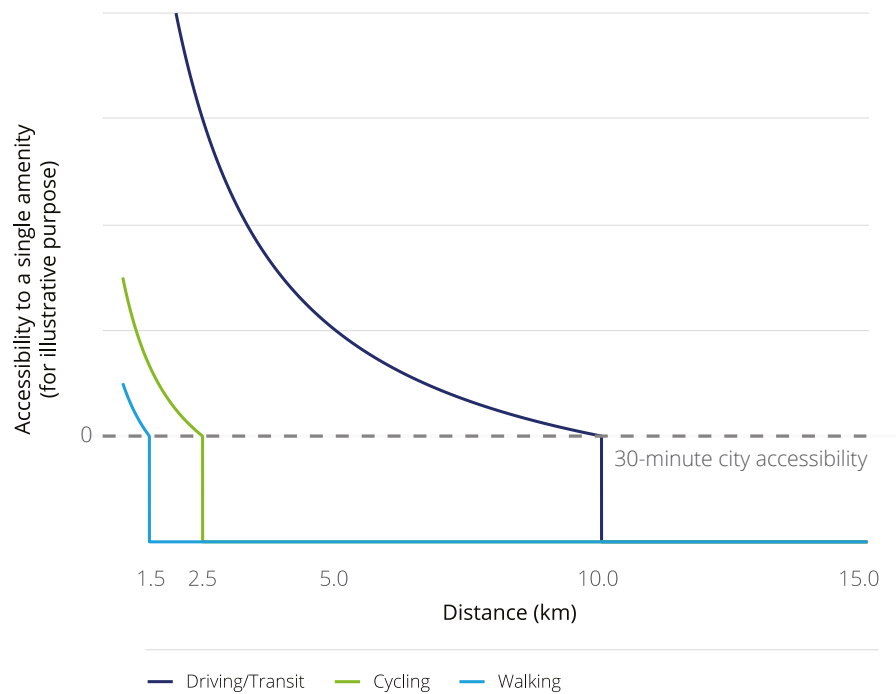


Figure A.2: Relationship between accessibility and distance by different transport mode

We have used the ABS Statistical Area 2 as the geographic unit to construct the 30-Minute City Index. The reasons are two-fold: 1) it is the most granular level at which the 2016 Census records commute origins and destinations; 2) the populations in SA2 areas are comparable in size.

The definition of accessibility for a given SA2 area comprises two related criteria, namely:

- The accessibility to places of interest (e.g. number of supermarkets) in the surrounding areas
- The accessibility of places of interest in the given SA2 area to people living in surrounding areas.



The first criterion is a standard measure of accessibility that captures the number of amenities in a given area.

The second is designed to highlight the 30-minute city concept by placing higher scores on areas with amenities that also support surrounding areas – echoing the contribution of CBD to total accessibility in a city like Sydney. In other words, the second criterion measures the reduction in total accessibility to Sydneysiders should the amenities in the given area disappear.

The definition of ‘surrounding’ areas reflects a ‘cut-off distance’ threshold, beyond which accessibility declines to zero. Accordingly, accessibility for places within the defined surrounding areas should decrease monotonically with distance and approach zero gradually as the travel time approaches 30 minutes. To illustrate, Figure A.2 shows an indicative relationship between accessibility and distance for driving/transit, cycling and walking respectively. The dotted horizontal line denotes zero accessibility at the 30-minute threshold. The blue and green lines show the decline of accessibility as distance increases. The driving/transit line, sits above the cycling and walking lines, as the travel speed is much faster, reflecting that the same place is more accessible if one could drive rather than walk.

The rate at which accessibility declines is governed by the inverse of travel time as a function of distance and travel mode. The rate at which accessibility declines reduces as distance increases, reflecting a higher marginal cost of travel at short distances (e.g. five minutes extra travel time on a five minute journey has a relatively larger cost than the same extra travel time on a 30-minute journey).

It is worth mentioning that Figure A.2 only depicts the relationship between accessibility and distance for a given SA2 with respect to a single amenity (e.g. a train station). In the full analysis, we account for all amenities accessible in a given SA2 based on its geographic location.

Figure A.3 shows the cut-off distances defined for different places of interest. The 10 km cut-off distance for driving/transit is based on the estimated weighted average travel speed of 19.53 km/hour at peak hours in Sydney (see details in Appendix B). The 2.5 km cut-off distance for walking is based on an average walking speed of 5 km/hour. It should be noted that the resulted SA2 rankings are not sensitive to small changes in the cut off distance, given the index declines towards zero quickly as travel time increases.

Accessibility Index	Travel mode	Cut-off distance (corresponds to 30 min travel time)
Work	Driving and transit	10 km
Hospitals	Driving	10 km
Supermarkets / groceries	Walking	2.5 km
Schools	Walking	2.5 km
Public transport	Walking	2.5 km

Figure A.3: Cut-off distance for various places of interest for calculating the 30-Minute accessibility Index

* These travel modes and corresponding distances are used in the Index to reflect how far people generally travel to these locations and still consider them accessible, rather than the actual mode of travel used. It is acknowledged that people may prefer to drive to the supermarket, schools or to access public transport, but would consider them less accessible if greater than 2.5km away.

The final accessibility Index is an equally weighted ranking based on the five sub-indices in Table A.1.

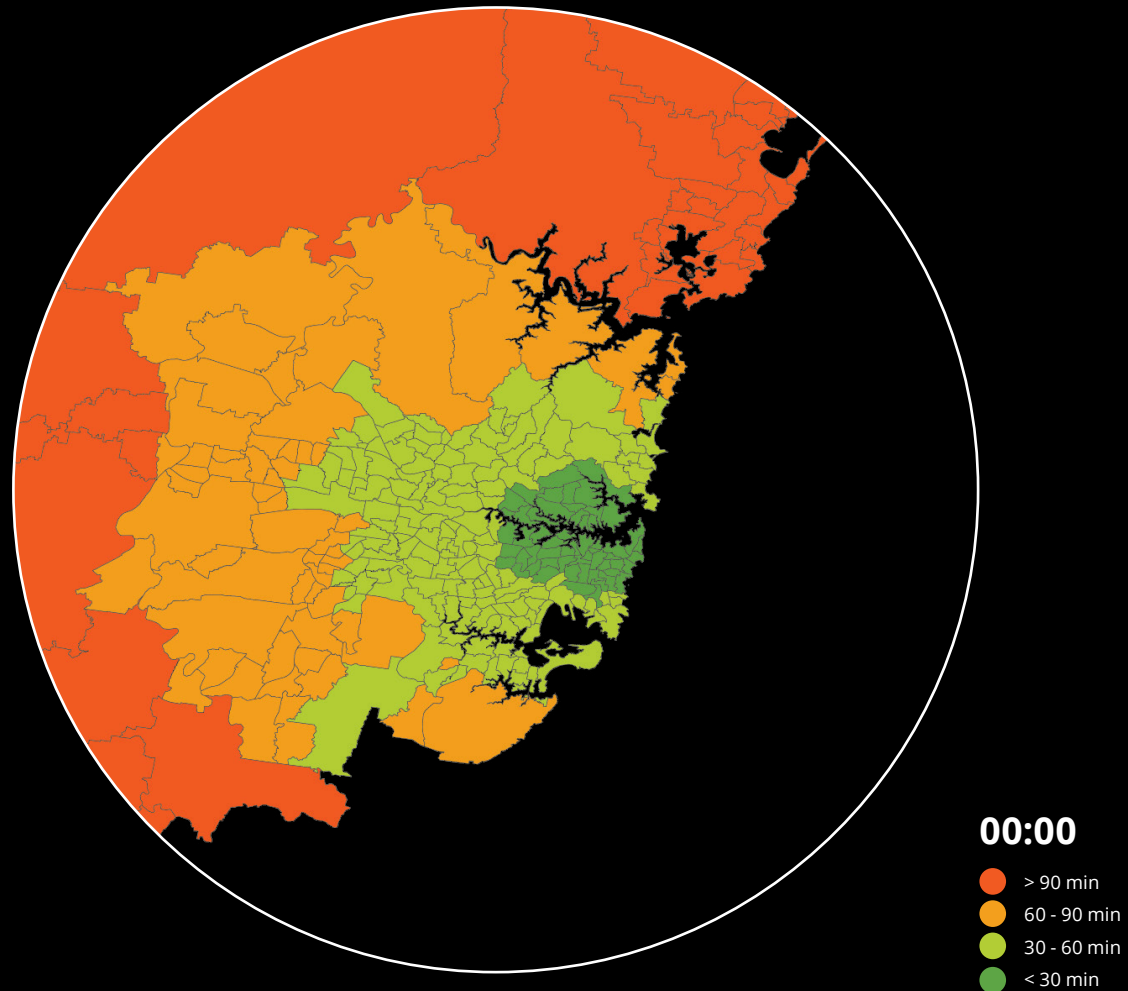


Definition of work accessibility

Time of travel

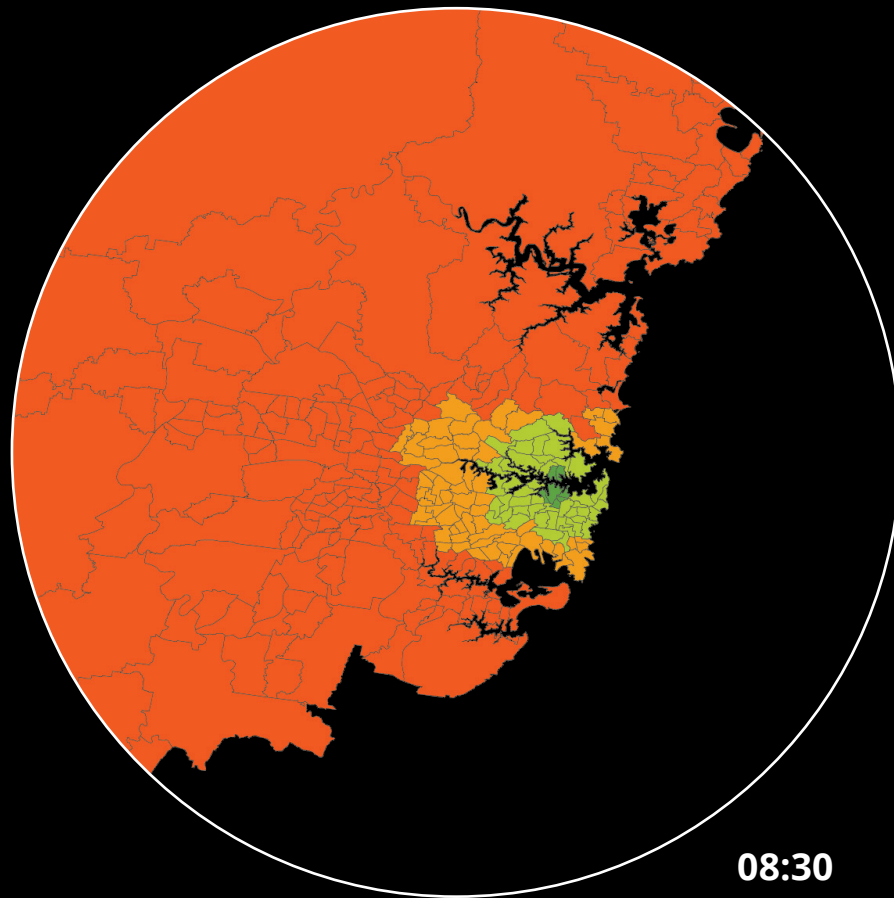
Traffic conditions at different times of the day have an effect on work accessibility. During peak commuting times, the number of jobs accessible within 30 minutes from any location is significantly lower than the number of jobs that are accessible during off-peak times. To reflect work accessibility at peak time, the index is calculated based on the number of jobs that can be reached within 30 minutes at particular times during peak travel periods (8:30 am to CBD and 5:30 pm from CBD).

Figure A.4 below shows the travel times from different SA2s to the CBD at 12am (off-peak), 8.30 am (peak) and 5.30 pm (peak) respectively. Compared to off-peak times, there are fewer SA2s where residents can travel to the CBD in given time budgets e.g. 30, 60 or 90 minutes during peak hours. This means that the travel speed during peak hour is much slower, which reduces the number of jobs that can be considered accessible.



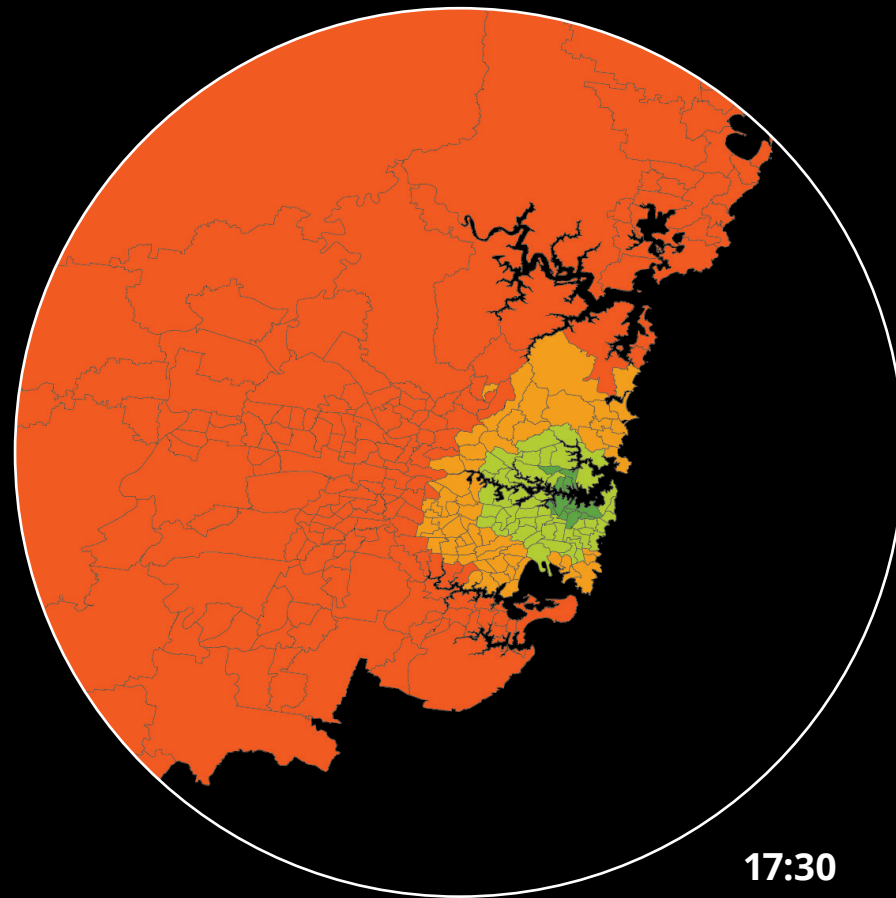
powered by Google

Figure A.4: Travel time to CBD at different time of day
(Source: Google Maps API data, Deloitte Access Economics analysis)



08:30

- > 90 min
- 60 - 90 min
- 30 - 60 min
- < 30 min



17:30

- > 90 min
- 60 - 90 min
- 30 - 60 min
- < 30 min

powered by Google

Figure A.4: Travel time to CBD at different time of day
(Source: Google Maps API data, Deloitte Access Economics analysis)



Driving vs public transport

Sydneysiders use various modes of transport for commuting. It is conceivable that driving is more sensitive to traffic conditions at peak hours, while public transport that does not use the road network such as the trains, ferries and light rails are less affected.

Assuming a travel time budget of 30 minutes, the number of jobs that are accessible from any location depends on the mode of transport used. Figure A.5 shows that travel time across the same distance to the CBD is roughly equivalent whether driving or taking public transport throughout the day, with driving only being faster than public transport at 5:30am or 8:30pm. The work accessibility index therefore uses the average speed of public transport and driving at peak hours to calculate the number of jobs that are accessible within 30 minutes.

Delays to driving time caused by congestion in peak hours of traffic is further illustrated in Figure A.6. The x-axis shows the time of the day, and the y-axis shows the ratio of travel time as a percentage of travel time at midnight (i.e. representative of a measure of delay). The blue lines provides the average, which represents all SA2 areas within 50 kilometres from CBD. It can be seen that average delays to driving time caused by traffic for public transit are relatively flat, meaning these are less affected by traffic.

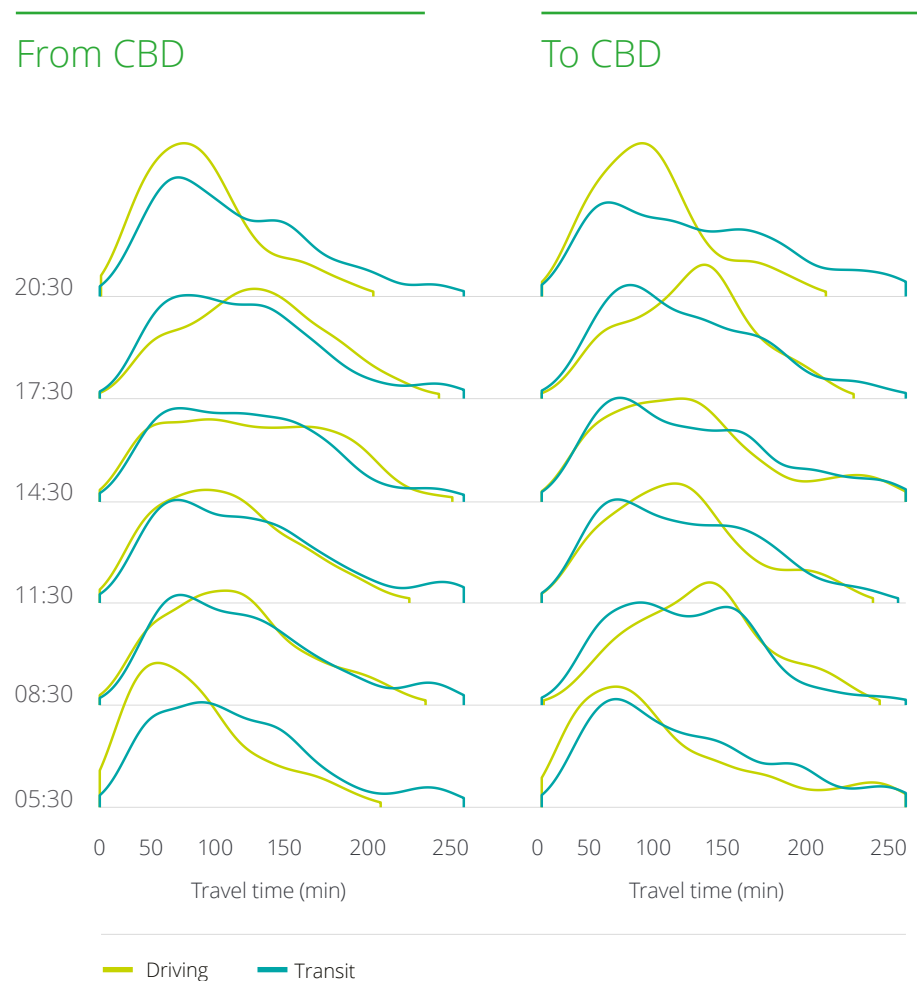


Figure A.5: Travel time density plots by transport modes
(Source: Google Maps API data, Deloitte Access Economics analysis)



Figure A.6: Travel time as a percentage of midnight travel time for driving and transit from or to CBD
(Source: Google Maps API data, Deloitte Access Economics analysis)

Comparison of the work accessibility index with raw count of jobs

Our work accessibility inputs are calculated based on the accessible number of employment opportunities, which is a better measure than a simple count of the total number of jobs (employed persons) in a given SA2 area.

To illustrate this, Figure A.7 shows the top 20 SA2 areas by employment for 2016-17. It can be seen that employment hubs further away from the CBD, such as Penrith and Campbelltown are highlighted on the map. However, areas such as Redfern and Waterloo are not included in the top 20 despite their close proximity to the CBD.

In contrast, Figure A.8 shows the top 20 areas with the highest work accessibility scores. The areas around the CBD are highlighted here as a whole, reflecting the indispensable accessibility to jobs offered by the current availability in the CBD.

Count map

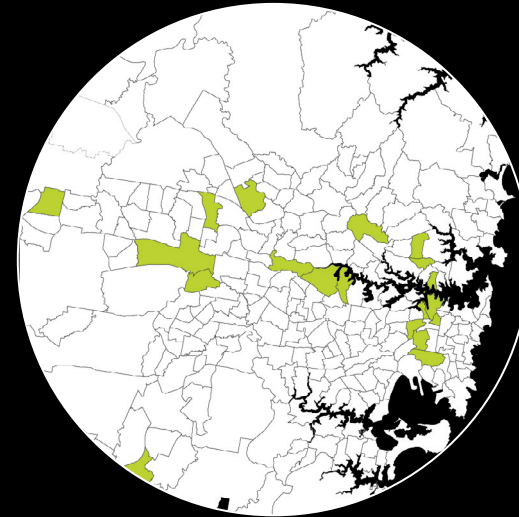


Figure A.7: Top 20 areas by number of employed persons

Gravity map

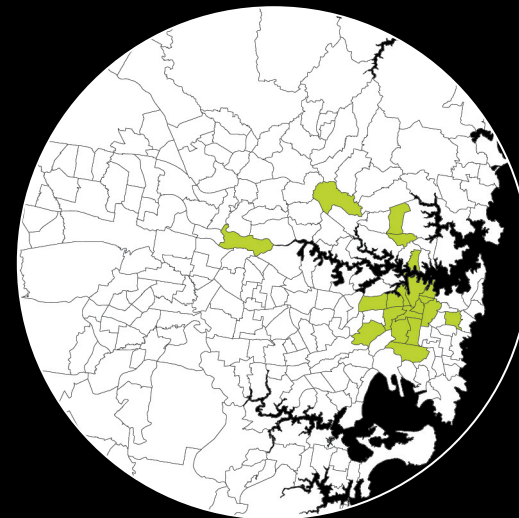


Figure A.8: Top 20 areas by work accessibility index



Appendix B: Modelling accessibility

The gravity model

The 30-Minute City Index is the measure of accessibility to places of interest for each SA2 in Sydney. The Index needs to take into account the spatially disjointed location of activities where accessibility declines as distance to places of residence increases.

The analysis can be accomplished through design of appropriate accessibility measures for groups of major activities such as work, shopping and services. The goal is to quantify accessibility to various places of interest for each SA2 area in Sydney, based on the geographic location of these places relative to the centroid of each SA2 polygons, and travel distance/speed data obtained from the Google distance matrix API.

The model we have applied refers to the cost of accessing activities and is based on a gravity model, which requires the level of accessibility between two SA2 areas to depend on the attraction to activities/places (e.g. shops) in the two areas, and is inversely dependent on their travel time. The model has in other words, two terms, an attraction function/term and a deterrence term (or cost function). Attraction to activities/places is generally represented by level of economic activity, which for instance can be represented through number of work places or stores in the given SA2 areas. The cost function is generally an inverse function of travel time or distance. For instance, for individuals

living in zone i , the potential accessibility to work opportunities in zone j is given by:

$$A_{ij}^{individual} = \frac{n_j}{\beta t_{ij}} \quad \forall j \neq i, t_{ij} < 30 \text{ min}$$

Where n_j represents the number of opportunities (e.g. number of jobs) in zone j and t_{ij} is travel time between zones i and j . β is the travel time parameter and is often gathered from destination choice model². Accordingly, accessibility for individuals living in zone i to all zones in the geography is then given by:

$$A_{ij}^{individual} = \frac{n_i}{\beta t_{ii}} + \sum_j \frac{n_j}{\beta t_{ij}} \quad \forall j \neq i, t_{ij} < 30 \text{ min}$$

The first term (the term before the summation sign) represents accessibility to activity n within own zone. t_{ii} refers to cost of traveling within own zone and n_i refers to the number of available activities of type n in own zone i .

To rank the SA2 areas, the accessibility Index also needs to highlight the accessibility of places in zone i to all individuals living in all zones, which can be calculated as:

$$A_i^{places} = n_i \sum_j \frac{1}{\beta t_{ij}} \quad \text{for } t_{ij} < 30 \text{ min}$$

Where n_i still represents the number of opportunities (e.g. number of jobs) in zone i and t_{ij} is travel time between zones i and j (t_{ii} for own zone). Succinctly, the accessibility of zone i can be calculated as:

$$A_{ij} = A_{ij}^{individual} + A_i^{places} = \sum_j \frac{n_i + n_j}{\beta t_{ij}} \quad \text{for } t_{ij} < 30 \text{ min}$$

This formula is used to calculate the gravity scores for each SA2 area with respect to the five categories of places listed in Table B.1 below.

Data	Source
Number of work places	ABS census 2016
Number of primary/secondary schools	DAE data & Google Maps API
Number of hospitals/clinics (number of beds)	DAE data & Google Maps API
Number of supermarket/groceries	yellowpages.com.au (for store locations) & Google Maps API
Number of public transport terminals (trains, ferries & light rails)	Transport NSW website (for station locations) & Google Maps API

Table B.1: Source of longitude and latitude data for places of interest in each SA2 area for the purpose of calculating the 30-Minute accessibility Index

² The value of β does not matter for the purpose of ranking, here we have used $\beta=1$.



Estimating travel time/speed

A key input to the gravity model is the travel time between each pair of SA2 areas in Sydney (i.e. a 279 by 279 matrix). Our approach is two-fold. We first obtained the travel time and distance data from each of the 279 SA2 areas to central CBD by driving and public transit through the Google Maps API. Figure B.1 shows the relationship between travel time and distance to CBD at different times of the day.

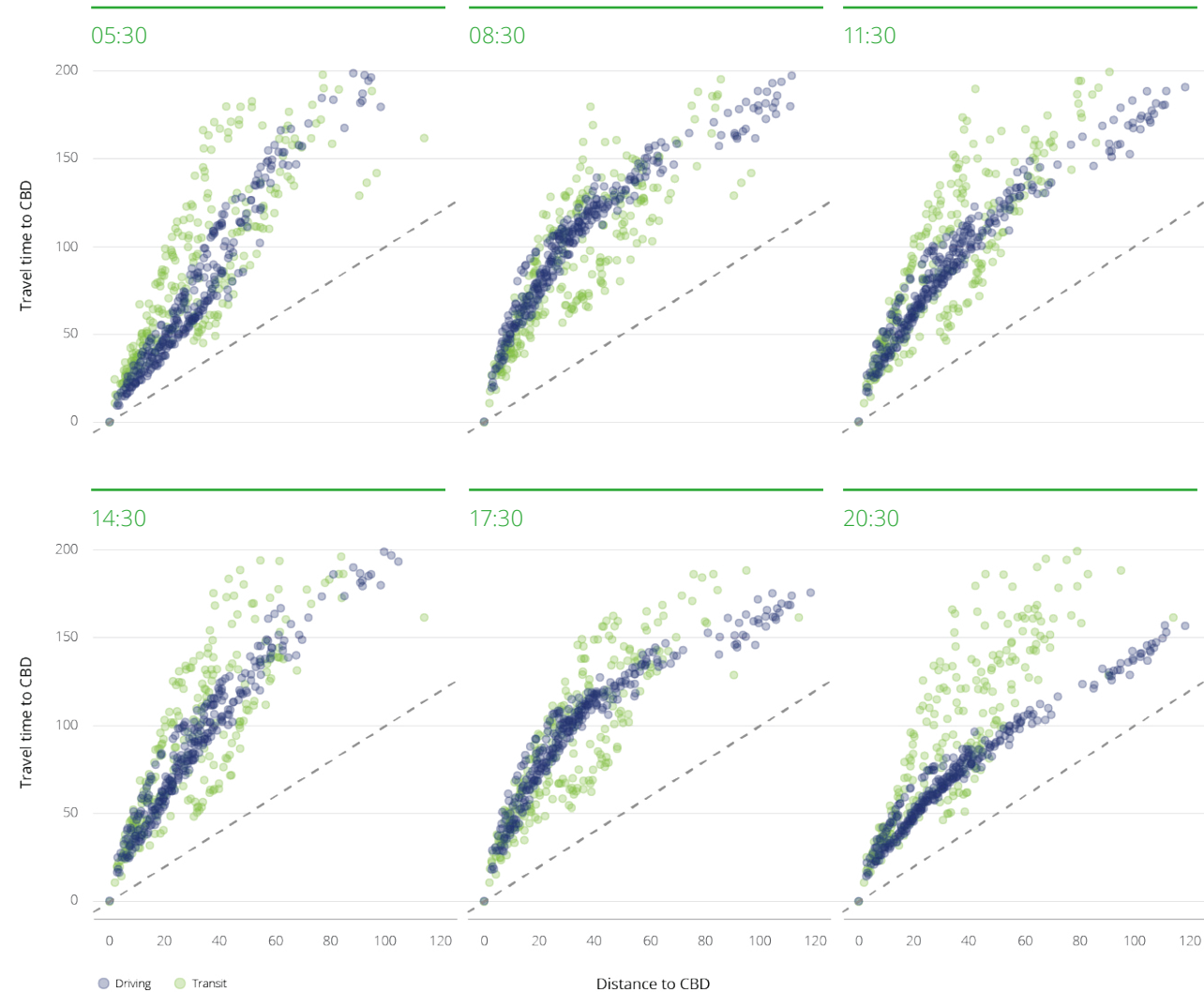


Figure B.1: Relationship between travel time and distance to CBD at different times of the day
(Source: Google Maps API data, Deloitte Access Economics analysis)



Figure B.1 above shows that travel time increases with distance, but at a decreasing rate for driving. In other words, the speed of driving increases over longer distances. This is reasonable given longer distances imply a higher probability of using highways and potentially improved average traffic conditions.

It follows then, that the travel time and distance data from Google can be used to derive the average speed, as a function of distance. Specifically, the following regression model is estimated for the 6 six sub-samples (as shown in Figure B.1) to derive the average speed of driving and transit at different times of day.

$$speed_{ij,t} = \alpha_{ij,t} + \beta_{ij,t} * distance_{ij}, \text{ where } j = CBD \quad (*)$$

Where $speed_{ij,t}$ is the travel speed at time t , from place i to place j (here $j=CBD$). Similarly, $distance_{ij}$ is the distance between $area_i$ and central CBD. To illustrate this, Figure B.2 shows the calculated average speed at 10 km distance from the CBD at different times of the day.

Secondly, we compute the spatial distance matrix between all SA2 areas using the `spDist` function from the 'sp' package in the statistical software R. The distance of travel for own area (i.e. travel within one SA2 area) is approximated by the radius of the polygon assuming it is a circle.

$$Radius_i = \sqrt{\frac{\text{Area of the polygon of the SA2 zone}}{\pi}} \quad (**)$$

Finally, the travel time between the pair of SA2 areas is calculated as the distance between the two areas divided by the average travel speed derived from the speed regression (*).

$$Travel\ time_{ij,t} = \frac{Distance_{ij}}{speed_{ij,t}}$$

Where $distance_{ij}$ is the distance between $area_i$ and $area_j$; for access to own area the $distance_{ij}$ would be estimated as $Radius_i$ from equation (**). For work accessibility, only the travel speed at 8:30am and 5:30pm is included in the averaging.

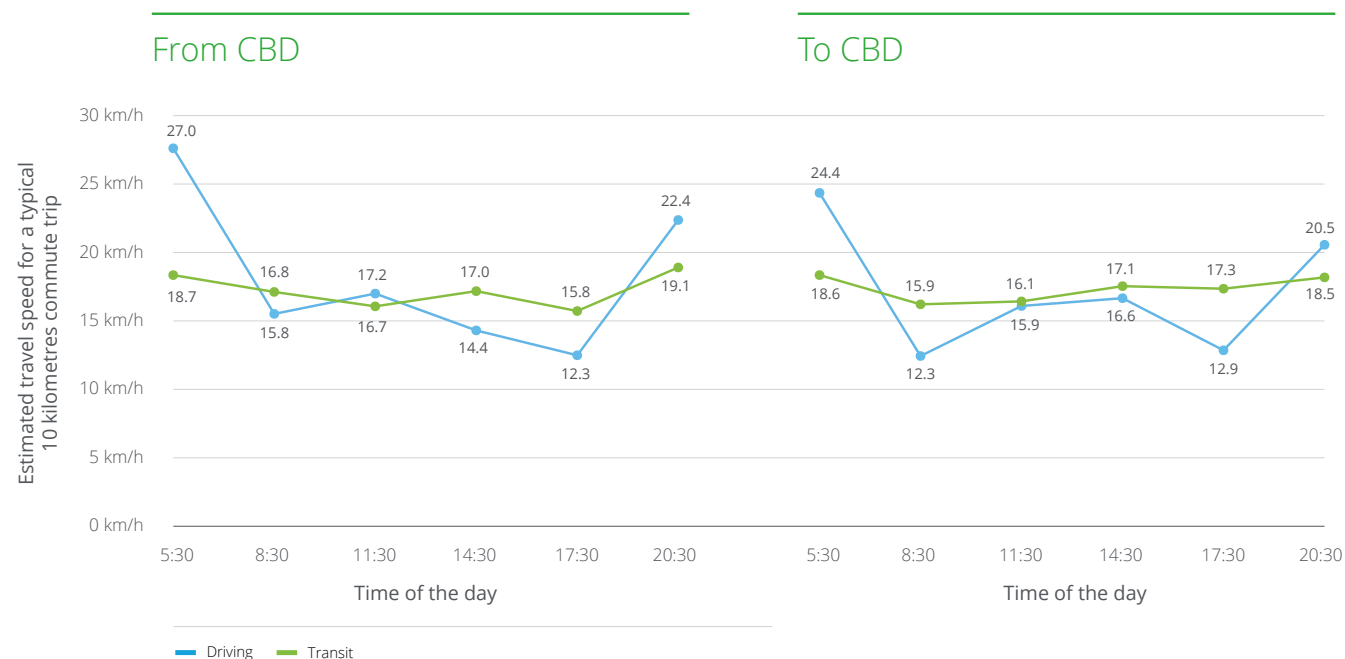


Figure B.2 Estimated average travel speed to & from CBD by driving/transit from 10 km away to the CBD in Sydney³
(Source: Google Maps API data, Deloitte Access Economics analysis)

³ Note that the estimated average travel speed at peak hours is around 15 kilometres per hour for people live 10 kilometres from the CBD. This is lower than the 20 kilometres per hour speed used to define the 10 kilometres cut-off distance for our 30-Minute City Index. This is expected because travel speed would increase for people living further away from the CBD. The estimated average travel speed for the all Sydneysiders would be higher than that for just those living in 10 kilometres from the CBD.



Appendix C: 30-Minute City Index rankings

SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Sydney - Haymarket - The Rocks	1	1	1	56
North Sydney - Lavender Bay	2	8	3	2
Potts Point - Woolloomooloo	2	6	6	17
Darlinghurst	4	3	5	59
Surry Hills	5	4	4	70
Newtown - Camperdown - Darlington	6	2	8	92
Neutral Bay - Kirribilli	7	18	24	5
Bondi Junction - Waverley	8	12	19	47
Pyrmont - Ultimo	9	9	2	77
Glebe - Forest Lodge	10	10	14	65
Chatswood (East) - Artarmon	11	14	17	48
Crows Nest - Waverton	12	20	22	13
Leichhardt - Annandale	13	11	18	69
Petersham - Stanmore	14	7	32	95
Ashfield	15	5	34	118
Kogarah	16	16	54	NA*
Redfern - Chippendale	17	15	10	121
Cremorne - Cammeray	18	30	42	3
Woollahra	19	38	36	11
Randwick - South	20	28	33	40
Marrickville	20	21	20	103
Erskineville - Alexandria	22	23	9	113
Paddington - Moore Park	23	45	16	18
Dulwich Hill - Lewisham	24	19	50	114
Double Bay - Bellevue Hill	25	43	30	26
Balmain	26	48	25	12
Lilyfield - Rozelle	26	33	28	58
Burwood - Croydon	28	24	26	130

SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Randwick - North	29	40	41	40
Haberfield - Summer Hill	30	25	45	101
Auburn - Central	31	13	85	146
Canterbury (South) - Campsie	32	17	59	149
Bondi - Tamarama - Bronte	33	44	62	24
Northmead	34	31	37	117
Rockdale - Banksia	35	22	83	124
St Leonards - Naremburn	36	73	11	6
Canterbury (North) - Ashbury	37	25	74	125
Lakemba	38	32	108	NA*
Concord West - North Strathfield	39	46	27	98
Liverpool	40	47	79	NA*
Strathfield	40	27	60	165
Waterloo - Beaconsfield	42	54	12	110
Centennial Park	43	70	49	23
Sydenham - Tempe - St Peters	44	55	35	102
Lane Cove - Greenwich	44	89	31	16
Homebush	46	49	44	128
Willoughby - Castle Cove - Northbridge	47	72	56	29
Parramatta - Rosehill	48	57	7	132
Bexley	49	36	115	109
Kogarah Bay - Carlton - Allawah	49	34	146	85
Miranda - Yowie Bay	51	42	124	87
Wiley Park	52	36	154	NA*
Croydon Park - Enfield	53	35	91	142
Belmore - Belfield	54	29	94	159
Wahroonga (East) - Warrawee	55	39	165	62
Coogee - Clovelly	56	74	71	27

* Region not included in Domain Liveable Cities Index



SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Hurstville	57	52	70	116
Mosman	58	107	46	1
Mascot - Eastlakes	59	67	13	115
Fairfield	60	56	101	NA*
Granville - Clyde	61	40	81	166
Hornsby - East	62	50	152	74
Hunters Hill - Woolwich	63	104	53	38
Arncliffe - Bardwell Valley	64	62	63	112
Kensington (NSW)	65	88	23	99
Five Dock - Abbotsford	66	85	40	88
Bankstown - South	67	51	78	163
Regents Park	68	63	105	NA*
Lidcombe	69	99	38	NA*
Eastwood - Denistone	70	71	98	72
Lindfield - Roseville	71	86	117	33
Kingsford	72	92	57	NA*
Maroubra - North	73	74	92	86
Maroubra - West	74	79	87	86
Bondi Beach - North Bondi	75	110	68	45
Caringbah	76	64	125	NA*
Rose Bay - Vaucluse - Watsons Bay	77	120	77	4
North Parramatta	78	104	69	81
Ryde	79	94	76	NA*
Waitara - Wahroonga (West)	80	59	190	62
Kingsgrove (North) - Earlwood	81	87	64	119
Bankstown - North	82	60	86	163
Merrylands - Holroyd	83	61	97	150
Kingsgrove (South) - Bardwell Park	84	67	128	104
South Hurstville - Blakehurst	85	69	148	83
Chatswood (West) - Lane Cove North	86	121	75	31
Blacktown (East) - Kings Park	87	76	55	156
West Ryde - Meadowbank	88	103	93	82

SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Fairfield - East	89	53	99	207
Mortdale - Penshurst	90	65	153	100
Oatlands - Dundas Valley	91	66	126	127
Dover Heights	92	125	89	19
Ermington - Rydalmere	93	112	52	106
North Ryde - East Ryde	94	130	58	38
Auburn - North	95	76	88	146
Pagewood - Hillsdale - Daceyville	95	109	61	111
Drummoyne - Rodd Point	97	123	39	94
Berala	98	80	135	NA*
Pendle Hill - Girraween	99	102	107	NA*
Greenacre - Mount Lewis	100	98	84	137
Yagoona - Birrong	101	58	123	190
Macquarie Park - Marsfield	102	147	15	54
Concord - Mortlake - Cabarita	103	127	51	91
Auburn - South	104	83	112	146
Dee Why - North Curl Curl	105	110	185	21
Oatley - Hurstville Grove	106	100	171	64
Chester Hill - Sefton	107	90	82	176
Peakhurst - Lugarno	108	115	134	61
Narwee - Beverly Hills	109	82	150	123
Gordon - Killara	110	126	130	32
Maroubra - South	111	118	103	86
Freshwater - Brookvale	111	138	104	25
Punchbowl	113	90	110	162
Strathfield South	114	114	106	NA*
Riverwood	115	96	156	NA*
Gladesville - Huntleys Point	116	154	47	43
Gymea - Grays Point	117	94	206	66
Monterey - Brighton-le-Sands - Kyeemagh	118	106	132	122
Toongabbie - Constitution Hill	118	80	129	161
Cabramatta - Lansvale	120	100	113	152

* Region not included in Domain Liveable Cities Index



SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Wentworthville - Westmead	121	97	119	157
Botany	122	135	48	120
Padstow	123	124	155	53
Carlingford	124	129	116	79
Revesby	125	122	161	67
Kingswood - Werrington	126	83	183	141
Sutherland - Kirrawee	127	132	145	52
Warwick Farm	128	113	151	NA*
Roselands	129	116	121	136
Epping - North Epping	130	144	120	55
Pennant Hills - Cheltenham	131	136	140	68
Canley Vale - Canley Heights	132	78	168	198
Guildford - South Granville	133	117	100	181
Mount Druitt - Whalan	134	93	173	187
Winston Hills	135	128	139	NA*
Manly - Fairlight	136	168	149	10
Greenfield Park - Prairiewood	137	108	157	184
Oyster Bay - Como - Jannali	138	141	192	49
Guildford West - Merrylands West	139	119	122	193
Rookwood Cemetery	140	134	141	NA*
Baulkham Hills (West) - Bella Vista	141	166	43	144
Baulkham Hills (East)	142	146	131	104
Seven Hills - Toongabbie	143	133	109	186
Balgowlah - Clontarf - Seaforth	144	198	95	7
Turramurra	145	150	194	50
Sydney Airport	146	179	29	NA*
Chullora	147	149	66	196
Castle Hill - North	148	162	147	89
Chipping Norton - Moorebank	149	159	90	153
Yennora Industrial	150	153	118	NA*
Malabar - La Perouse - Chifley	151	156	163	90
Castle Hill - South	152	155	166	89

SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Hornsby - West	153	143	210	74
Castle Hill - Central	154	178	102	89
Pymble	155	180	142	42
Campbelltown - Woodbine	156	140	182	126
Homebush Bay - Silverwater	157	194	21	131
Normanhurst - Thornleigh - Westleigh	158	176	172	60
Sylvania - Taren Point	159	173	158	93
Fairfield - West	160	131	160	213
Caringbah South	161	157	230	71
Blacktown (West)	162	145	179	NA*
Putney	162	175	114	NA*
Lalor Park - Kings Langley	164	185	73	147
Sans Souci - Ramsgate	165	172	174	108
Beacon Hill - Narraweena	165	180	204	34
Blacktown (North) - Marayong	167	139	186	185
Bass Hill - Georges Hall	168	163	133	173
Woolaware - Burraneer	169	137	231	NA*
Kellyville	170	161	180	139
Doonside - Woodcroft	171	147	188	160
Panania - Milperra - Picnic Point	171	167	175	134
Narrabeen - Collaroy	173	189	214	20
Lurnea - Cartwright	174	142	215	NA*
Greystanes - Pemulwuy	175	183	111	138
North Rocks	176	203	127	75
Banksmeadow	177	195	65	NA*
Blacktown (South)	178	164	177	NA*
Warriewood - Mona Vale	179	196	196	28
Forestville - Killarney Heights	180	215	164	22
Manly Vale - Allambie Heights	181	217	169	14
Green Valley	182	152	213	NA*
Cherrybrook	183	187	184	97
St Ives	184	209	187	34

* Region not included in Domain Liveable Cities Index



SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
St Johns Park - Wakeley	185	170	181	177
Castle Hill - East	186	190	201	89
West Pennant Hills	186	210	159	73
Gosford - Springfield	188	182	162	NA*
Quakers Hill	189	174	200	NA*
Ashcroft - Busby - Miller	190	158	202	205
Frenchs Forest - Belrose	191	237	144	15
Bonnyrigg Heights - Bonnyrigg	192	168	189	202
Penrith	193	205	143	129
Castle Hill - West	194	199	198	89
Bidwill - Hebersham - Emerton	195	150	222	214
Hassall Grove - Plumpton	195	160	207	210
Edensor Park	197	165	208	200
Cambridge Park	198	171	232	171
Rooty Hill - Minchinbury	199	191	137	178
Cromer	200	221	217	36
Colyton - Oxley Park	201	177	229	NA*
Cabramatta West - Mount Pritchard	202	183	191	179
Smithfield - Wetherill Park	203	197	136	195
Condell Park	204	224	72	174
Smithfield Industrial	204	216	80	208
Casula	206	205	199	133
St Marys - North St Marys	207	208	170	170
Jamisontown - South Penrith	208	201	212	148
Port Botany Industrial	209	218	138	NA*
St Clair	210	187	226	180
Bossley Park - Abbotsbury	211	210	197	145
Wetherill Park Industrial	212	243	67	NA*
Cronulla - Kurnell - Bundeena	213	239	211	44
Illawong - Alfords Point	213	230	216	57
Prestons - Edmondson Park	215	207	167	201
Acacia Gardens	216	202	203	NA*

SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Hoxton Park - Carnes Hill - Horningsea Park	217	186	227	212
Avalon - Palm Beach	218	245	270	8
Glenwood	219	213	178	198
Loftus - Yarrawarra	220	192	248	NA*
Emu Plains - Leonay	221	228	234	96
Lilli Pilli - Port Hacking - Dolans Bay	222	193	251	NA*
Engadine	222	200	239	NA*
Asquith - Mount Colah	224	242	249	63
Glenmore Park - Regentville	225	204	241	203
Glendenning - Dean Park	226	225	176	NA*
Newport - Bilgola	227	269	259	9
Minto - St Andrews	228	213	218	209
Prospect Reservoir	229	256	96	NA*
Erina - Green Point	230	222	209	NA*
Menai - Lucas Heights - Woronora	231	281	220	51
Glenhaven	232	220	225	NA*
Macquarie Fields - Glenfield	233	223	228	183
Terrey Hills - Duffys Forest	234	265	265	46
Woy Woy - Blackwall	235	212	260	NA*
West Hoxton - Middleton Grange	236	219	242	NA*
Erskine Park	237	235	205	182
Hinchinbrook	238	227	223	NA*
Bayview - Elanora Heights	239	283	280	37
Parklea - Kellyville Ridge	240	234	195	215
Ingleburn - Denham Court	241	266	193	155
Springwood - Winmalee	242	257	285	84
Lethbridge Park - Tregear	243	229	238	206
Blaxland - Warrimoo - Lapstone	244	282	263	78
Heathcote - Waterfall	245	295	292	41
Bateau Bay - Killarney Vale	246	225	257	NA*
Windsor - Bligh Park	247	246	262	164
Camden - Ellis Lane	248	247	274	140

* Region not included in Domain Liveable Cities Index



SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Mount Annan - Currans Hill	249	255	224	167
Wyoming	250	232	237	NA*
Holsworthy - Wattle Grove	251	276	219	154
Chittaway Bay - Tumby Umbi	252	231	250	NA*
Leumeah - Minto Heights	253	260	258	135
Cecil Hills	254	244	235	NA*
Niagara Park - Lisarow	254	237	243	NA*
Castlereagh - Cranebrook	256	268	253	151
Richmond - Clarendon	256	250	271	172
Berowra - Brooklyn - Cowan	258	295	294	80
Elderslie - Harrington Park	259	263	245	168
Warnervale - Wadalba	260	241	256	NA*
Claymore - Eagle Vale - Raby	261	259	247	175
Point Clare - Koolewong	262	235	261	NA*
Riverstone - Marsden Park	263	269	221	189
Kariong	264	233	268	NA*
Narara	265	239	266	NA*
Woronora Heights	266	248	244	NA*
Terrigal - North Avoca	267	251	246	NA*
Dural - Kenthurst - Wisemans Ferry	268	295	300	107
Bradbury - Wedderburn	269	273	278	158
Rouse Hill - Beaumont Hills	270	280	236	191
Kincumber - Picketts Valley	271	254	252	NA*
Wamberal - Forresters Beach	271	251	264	NA*
Saratoga - Davistown	273	249	267	NA*
Wyong	274	258	254	NA*
Horsley Park - Kemps Creek	275	277	233	NA*
Rosemeadow - Glen Alpine	276	272	276	194
Tuggerah - Kangy Angy	277	274	240	NA*
Gorokan - Kanwal - Charmhaven	278	261	255	NA*
Katoomba - Leura	279	253	282	NA*
Avoca Beach - Copacabana	280	263	269	NA*

SA2	30-Minute City Index rankings	Local accessibility Index rankings	Work accessibility Index rankings	Liveability Index rankings
Box Head - MacMasters Beach	281	261	272	NA*
Pitt Town - McGraths Hill	282	290	283	192
Mulgoa - Luddenham - Orchard Hills	283	271	275	NA*
Royal National Park	284	267	284	NA*
Umina - Booker Bay - Patonga	285	275	279	NA*
The Entrance	286	283	273	NA*
Yarramundi - Londonderry	287	279	287	NA*
Holsworthy Military Area	288	278	290	NA*
Toukley - Norah Head	289	287	281	NA*
Cobbitty - Leppington	290	295	277	NA*
Budgewoi - Buff Point - Halekulani	291	290	286	NA*
Blue Haven - San Remo	292	289	291	NA*
Wentworth Falls	292	286	293	NA*
Ourimbah - Fountaindale	294	293	288	NA*
Blackheath - Megalong Valley	295	285	298	NA*
Kurrajong Heights - Ebenezer	296	287	297	NA*
Austral - Greendale	296	295	289	NA*
Galston - Laughtondale	298	295	295	NA*
Lake Munmorah - Mannering Park	299	295	296	NA*
Summerland Point - Gwandalan	299	290	302	NA*
Badgerys Creek	301	294	299	NA*
Lawson - Hazelbrook - Linden	302	295	301	NA*
Picton - Tahmoor - Buxton	303	295	303	NA*
Douglas Park - Appin	304	295	304	NA*
Bargo	305	295	305	NA*
Warragamba - Silverdale	306	295	306	NA*
Calga - Kulnura	307	295	307	NA*
Bilpin - Colo - St Albans	307	295	307	NA*
The Oaks - Oakdale	307	295	307	NA*
Blue Mountains - North	307	295	307	NA*
Blue Mountains - South	307	295	307	NA*
Jilliby - Yarramalong	307	295	307	NA*

* Region not included in Domain Liveable Cities Index



Appendix D: Economic value of a 30-minute city

The economic value of a 30-minute city can be estimated as the time saving benefits of reduced commuting, with a value of \$3.5 billion.

In calculating the work accessibility index, Appendix B shows that the travel time between each pair of SA2 areas can be estimated using the Google Maps API data. Combining this with the share of people working in each SA2 area from the ABS census, we can derive the weighted average commute time for people living in a given SA2 areas.

Figure D.1 depicts a heat map of the count of people living and working in the top 50 SA2 areas in Sydney. It is clear that a significant number of people work in either the CBD or the same SA2 that they live in.

However, it is worth noting that most Sydneysiders do travel to SA2 areas other than the CBD or their places of residence for work. Approximately 14.5% of people are working in CBD and approximately 14.6% of people are working in their own SA2 area. Accordingly, the remaining 70% are working in other SA2 areas, including local employment hubs such as Macquarie Park, North Sydney, Parramatta, etc.



Figure D.1 Places of work by places of residence

(Source: ABS census 2016 data, Deloitte Access Economics analysis).



Figure D.2 shows the distribution of the weighted average one-way commute time in Sydney. The green curve shows the current distribution with an average of 42.4 minutes, meaning that most of the commuters in Sydney are not living in a 30-minute city. In comparison, the respondents to our travel time survey suggested that the weighted average commute time in Sydney is 37.5 minutes. These estimates are slightly higher but still comparable to those from BITRE (2016)⁴.

The advantage of having granular estimates of commute time at the SA2 level is that we can derive the economic value of time savings from a 30-minute city in Sydney. It is conceivable that areas currently experiencing higher commute

times will experience the greatest benefit. At a high level, this can be modelled by reducing the commute time for all areas by 30%, where areas with higher commute time achieve a greater time saving, bringing the average commute time to 30 minutes.

The dark blue line in Figure D.2 shows the distribution of commute time in a future 30 minute Sydney. Taking into account the number of Sydney commuters (2.1 million) and their respective origins and destinations (by SA2) for commuting journeys from the 2016 Census, the total saving in commute time is estimated at around 220 million hours which is associated with an economic value of \$3.5 billion⁵. Figure D.3 shows the workflow of this calculation.

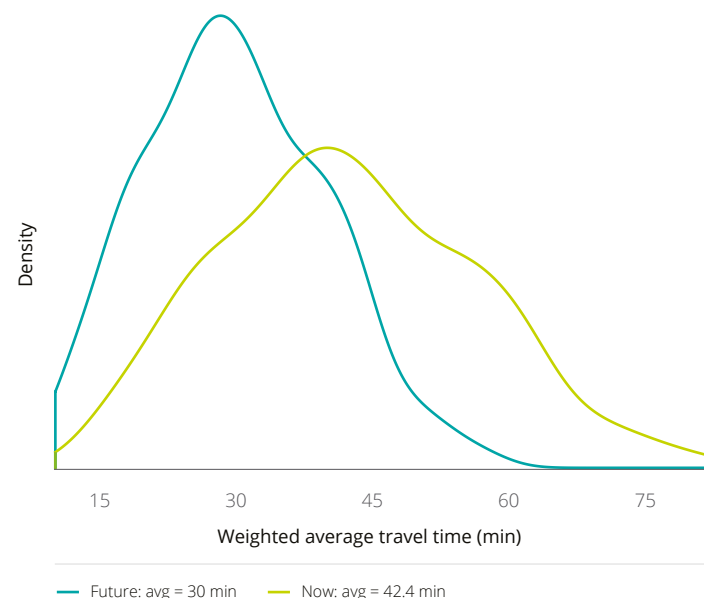


Figure D.2 Distribution of one-way commute time in Sydney

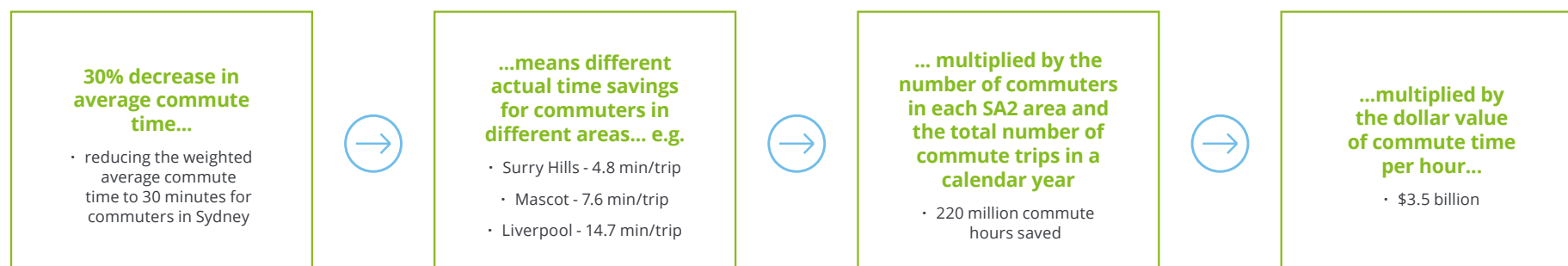


Figure D.3 Illustration of the calculation of economic benefit associated with the reduction in commute time for Sydneysiders

⁴ The HILDA wave 12 average for Sydney was 35.4 minutes, with a 95 per cent confidence interval of 33.6 to 37.2. The HTS average for the Sydney GCCSA was 33.3 minutes based on the 5-year pooled dataset. The averages from the PC Community Survey are higher at 39.2 minutes for Sydney.

⁵ Based on the value of commute time at \$16.26/hour (Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives) and 250 working days in a year.



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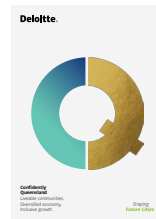


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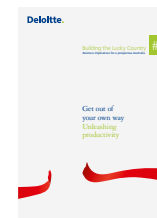
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