Travel Zone Projections 2019 (TZP19) for Population, Workforce & Employment in New South Wales

Technical Guide

Version 1

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Glossary and abbreviations

Term	Definition	Abbreviation
Average Annual Growth Rate (%)	Growth rate over a given period divided by the number of years in the period	AAGR
Australian and New Zealand Standard Industry Classifications	A standard classification system for industry breakdowns used by and prepared by the Australian Bureau of Statistics (see ABS Cat. 1292.0 for more information)	ANZSIC (2006)
Australian Bureau of Statistics	The ABS is Australia's national statistical agency, providing trusted official statistics on a wide range of economic, social, population and environmental matters of importance to Australia.	ABS
Australian Standard Geographical Classification	Now outdated, the Australian Standard Geographical Classification was used from 1984 to 2011 by the ABS for the collection and dissemination of geographically classified statistics.	ASGC
Australian Statistical Geography Standard	The Australian Statistical Geography Standard is the ABS' new geographical framework and it is effective from July 2011, replacing the ASGC. The vast majority of ABS spatial data will be based on the ASGS by 2016.	ASGS
Department of Planning, Industry and Environment	New South Wales state government agency	DPIE
Employment	Employed persons by place of work	Emp
Estimated Resident Population	The total number of people that live within a defined area. This includes both people residing in private and non-private dwellings (i.e. college dormitories, jails, nursing homes).	ERP
Freight Movement Model	Transport for NSW in-house model associated with freight movements across New South Wales	FMM

Greater Metropolitan Area	The Greater Metropolitan Area is the area used for TfNSW's Strategic Travel Model. The GMA includes the Sydney Greater Capital City Statistical Area (GCCSA), the Southern Highlands and Shoalhaven SA4, Illawarra SA4, Newcastle and Lake Macquarie SA4 and Lower Hunter, Port Stephens, Maitland SA3s as defined by the ABS.	GMA
Greater Sydney Commission	An independent organisation funded by the NSW Government to coordinate and align the planning that will shape the future of Greater Sydney.	GSC
Household size	The ratio of *persons in occupied private dwellings* to *occupied private dwellings* (e.g. if the *household ratio* in place "y" is 1.91. This means on average there are 1.91 persons in each occupied private dwelling).	
Sydney Housing Supply Forecast	The 2019 Sydney Housing Supply Forecast provides estimates of future housing supply that will be built over the next 5 years. Estimates are prepared by the NSW Department of Planning & Environment to inform infrastructure planning and service delivery, as well as to inform decisions on future land use zoning. TPA has SHSF projections that go out to 2039	SHSF
Household Travel Survey	HTS is a dataset that captures a household's travel movements – by car, public transport, bicycle, etc made in a 24 hour period for a private household. Sample size is about 3,000 to 3,500 per annum. Three or more years of data are pooled to produce reliable estimates of travel at a particular geographical level.	HTS
Intergenerational Report	2015 report by the Australian Government which assesses long-term changes including Australia's population size, age profile, economic growth and workforce	IGR
Iterative Proportional Fitting	Statistical method which aligns known totals to an estimated distribution	IPF
Workforce	Persons of working age who are employed or are unemployed but are actively seeking work by place of residence.	WF
Land Use	In this context it refers to Population, Workforce, Employment and Student projections dataset	LU
Local Government Area	Area of the third tier of government in Australia with responsibilities under the Local Government Act. LGA boundaries defined as at 2018. There are128 LGAs in NSW.	LGA
New South Wales	The State of New South Wales is the area analysed for the TZP19 projections. Previous land use forecasts were undertaken at the Greater Metropolitan Area (GMA) level.	NSW
Non Private Dwelling	Communal accommodation provided by institutions such as hospitals or prisons and transitory accommodation such as hotels and motels (see ABS Census dictionary Cat 2901.0 for more detail)	NPD
Occupied Private Dwellings	A private dwelling that is occupied on Census night. Also represents households (see ABS Census dictionary Cat 2901.0 for more detail).	OPD
Occupancy Rate	The number of Occupied Private Dwellings as a proportion of all Structural Private Dwellings	OR

People in Occupied Private Dwellings	Estimated resident population who reside in occupied private dwellings	POPD
People in Non-Private Dwellings	This includes persons in communal or transitory type accommodation (i.e. prisons, boarding school, hospital, defence establishments).	PNPD
Place of Institution	Refers to variables which are based on education (school, university, college) locations (e.g. the number of people attending a tertiary institution within a particular zone)	PoI
Place of Usual Residence	Refers to variables which are based on the home location of population (e.g. the number of people who live in a particular zone)	PUR
Place of Work	Refers to variables which are based on employment locations (e.g. the number of 'Retail Trade' industry jobs within a particular zone)	PoW
Population Synthesiser	Model uses land use data to create 'agents' for input into STM	Pop Synth
SGS Economics and Planning	A private consulting firm that has helped to deliver the TZP19 data	SGS
Strategic Transport Model	The STM combines travel behaviour with likely population, employment and transport networks to estimate future travel under different strategic land use and transport scenarios.	STM
Structural Private Dwelling	A privately owned building or structure that people live in. This may include a house, an apartment, or it may be a mobile dwelling such as a caravan. It may either be occupied or unoccupied on Census night.	SPD
Transport for New South Wales	Transport for NSW leads the development of safe, integrated and efficient transport systems for the people of NSW. Our customers are at the centre of everything that we do, including transport planning, strategy, policy, procurement and other non-service delivery functions across all modes of transport - roads, rail, ferries, light rail and point to point.	TfNSW
Transport Performance and Analytics	Transport Performance and Analytics is a part of TfNSW that provides objective and credible transport data, advice and analysis for Transport in NSW.	TPA
Travel Zone	Travel Zones (TZs) are the smallest standard geography used for a number of transport datasets in NSW. They represent geographical areas that are used in origin-destination transport modelling. Latest version was created in 2016 and largely aligns with 2016 ABS Destination Zones. See https://opendata.transport.nsw.gov.au/dataset/travel-zones-2016 for additional information	TZ or TZ16
Trip Attractors	Variables relate to destinations. These destinations range from places of work and education to destinations such as shopping centres.	

Trip Generators	Variables relate to the origin location of travel (i.e. place of residence)	
Unemployment Rate	Number of unemployed persons expressed as a percentage of the workforce.	UR
Victoria University	Victoria University created the State Employment forecasts by 1-digit ANZSIC industry group from 2016-2056 using the VUEF	VU
Victorian University Economic Forecast	The Computerised General Equilibrium Economic Forecast model run by VU that provides future industry growth rates in TZP19	VUEF

1 Introduction

1.1 Background

Transport Performance and Analytics (TPA) within Transport for NSW (TfNSW) produces Travel Zone (TZ) level projections (population, students, workforce and employment) for New South Wales (NSW) as an input into the Strategic Travel Model ('STM'). The Travel Zone projections are also used for a range of other strategic and policy work across government and the private sector.

The data is available to download from the TfNSW Open Data Hub (https://opendata.transport.nsw.gov.au/) and is used as an input into a diverse range of local planning and research work by a wide range of practitioners.

These Travel Zone Projections are developed to support a strategic view of New South Wales and are calibrated with that view in mind. When modelling the possible land use, it should be understood there is no one single future. Therefore, these projections seek to represent a likely urban and regional future based on NSW Common Planning Assumptions, current data, trends and an understanding of policy/structural changes that may impact the future.

Projections are regularly updated through major and interim updates. Major updates realign to ABS Census data releases and geographies, while interim updates incorporate other updated datasets and technical improvements.

This version (Travel Zone Projections 2019 or TZP19) reflects a major update, based on 2019 population projections that have been released from the Department of Planning, Industry and Environment (DPIE), as well as updated employment forecasts from NSW Treasury and from Victoria University (VU). TZP19 also builds upon the improvements made to TZP16 v1.51, with enhanced automation and data validation features.

The projections in TZP19 extend from 2016 out to 2056. Consideration should be given to the fact that there is detailed planning and economic data available up to 2036, with less detailed inputs available post 2036.

1.2 Audience and objective of this report

This report documents the overall approach, assumptions and data sources for the development of TZP19. It is intended for a reader with a general understanding of economic and projection techniques. This version of the TZP19 technical guide details the high level methodology to develop the travel zone projections. It provides an overview of the respective modules used to develop the constituent parts of the projections and the data flow of information between them.

It should be noted that further detail regarding the functionality of each module is also contained with the individual model files. Detailed datasheets also include the final TZP19 results, along with a number of additional summary breakdowns by Districts, Local Government Areas and Precincts.

The TZP19 Insights Report provides a summary of the projection results including a comparison with the previously published dataset.

1.3 Data limitations and cautions

The TZP dataset is extremely detailed, with millions of datapoints across 60+ variables, 9 time periods and 3,758 travel zones. For a strategic transport model what

is critical is that **all** people/workers/students are allocated down to a zone - to then create travel flows from one location to another. This requirement means there cannot be undefined/unallocated locations or variable categories. There must be a strong nexus between all data variables throughout the model.

This detail is required for the STM to create and allocate trips. It means assumptions are required to fill data gaps/uncertainty, which may not be necessary under other circumstances where undefined categories are not problematic and certainty of outcomes is more critical.

Therefore, similar to the STM, the TZP dataset should be seen as a strategic state-wide dataset. A high degree of caution should be exercised when using the data, particularly at more detailed levels. Users should further note that comprehensive analysis of individual sites or precincts has not been undertaken in the development of TZP. Figures for an individual TZ should not be considered accurate, even in base or historic years, as source data is generally not available at this geographic extent. Instead, estimates have been derived using rules to disaggregate source data from larger geographic areas down to this level.

Important notes and cautions for TZP19 users

Travel Zone Projections are a strategic state-wide dataset and caution should be exercised when considering results at detailed breakdowns.

- The TZP19 outputs represent a point in time set of projections (as at December 2019, pre-COVID19).
- Travel Zone (TZ) level outputs are projections only and should be used as a guide. As with all small area data, aggregating of travel zone projections to higher geographies leads to more robust results.
- As a general rule, TZ-level projections are illustrative of a possible future only.
- Caution is advised when comparing TZP19 with the previous TZP16 v1.51 due to differences linked to changes in geographical classifications, the inclusion of 2016 Census inputs, addition of new data sources for the most recent years, and adjustments to methodology.
- Particular caution is advised for areas in Regional NSW affected by new Special Activation Precincts (Wagga Wagga, and Parkes) as assumptions have been made about these Precincts proceeding and generating jobs numbers based on NSW Government planning documents from September 2019.
- Employment estimates in the base year (2016) may not align with published ABS Census results as they are adjusted for Census undercount.
- The Future Employment Development Database (FEDD) is a point-in-time projection dataset compiled in late 2019. It presents the number of jobs expected from major projects and plans identified in publicly-available planning documents. The scope of project coverage within the FEDD is focused on large projects because of their impact on employment at the local level. The FEDD contains significant caveats because:
    - revisions to projects and plans occur on an ongoing basis
    - job estimates found in planning documentation are often optimistic or 'best case' scenarios and require adjustment;
    - job types identified in planning documentation tends to favour the ability of a project to attract white-collar knowledge workers. As such, the FEDD tends to skew towards knowledge intensive employment, such as Professional, Scientific and Technical Services.
    - project data for many projects is incomplete or contain discrepancies about the number, type and timing of project jobs. and
    - limited planning documentation about projects beyond a 20-year time horizon.
- FEDD inputs to TZP19 were tempered where necessary using professional judgement to ensure a reasonable balance between population and employment emerges in future years.
- Users can ascertain whether a particular Travel Zone is impacted by a FEDD project from the employment projections summary spreadsheet, which notes the relevant FEDD project number. Users can request more information about the specific assumptions related to a project's size and timing.
- Some TZ-level adjustments are made to employment outputs to correct known issues with ABS small area employment data (e.g. mesh-block classifications, Destination Zone employment data, etc).

Table 1 provides an indicative view of the reliability of the data at different spatial and temporal levels.

Table 1 Data Reliability Summary

1A. Assessment of reliability – occupied private dwellings (OPD) and population in private dwellings (POPD)

	State level	GMA			Regional		
		Total	SA2	TZ	Total	SA2	TZ
2019	High						
2016-2020	High						
2021-2025	High						
2026-2036	High						Medium
2036-2056	High			Low	High		Low
2056-2066	High			Low	High		Low

1B. Assessment of reliability– age-sex distribution

	State level	GMA			Regional		
		Total	SA2	TZ	Total	SA2	TZ
2016-2020	High						
2021-2025	High		Medium		High	Medium	
2026-2036			Medium			Medium	
2036-2056			Low			Low	
2056-2066			Low			Low	

1C. Assessment of reliability – household type distribution

	State level	GMA			Regional		
		Total	SA2	TZ	Total	SA2	TZ
2016-2020	High						
2021-2025	High		Medium		High	Medium	
2026-2036	High		Medium		High	Medium	
2036-2056	High		Low		High	Low	
2056-2066	High		Low		High	Low	

1D. student enrolments at destination

	State level	GMA			Regional		
		Total	SA2	TZ	Total	SA2	TZ
2016-2020	High						
2021-2025	High		Medium		High	Medium	
2026-2036			Medium			Medium	
2036-2056			Low			Low	
2056-2066			Low			Low	

1E. Assessment of reliability– student enrolment at origin

	State level	GMA			Regional		
		Total	SA2	TZ	Total	SA2	TZ
2016-2020	High				High		
2021-2025	High		Medium		High	Medium	
2026-2036			Medium			Medium	
2036-2056			Low			Low	
2056-2066			Low			Low	

1F. Assessment – student enrolment at destination

	State level	GMA			Regional		
		Total	SA3	TZ	Total	SA3	TZ
2016-2020	High				High		
2021-2025	High				High		
2026-2036	High			Low	High		Low
2036-2056	Medium				Medium		
2056-2066	Low				Low		

1G. Assessment of reliability – employment type (excl. part-time rates)

	State level	GMA			Regional		
		Total	SA4	TZ	Total	SA4	TZ
2016-2020	High			Medium	High		Medium
2021-2025	High			Medium	High		Medium
2026-2036	High	Medium					
2036-2056		Low					
2056-2066		Low					

1H. Assessment of reliability - employment time and income bands

	State level	GMA			Regional		
		Total	SA4	TZ	Total	SA4	TZ
2016-2020	High			Medium	High		Medium
2021-2025	High			Medium	High		Medium
2026-2036	Medium						
2036-2056	Low						
2056-2066	Low						

1I. Assessment of reliability – employment

	State level	GMA			Regional		
		Total	SA2	TZ	Total	SA2	TZ
2016-2020	High				High		
2021-2025	High				High		
2026-2036	High	Medium					
2036-2056	Medium		Low		Medium	Low	
2056-2066	Low						

1.4 High Level Results

This chapter provides a high level overview of the Travel Zone Projections 2019 results. For an additional fine grain level view of results, data is presented on a data explorer visualisation with an interactive map, accessible on the TfNSW website.[1]

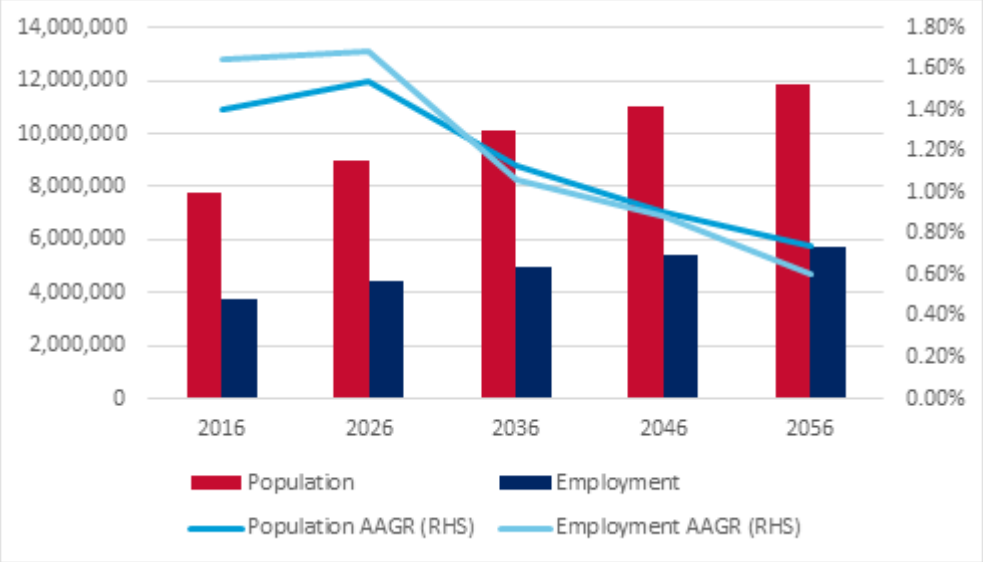
In addition, a TZP19 Insights Report highlighting results in more detail can be requested from TfNSW which provides more detail on specific locations and trends by different components of the forecast including mapped summaries.

1.4.1 Land Use Forecasts

By 2056 there are projected to be more than 5.7 million jobs and more than 11.8 million people in New South Wales. The majority of people and jobs will be in established urban areas such as Greater Sydney, Newcastle and Wollongong, which currently have approximately 80 percent of people and jobs. This will increase to 85 percent of the total population and 86 percent of jobs by 2056.

Figure 1 shows a summary of the NSW employment and population growth out to 2056. Growth rates for both employment and population are similar, consequently, the ratio of people to jobs remains relatively constant across NSW to 2056 at approximately 2.1 people for every job in NSW.

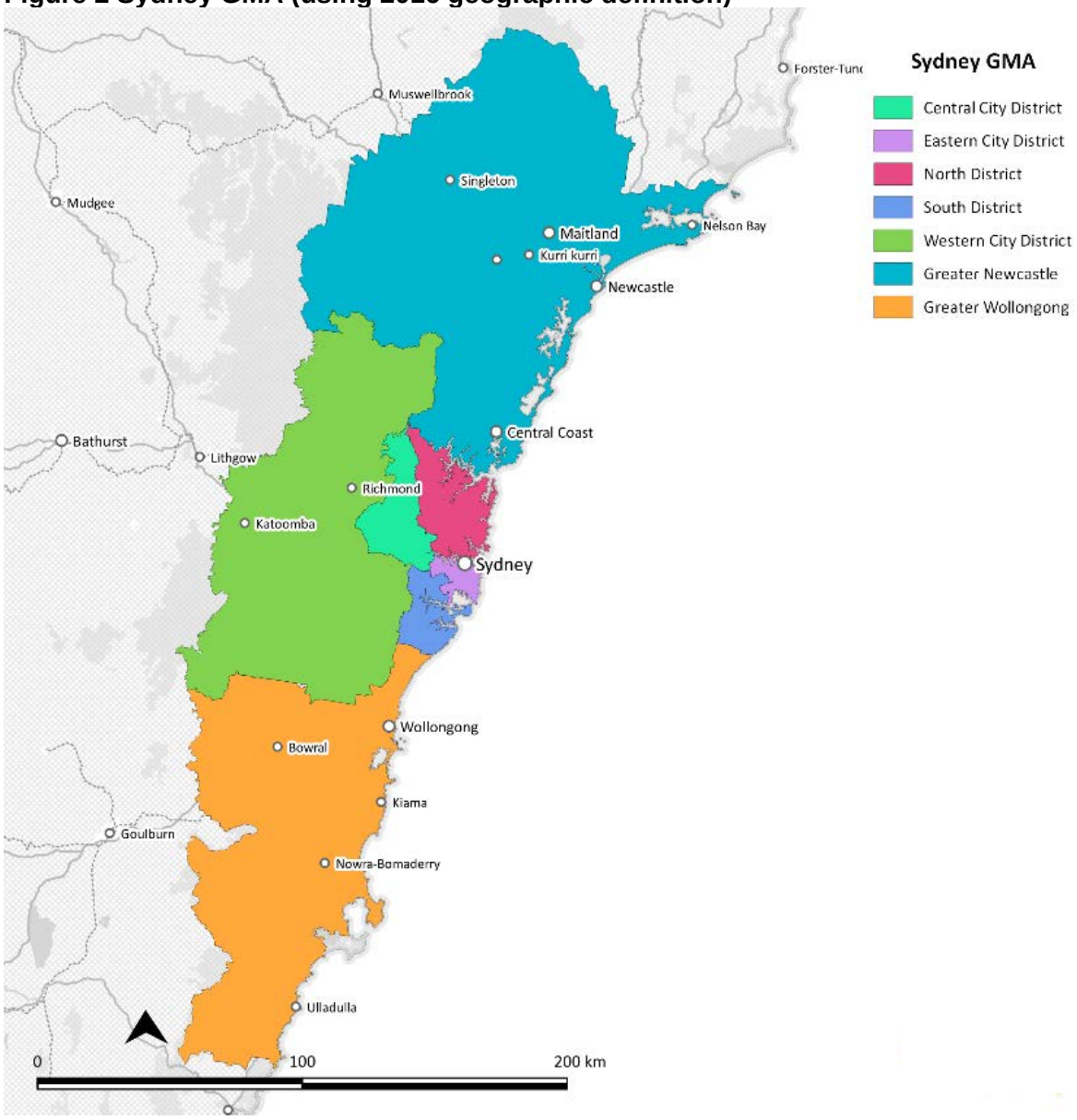
Figure 1 NSW employment and population growth



The following pages provide a summary of the forecasts by key districts and regions. The 5 Greater Sydney Commission (GSC) Districts (Eastern City, North, South, Central City and Western City) are used. These align with the NSW Government's Greater Sydney Region Plan *A Metropolis of Three Cities.* Newcastle and Wollongong regions are added to Greater Sydney, together forming the Sydney Greater Metropolitan Area (GMA – see Figure 2 for map and glossary for definition), with anything outside considered as the Rest of NSW for the purposes of this report.

[1] https://www.transport.nsw.gov.au/data-and-research/forecasts-and-projections

Figure 2 Sydney GMA (using 2016 geographic definition)



1.4.2 Population and Dwellings

Table 2 provides a summary of the dwelling projections by key districts and regions in Greater Sydney and NSW. The data shows the existing concentration of population in the Sydney GMA, with approximately 75% of dwellings in 2016, this increases to 82% by 2056 with the strongest growth in the Central City District and the Western City District associated with identified growth areas and land availability to support the Western Sydney Aerotropolis. This represents a declining proportion of dwellings in the Rest of NSW, with a greater density in Greater Sydney and the Sydney GMA.

Table 2 Structural Private Dwelling Projections by District and Region 2016-2056

District and Region	2016	2026	2036	2056	AAGR 2016-26	AAGR 2026-36	AAGR 2036-56
Eastern City District	518,005	602,424	822,218	778,113	1.52%	3.16%	-0.28%
North District	389,079	443,802	481,867	551,856	1.32%	0.83%	0.68%
South District	291,914	336,778	363,895	428,585	1.44%	0.78%	0.82%
Central City District	358,457	508,833	605,936	786,296	3.57%	1.76%	1.31%
Western City District	400,078	498,238	637,072	861,866	2.22%	2.49%	1.52%
Total GSC	**1,957,534**	**2,390,075**	**2,756,861**	**3,406,716**	**2.02%**	**1.44%**	**1.06%**
xGSC Newcastle	452,733	500,734	541,691	604,244	1.01%	0.79%	0.55%
xGSC Wollongong	224,593	247,366	265,564	293,106	0.97%	0.71%	0.49%
Total GMA	**2,634,861**	**3,138,175**	**3,564,116**	**4,304,066**	**1.76%**	**1.28%**	**0.95%**
Rest of NSW	882,542	926,757	953,264	983,202	0.49%	0.28%	0.15%
Total NSW	**3,517,403**	**4,064,932**	**4,517,381**	**5,287,269**	**1.46%**	**1.06%**	**0.79%**

AAGR is the Annual Average Growth Rate (%)

GMA is the Greater Metropolitan Area (see Section 2.4 Spatial Geographies for additional details)

GSC refers to the Greater Sydney Commission's 5 Districts

Table 3 shows the same trend in dwellings is also evident in the population projections, with an increasing share of population in the Sydney GMA highlighted by the growth in the Central City and Western City districts.

Table 3 Estimated Resident Population Projections by District and Region 2016-2056

District and Region	2016	2026	2036	2056	AAGR 2016-26	AAGR 2026-36	AAGR 2036-56
Eastern City District	1,030,360	1,205,552	1,345,559	1,571,334	1.58%	1.10%	0.78%
North District	887,019	1,007,461	1,091,203	1,245,684	1.28%	0.80%	0.66%
South District	741,116	853,772	922,602	1,086,577	1.43%	0.78%	0.82%
Central City District	972,926	1,367,851	1,620,431	2,098,192	3.47%	1.71%	1.30%
Western City District	1,056,884	1,312,245	1,681,979	2,281,079	2.19%	2.51%	1.54%
Total GSC	**4,688,305**	**5,746,880**	**6,661,775**	**8,282,867**	**2.06%**	**1.49%**	**1.09%**
xGSC Newcastle	944,454	1,045,771	1,132,312	1,263,253	1.02%	0.80%	0.55%
xGSC Wollongong	453,612	501,121	539,862	596,581	1.00%	0.75%	0.50%
Total GMA	**6,086,371**	**7,293,772**	**8,333,949**	**10,142,701**	**1.83%**	**1.34%**	**0.99%**
Rest of NSW	1,646,483	1,717,233	1,744,010	1,730,008	0.42%	0.15%	-0.04%
Total NSW	**7,732,854**	**9,011,005**	**10,077,959**	**11,872,709**	1.54%	1.13%	0.82%

AAGR is the Annual Average Growth Rate (%)

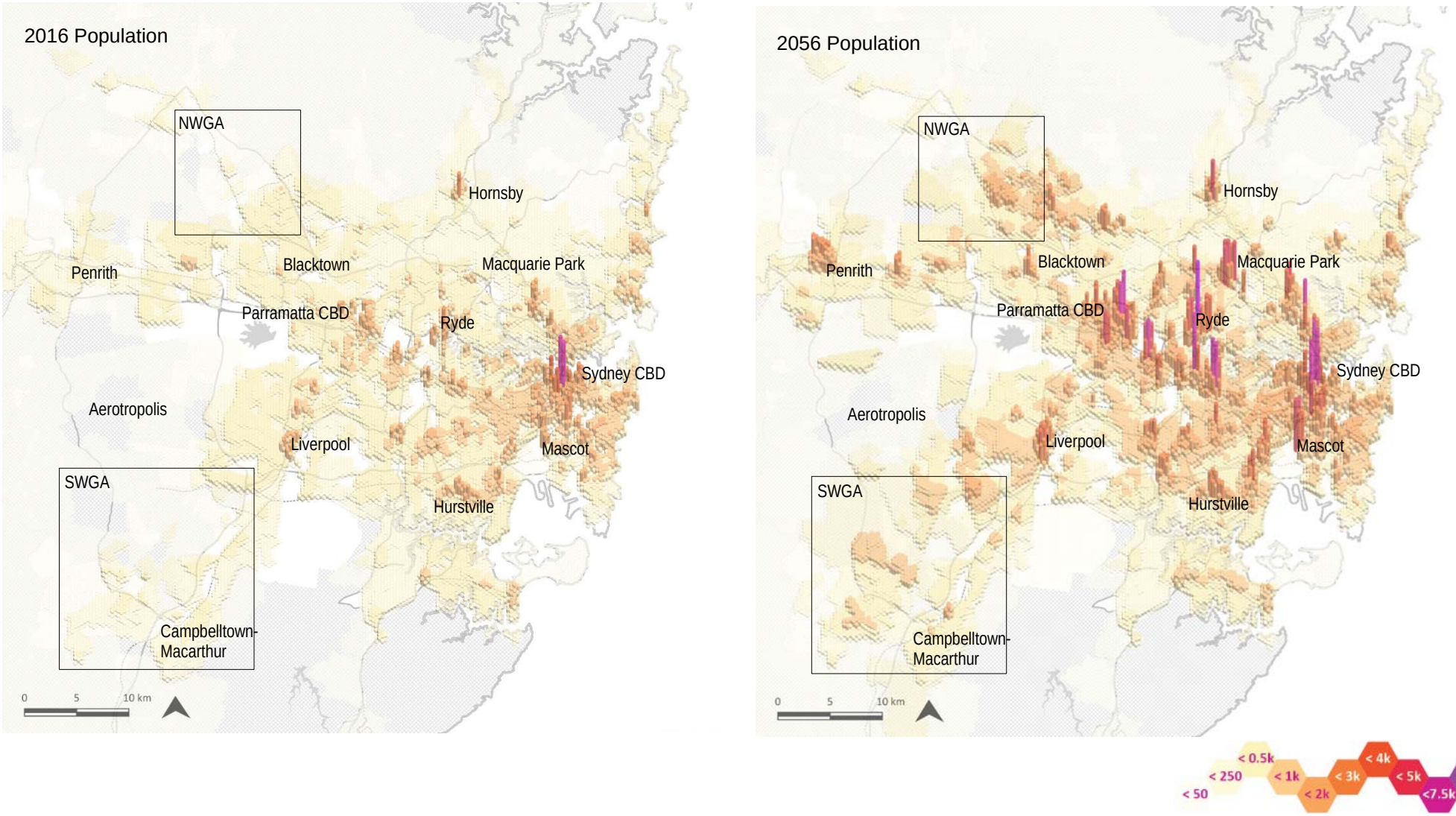
GMA is the Greater Metropolitan Area (see Section 2.4 Spatial Geographies for additional details)

GSC refers to the Greater Sydney Commission's 5 Districts

Figure 3 shows the distribution of population (based on ERP) for Greater Sydney in 2016 and 2056. In 2016 it shows a concentration of population around the inner city and distributed

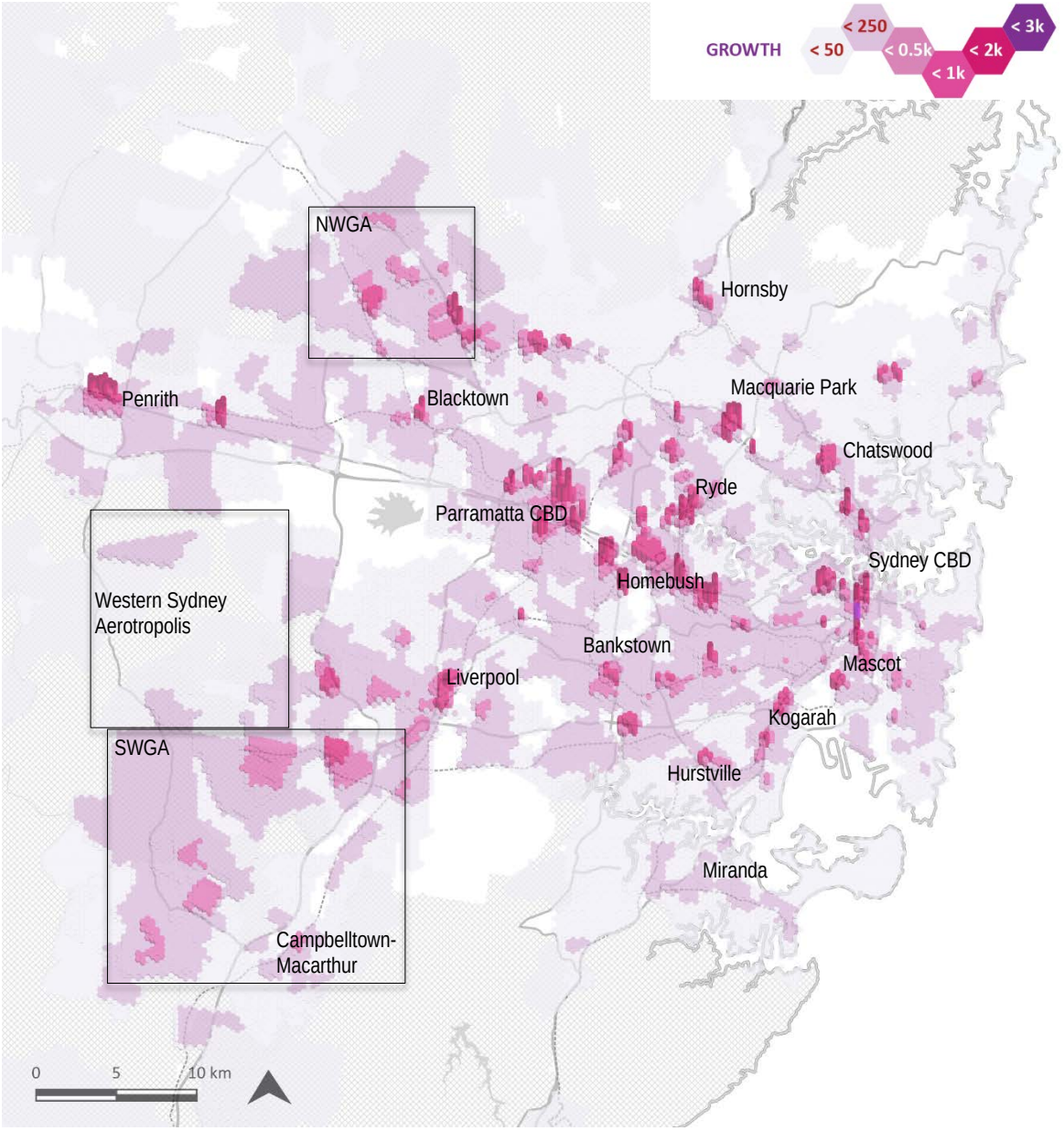
along key transport corridors, such as Parramatta to Sydney CBD and emerging population in the north-west and south-west of Sydney. High densities of population are seen to the south of Sydney Central Business District (CBD) around Green Square In 2056 density south of the Sydney CBD continues to increase and significant population growth in the Central City and Western City Districts.

Figure 3 Greater Sydney ERP Distribution 2016 and 2056



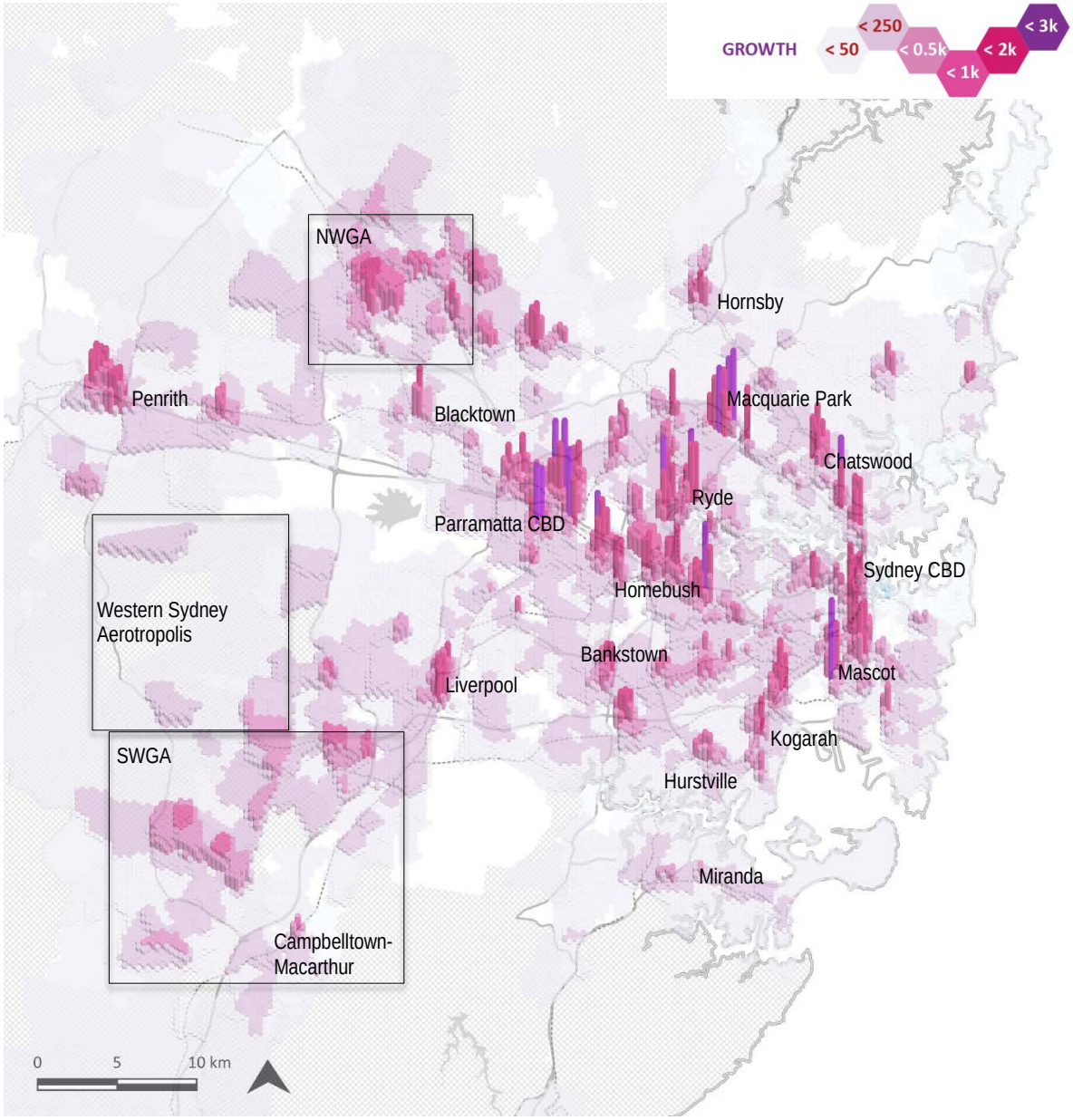
Growth over the first 20 years to 2036 is shown in Figure 4. Growth continues along existing distributions, with more focus around the South West Growth Area and continued growth in the North West. Emerging populations are establishing around the Western Sydney Aerotropolis.

Figure 4 Greater Sydney ERP Growth Distribution 2016-2036



Growth continues westward to 2056 but at a lower rate, as shown in Figure 5, particularly in the south west.

Figure 5 Greater Sydney ERP Growth Distribution 2036-2056



1.4.3 Workforce and Employment

Table 4 provides details of the distribution of the resident workforce across NSW projected to 2056. Workforce represents the available number of people, based on where they live, that are either actively employed or looking for work. Therefore, it differs to employment which is based on the number of jobs at the location of work.

This means the two variables, workforce and employment, will have a different spatial distribution as people travel, sometimes large distances, to work. In addition, there will be a proportion of the population that is unemployed and looking for work. The projections of workforce shows a similar spatial and growth trend to dwellings and population, which is not surprising as the variable is also based on where people live, but also considers the age of the resident population and whether they are participating in the workforce.

Table 4 Workforce projections by Districts and Regions: 2016-2056

District and Region	2016	2026	2036	2056	AAGR 2016-26	AAGR 2026-36	AAGR 2036-66
Eastern City District	610,137	716,876	786,537	895,829	1.63%	0.93%	0.65%
North District	494,598	569,616	610,874	677,927	1.42%	0.70%	0.52%
South District	373,979	431,409	457,425	534,638	1.44%	0.59%	0.78%
Central City District	509,822	740,111	871,189	1,121,614	3.80%	1.64%	1.27%
Western City District	532,213	651,531	837,004	1,122,610	2.04%	2.54%	1.48%
Total GSC	**2,520,749**	**3,109,543**	**3,563,029**	**4,352,618**	**2.12%**	**1.37%**	**1.01%**
xGSC Newcastle	483,781	522,605	559,964	608,730	0.77%	0.69%	0.42%
xGSC Wollongong	212,210	233,196	247,786	266,070	0.95%	0.61%	0.36%
Total GMA	**3,216,740**	**3,865,345**	**4,370,779**	**5,227,418**	**1.85%**	**1.24%**	**0.90%**
Rest of NSW	778,086	820,383	820,537	790,013	0.53%	0.00%	-0.19%
Total NSW	**3,994,826**	**4,685,728**	**5,191,316**	**6,017,431**	**1.61%**	**1.03%**	**0.74%**

Note:

AAGR is the Annual Average Growth Rate (%)

GMA is the Greater Metropolitan Area (see Section 2.4 Spatial Geographies for additional details)

GSC refers to the Greater Sydney Commission's 5 Districts

The growth of workforce is also driven by increasing participation rates over the next 20 years due to a variety of factors, such as the continuing trend of increasing female participation rates and people staying in the workforce for longer.

Employment projections by district are shown below in Table 5. Employment is expected to continue to grow most strongly within the Central City District and Western City District.

Table 5 Employment projections by districts: 2016-2056

District and Region	2016	2026	2036	2056	AAGR 2016-26	AAGR 2026-36	AAGR 2036-56
Eastern City District	926,876	1,109,111	1,227,159	1,442,629	1.81%	1.02%	0.81%
North District	471,102	563,496	629,318	741,548	1.81%	1.11%	0.82%
South District	236,433	278,543	308,789	362,276	1.65%	1.04%	0.80%
Central City District	440,606	564,939	649,939	777,956	2.52%	1.41%	0.90%
Western City District	371,891	471,803	578,198	767,119	2.41%	2.05%	1.42%
Total GSC	**2,446,909**	**2,987,892**	**3,393,403**	**4,091,529**	**2.02%**	**1.28%**	**0.94%**
xGSC Newcastle	408,425	467,306	511,556	576,453	1.36%	0.91%	0.60%
xGSC Wollongong	180,719	205,715	222,337	242,757	1.30%	0.78%	0.44%
Total GMA	**3,036,053**	**3,660,913**	**4,127,297**	**4,910,739**	**1.89%**	**1.21%**	**0.87%**
Rest of NSW	718,850	776,894	805,824	807,408	0.78%	0.37%	0.01%
Total NSW	**3,754,903**	**4,437,806**	**4,933,121**	**5,718,147**	**1.69%**	**1.06%**	**0.74%**

Note: Emp refers to the jobs available.

AAGR is the Annual Average Growth Rate (%)

GMA is the Greater Metropolitan Area (see Section 4.4 Spatial Geographies for additional details)

GSC refers to the Greater Sydney Commission's 5 Districts

Comparing district-wide employment to workforce, Figure 6 shows the persistence of distributional features.

The Eastern City district will continue to have a large net inflow of workers, while the Central and Western City will have significant outflows. Noting that the rate of population and therefore workforce growth is much higher in the Central and Western City Districts compared to employment growth.

These summaries are based on total employment and therefore do not consider specific employment industries and their resident workforce distribution.

Figure 2 Workforce and employment by District and Region 2016

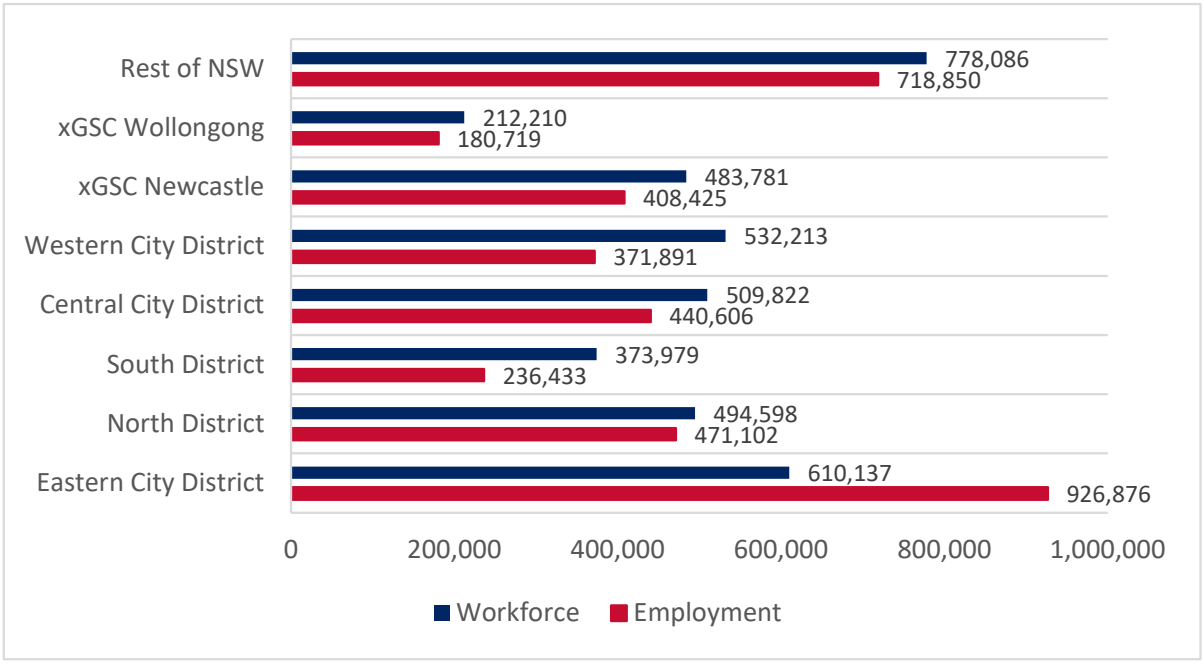


Figure 3 Workforce and employment by District and Region 2056

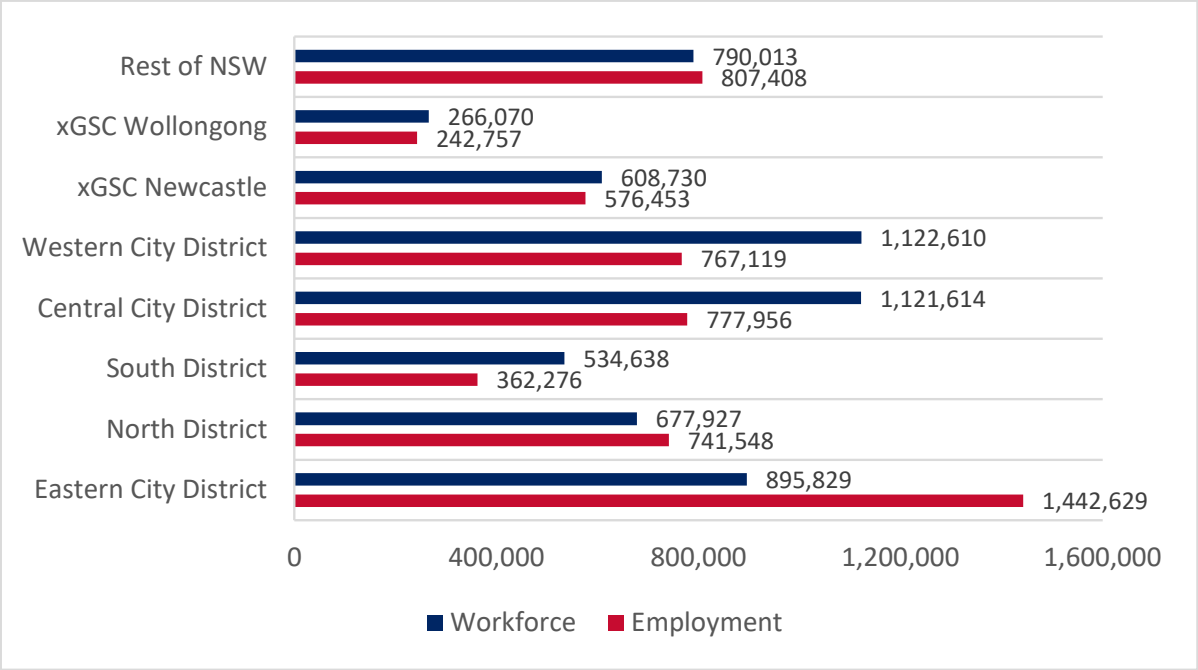
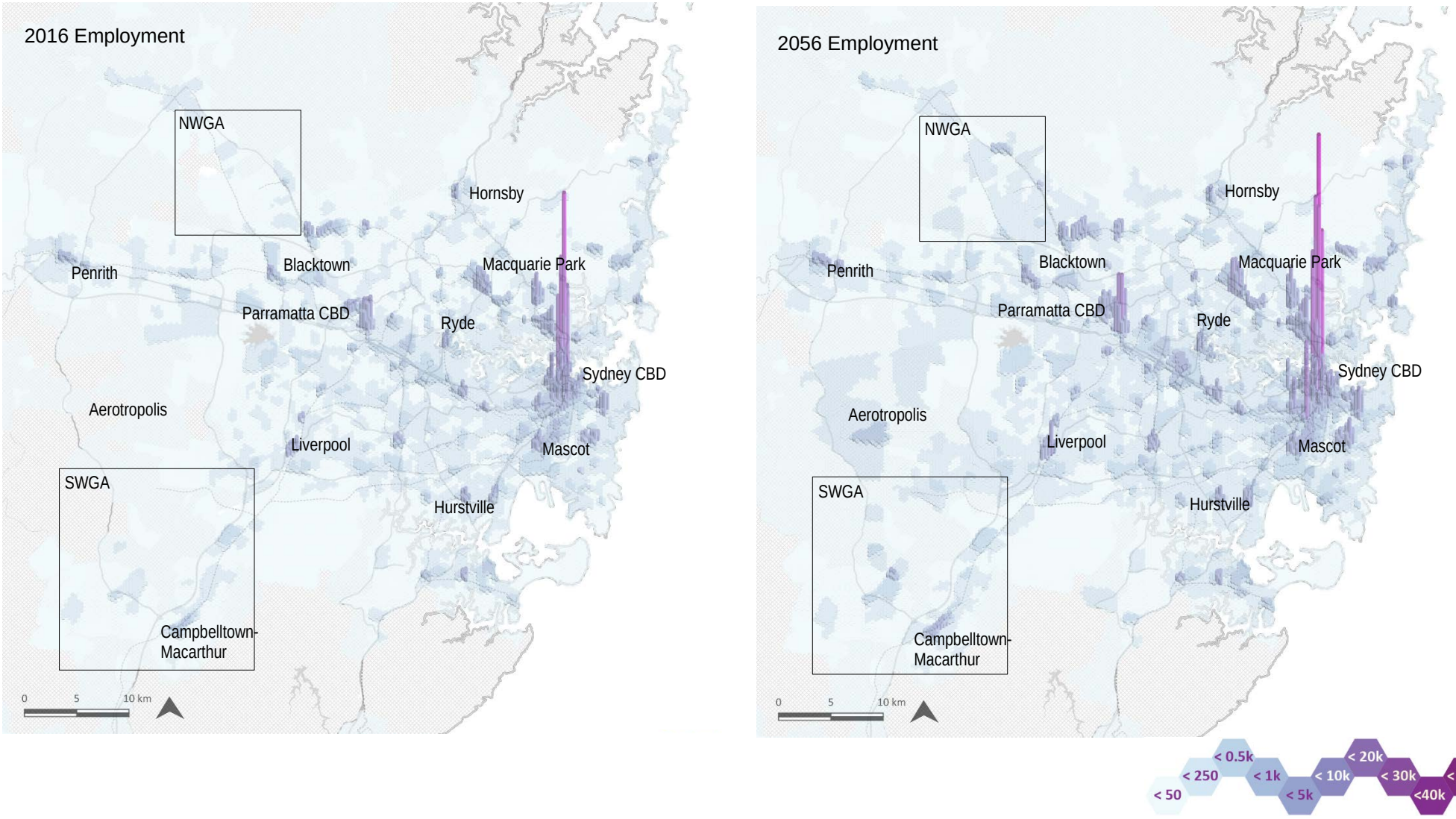


Figure 8 shows the distribution of employment for Greater Sydney in 2016 and 2056. In 2016 the figure shows the high concentration of employment in the Sydney CBD and inner suburbs extending towards Macquarie Park and Parramatta with sparse employment in the western edge of the city. In 2056 an increase in employment in centres such as Parramatta, Macquarie Park and Liverpool can be seen as well as employment in the Aerotopolis, North West and South West Growth Areas. The Sydney CBD and inner Sydney are still the largest employment centres, highlighting the continued gap in workforce and employment distribution.

Figure 8 Greater Sydney Employment Distribution 2016 and 2056



Growth in employment to 2036 consolidates in the eastern part of the city, with emerging employment hubs centred around the Western Sydney Aerotropolis and more employment focused in the North West and South West Growth Areas highlighted in Figure 9.

Figure 4 Greater Sydney Employment Growth Distribution 2016-2036

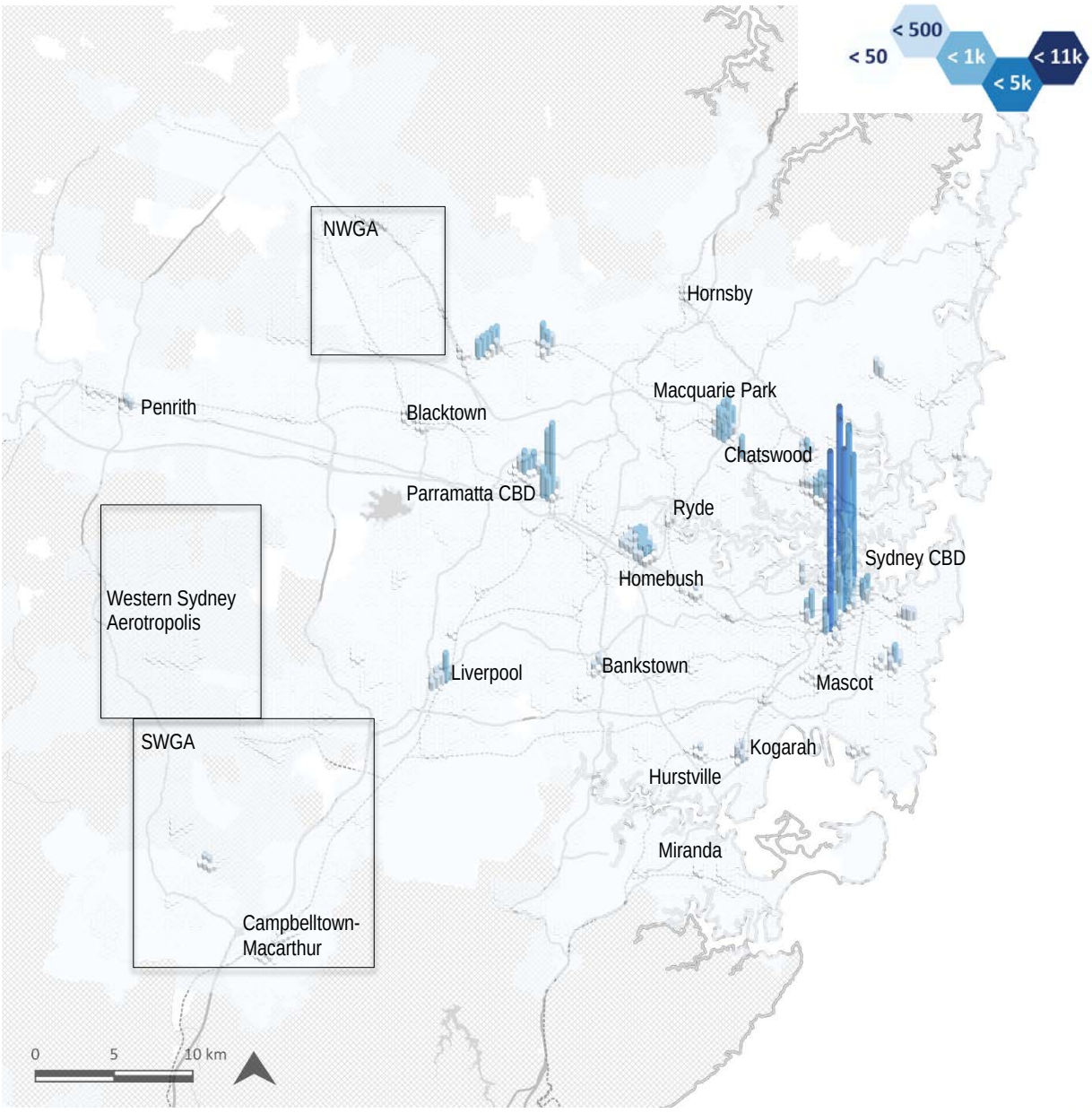
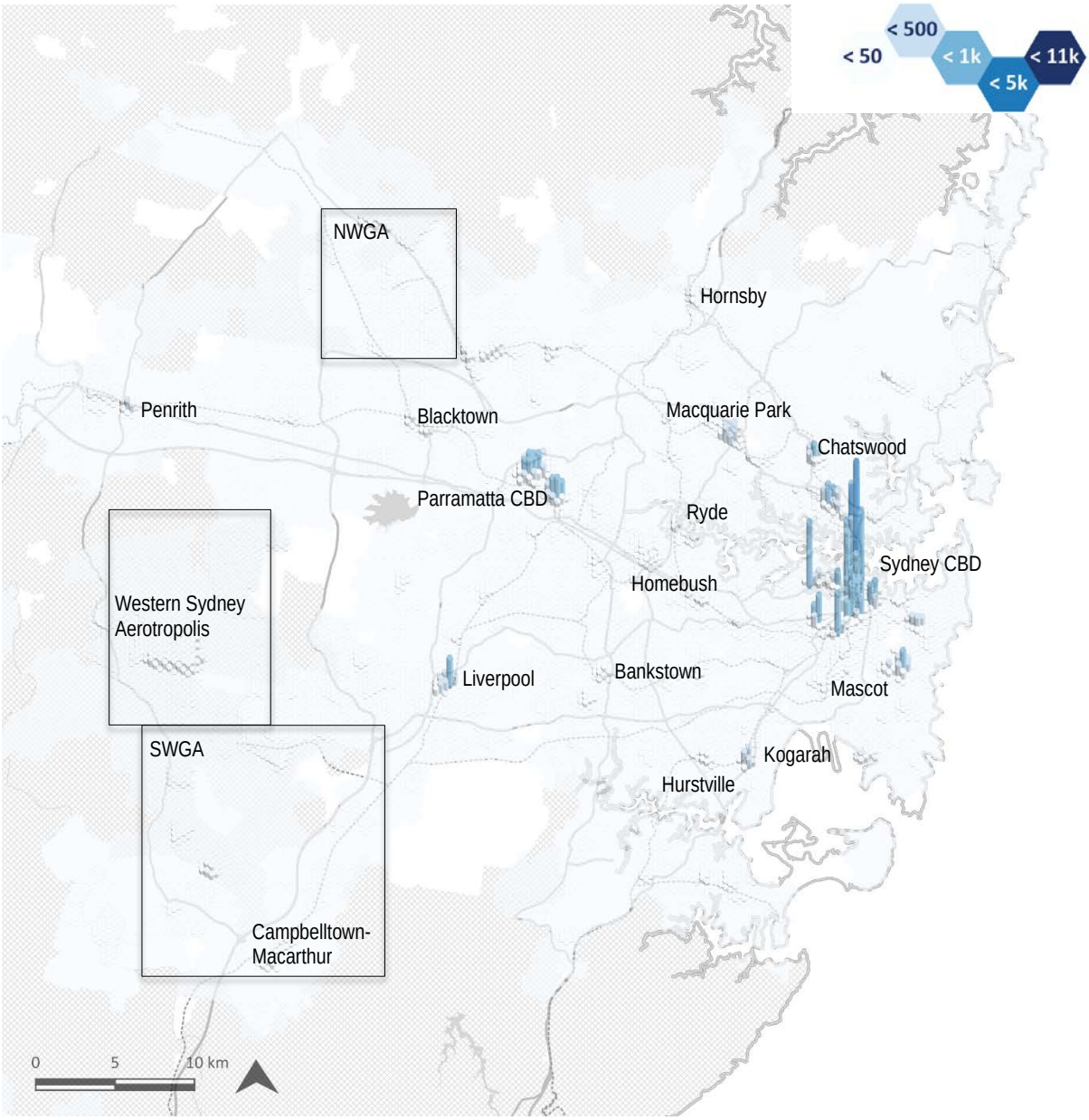


Figure 10 shows this continuing towards 2056, with significant employment generated by the Aerotropolis, continued growth in Liverpool and the corridor south to Campbelltown-Macarthur. Growth in the Sydney CBD also continues to be strong.

Figure 5 Greater Sydney Employment Growth Distribution 2036-2056



1.5 Report structure

The remainder of the report is structured as follows:

Section 2	Model framework and data specification
Section 3	Module 1: Population and Households
Section 4	Module 2: Age - sex
Section 5	Module 3: Household Type
Section 6	Module 4: Students
Section 7	Module 5: Workforce segmentation
Section 8	Module 6: Employment by Industry
Appendix A	Future Employment Development Database (FEDD)
Appendix B	Travel Zone Projections 2019 Process Maps
Appendix C	Table of assumptions
Appendix D	Output files
Appendix E	Employment allocation model
Appendix F	Important cautions and notes for TZP Users

2 Model framework and data specification

This chapter provides a comprehensive summary of the data generated by the Travel Zone Projection model and how it links to internal and to external requirements. Understanding the overall linkages between each module of the model is critical to understand the role and function of each.

2.1 TZP dataset overview

TPA creates Travel Zone Projections of population, workforce, students and employment which are used as inputs in the Pop Synth, STM and FMM models for transport forecasting.

The population synthesiser is used to create 'agents'. These agents, along with additional TZP inputs, are then used by STM to create travel flows. Some of the TPA small area data is also published online and used for other purposes.

At a high level, the TZP data covers three dimensions:

- Time Period: 5 yearly time periods from 2016 to 2056
- Geography: TZP19 is available in TZ16 geography with 3,758 travel zones across New South Wales.
- Profiling Variables: 60 variables covering people, households, workforce, employment and students.

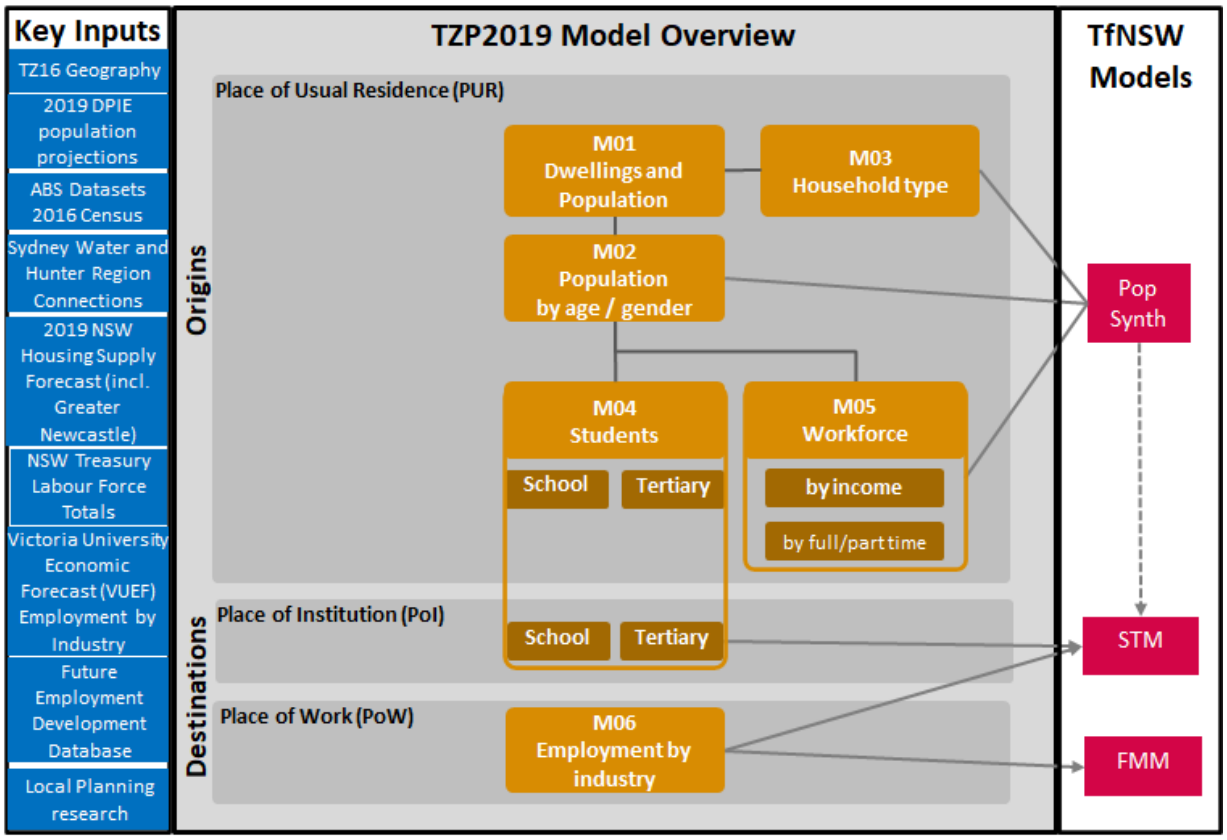
These various attributes are currently created using a series of interrelated MS Excel, VBA, Python and R based modules.

The remainder of this section provides additional detail around the TZP framework, time periods, geographies and variables as a summary of the methodology which is detailed in Chapters 3-9.

2.2 TZP modelling overview

The following diagram highlights the key data inputs and steps used to create TZP19. It also highlights the key links to the Population Synthesiser ('Pop Synth') and STM/FMM models.

Figure 6: Travel Zone Projections 2019 Model Structure Diagram



Source: SGS Economics and Planning, 2020

At a high level, official DPIE Local Government Area population and household projections are disaggregated to travel zones using a number of small area input sources on current and future development trends. From this, population is segmented by age and sex, household type, students by education level and workforce status.

State workforce projections from NSW Treasury are then combined with State employment by Industry projections provided by VU after some adjustment aimed at ensuring consistency with the rest of the model. Employment by industry forecasts from the Victoria University Economic Forecast (VUEF) model are first disaggregated from the State level to regions and finally to travel zones, using a number of small area input sources on historical and future employment trends.

The following section provides a high level summary of the TZP19 process. This summary is then discussed in further detail in forthcoming sections of the report.

2.2.1 Modules 1/2/3: Dwellings, population and segmentation

Control totals

In TZP19 the control totals for population and dwellings are set at Statistical Area 2 (SA2) level. The main input in establishing the control totals are 2019 DPIE population projections by LGA (2016 to 2041) and SA2 (2016-2056, provided to TPA in confidence).

Population Control totals. 2019 DPIE Population projections by LGA for Estimated Resident Population (ERP), Population in Occupied Private Dwellings (POPD) and Population in non-private Dwellings (PNPD) are available by LGA and are concorded to SA2s. The proportions of POPD and PNPD resulting from the concording process are applied to the ERP data at SA2 level provided by DPIE.

Dwelling Control Totals. The SA2 control totals for dwellings are based off the Population estimates. Structural Private Dwellings (SPD) are calculated by converting ERP control totals at SA2 level to SPDs for all forecast years. Occupied Private Dwellings (OPDs) are calculated by converting POPD control totals at SA2 level to OPDs across all forecast years.

Base distribution (2016).

Structural Private Dwellings (SPD) (i.e. occupied and unoccupied private dwellings) are the first variable to be estimated. Census data by Place of Usual Residence (PUR) is used in the travel zone level dwelling distribution.

The base SPD dwelling distribution is sourced from ABS 2016 Census data by Statistical Area 1 (SA1), realigned to Travel Zone16 geography. ABS Buildings Approvals, Sydney Water Connections and Hunter Water Connection Data are used to update this base dwelling distribution to 2019. It is then benchmarked to the SA2 control totals, to align with DPIE projections for 2019.

Projection distribution

The Sydney Housing Supply Forecast (2019) and the Greater Newcastle dwellings supply forecast (2018) are the two primary inputs in the future distribution of dwellings in the next 20 years. All dwelling development data is treated as ‘possible capacity’ with a ‘preferred timing’. SA2 control totals are then distributed down to this ‘possible capacity’.

If the control totals are too high (i.e., above capacity), ‘capacity’ is brought forward to meet the DPIE projection. This effectively means demand is stronger than supply and so developments come online sooner than planned. Conversely if the control totals are too low (below capacity), ‘capacity’ is pushed out to meet the DPIE projection and in some circumstances may not be fully realised in the modelling horizon. This effectively means demand is lower than planned supply, so developments are delayed.

SPDs are systematically used as the basis to identify occupied private dwellings, population splits, age-sex, household types, students by education category and workforce status. All population segments refer to persons living in private dwellings (i.e. exclude people in non-private dwellings, nursing homes, jails, etc.).

Base 2016 disaggregation ratios (i.e. household size, age splits, etc.) are sourced from the ABS 2016 Census at SA1 level realigned to travel zones. Data is benchmarked back to control totals at the SA2 level. Control totals are largely sourced from DPIE by LGA and where available by SA2, and then adjusted as per the SPD steps above.

An Iterative Proportional Fitting (IPF) approach is used to adjust the travel zone distribution over time while aligning to the SA2 controls totals. The population profile of seed values for new residential locations (i.e. where no base exists) are sourced from the respective local region.

The following primary inputs are used to project population and dwellings:

- DPIE LGA forecasts (2016 – 2041)
- DPIE SA2 ERP Forecasts (2016-56)
- Sydney Water Dwellings data (2016-2019)
- Hunter Water connections (2016 -2019)
- Sydney Housing Supply Forecast (SHSF) Data (2018/19 – 2038/39)
- Greater Newcastle Housing Forecast (2018/19 -2038/39)
- Various local planning and research information
- ABS Census data (2016)
- ABS Building Approvals

A process map of modules 1,2 and 3 are included in Appendix B: Travel Zone Projections 2016 Process Maps.

2.2.2 Module 4: Students

Students by place of residence are estimated then translated into Students by place of institution.

Population by age is translated into primary, secondary and tertiary (University and Vocational Education & Training) students, using a similar process as for other population segmentations. A base distribution is sourced from 2016 ABS Census and 2016 student enrolment data from the Australian Curriculum, Assessment and Reporting Authority (ACARA). Total future students are then disaggregated to SA4s and then to Travel Zone level using the IPF approach.

A gravity model is then used to convert primary and secondary students by place of residence, to place of institution. High level enrolment caps for schools are then put in place to redirect students to their next closest school.

The following key inputs are used to project Students at the Primary, Secondary and Tertiary levels:

- 2016 Student enrolments from ACARA
- School Infrastructure NSW Student projections to 2021
- Australian University Enrolments 2019
- National Centre for Vocational Education Research enrolments 2019
- Population projections 2016-2056 (from M01a)

2.2.3 Module 5: Workforce and Income

NSW Labour Force projections data is provided by NSW Treasury and is utilised to break down the population into employed, unemployed and persons not in the labour force. These workforce numbers are then disaggregated to SA4s and Travel Zones. These numbers are also split into full/part time employment categories and income bands, which are utilised for calibration of the TfNSW STM. SA4 level and travel zone variance in participation rates, unemployment rates, full/part time and income bands are captured by drawing on quarterly trends from data published as part of the ABS Labour Force Survey, along with the projected age-sex composition of the workforce identified from Module 02.

The following primary inputs are used to project workforce:

- NSW Treasury State-level Labour Force Projections
- ABS Labour Force Survey data (at SA4 level)
- ABS Census data
- NSW Treasury Long term Fiscal Pressures model.

2.2.4 Module 6: Employment

State employment by industry forecasts are calculated externally by VU. These forecasts are adjusted to be consistent with the workforce side of the model, then disaggregated to SA3s and then travel zones. Trend analysis and indicator series are used at the SA3 level to break down the employment by industry projections. This ensures population-serving employment (i.e. retail, education, etc.) is shifted appropriately to where population growth is projected to occur, while the spatial distribution of other industries remains consistent with recent trends.

The future employment development database (FEDD) provides small area level future employment inputs and is used as the primary input to shift census trend projections. Similar to the Sydney Housing Supply Forecast data for dwellings, this database is used as a ‘possible capacity’ and ‘preferred timing’ dataset. A feedback loop exists within the model to adjust broader trends where the FEDD is signalling a clear shift in policy and base trends. Though the FEDD is state-wide, it has a heavy skew towards Greater Sydney.

The following primary inputs are used to project employment:

- VU NSW Employment Forecasts by 19 Industry Divisions
- ABS Labour Force Survey data
- ABS Census data
- Future Employments Development Database, which contains various assumed employment developments across NSW. For more details see Appendix A: Future Employment Development Database (FEDD).

2.3 Time periods

Projections are created from a model base year of 2016. Future periods are produced in five-yearly bands (e.g. 2021, 2026, 2031, etc) out to 2056.

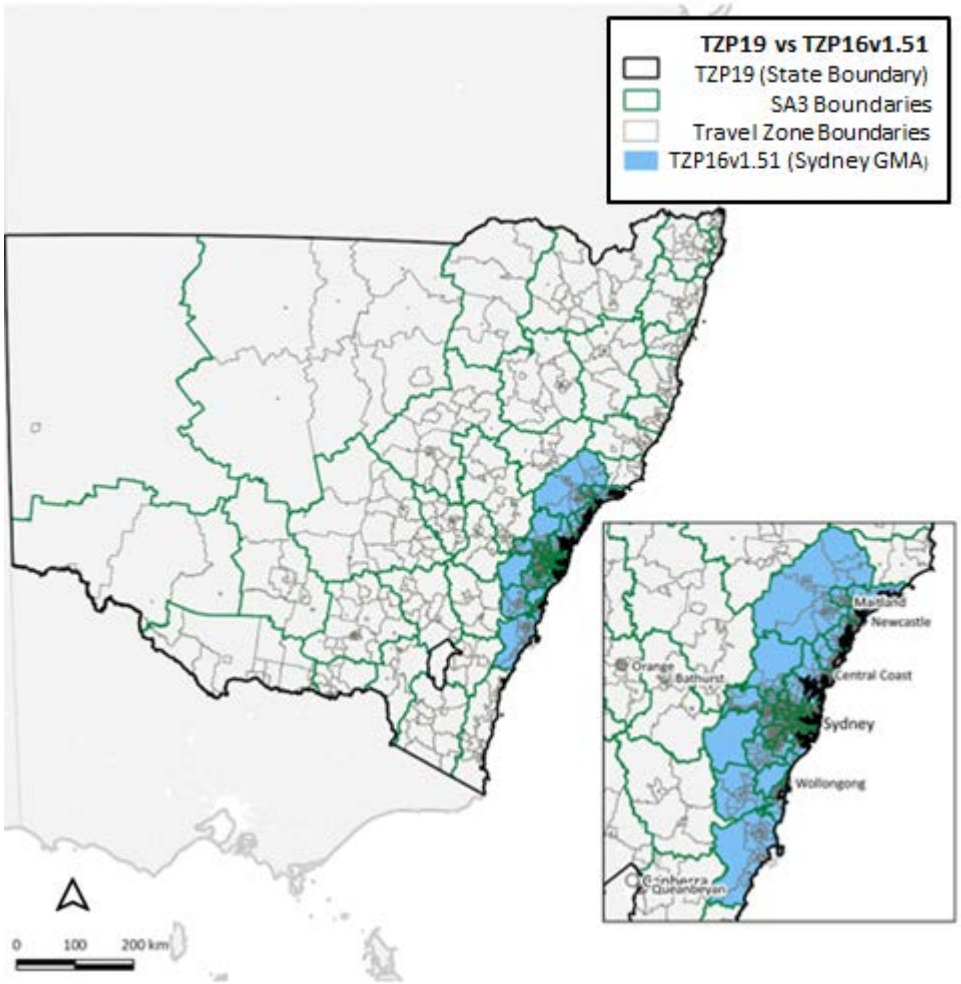
2.4 Spatial geographies

2.4.1 2016 Travel Zones

All land use variables are generated by TPAs Travel Zone 2016 (TZ16) geography classification. The TZ16 geography has 3,758 travel zones covering NSW and aligns with the 2016 ABS Census Destination Zones and the associated ASGS (SA2, SA3 and SA4) structure.

TZP19 extends beyond the Sydney GMA and covers the entire state of New South Wales. A geographic comparison between TZP19 and the previous set of projections TZP16 v1.51 is shown in Figure 13.

Figure 7: TZP19 vs TZP16 v1.51 geographic comparison



Source: SGS Economics and Planning, 2020

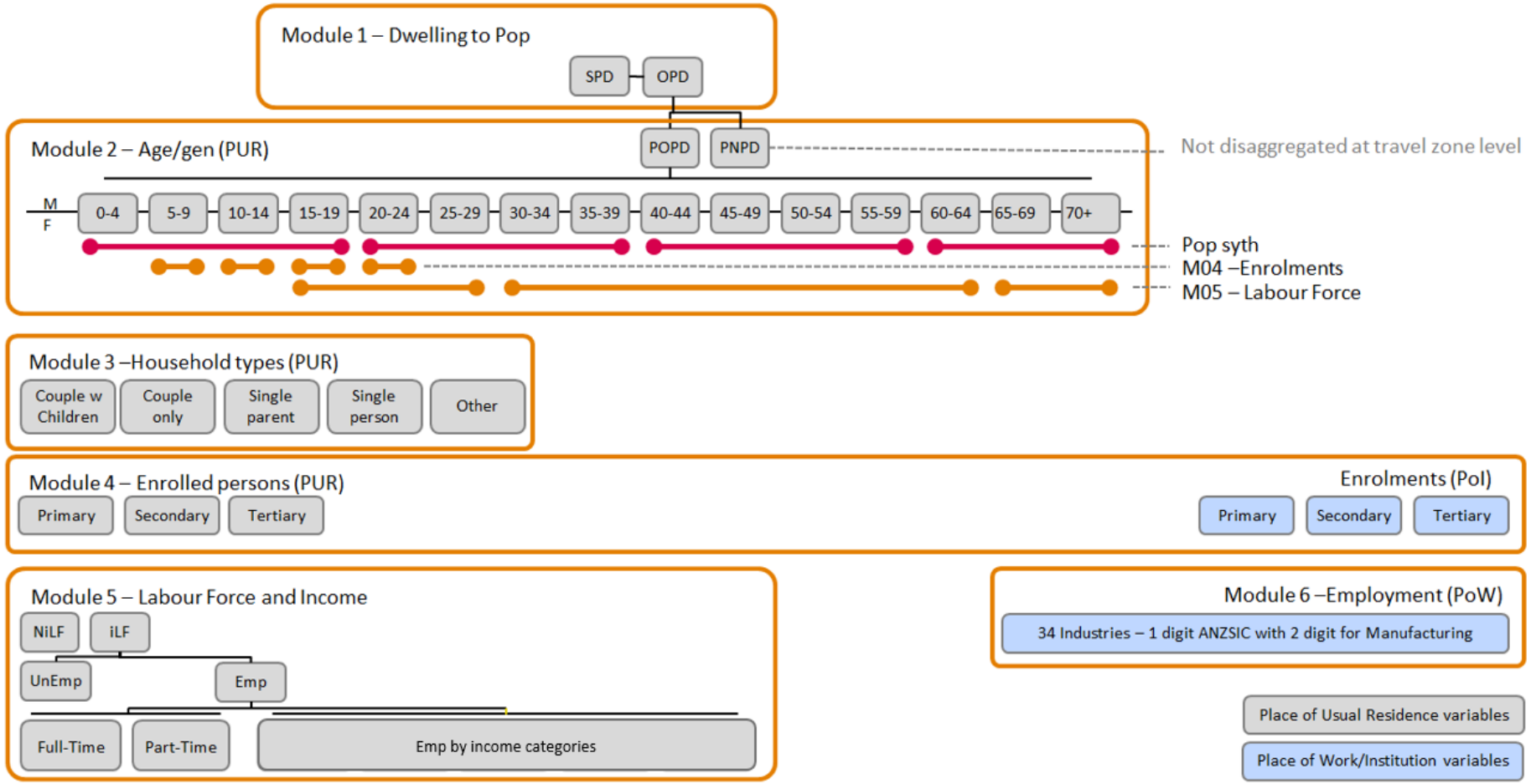
2.5 Variable breakdowns

Numerous variables are created in each of the six modules. Projections of these variables are used for both external requirements and as inputs into subsequent modules. Detailed breakdowns are required to create an accurate picture of trip attraction and generation as part of the STM. However, too many variable breakdowns may undermine the data quality, making the process overly complicated. Understanding the exact requirements and tailoring module structure around this is critical.

Beyond the core transport model requirements, the data is also available to download from the TfNSW Open Data Hub and used as an input into a diverse range of local planning and research work by a wide range of practitioners. As highlighted earlier, there are also interrelationships between Modules and associated variable requirements. For example, detailed age/sex breakdowns are required for the development of Workforce variables.

Figure 14 seeks to define the entire scope of variables that the Land Use Forecasting team needs to produce. This covers requirements for Transport Modelling, website publishing and Module interdependencies.

Figure 8: Model variable generation and module dependencies



Source: SGS Economics and Planning, 2020

Detailed Module Specification

3 Module 00: Concordance Module

This chapter provides a summary of the concordance module of TZP19. This is a new module introduced in TZP19 to separate all concordance computations. Previously, in TZP16 v1.51, concordance calculations were performed separately within each module.

3.1 Module 0 Technical overview

There are three sub-modules within M00, being M00a, M00b and M00x.

M00a acts as the mechanism used to create and check the spatial distribution used in later concordance steps. This sub-module is primarily utilized for splitting Estimated Resident Population (ERP) between Persons in Occupied Private Dwellings (POPD) and Persons in Non-Private Dwellings (PNPD). Inputs into this sub-module comprise ABS census data from 2016, being counts of Dwellings by (SA1 & SA2), counts of persons by (SA1 & SA2), ABS Regional Population Growth 3218.0 (SA2), and a shapefile providing TZ16 boundaries for NSW. This sub-module has one key function, to store and create spatial distributions used in later concordance steps.

The role of M00b is to convert data from various geographies to geographies utilised in later modules. The concordances are derived by creating weights, derived using geospatial data and ABS census data to weight concordances by Area, Population, Dwellings or Employment.

Key inputs into M00b comprise ABS census of population Age and Sex by SA1, PUR and PoW (Employment) data, ERP data from 2017, other ABS data comprises Quarterly building approvals from census time 2016 to June 2019, and data from other, non-ABS sources, comprising, DPIEs SHSF 2019, showing forecasts of dwellings by Mesh Block to 2039, DPIEs Greater Newcastle Dwelling Supply Forecast (SA2 level), Sydney Water Corporation's Dwelling Connections Data (2016-2019), along with Hunter Water Connections data (2016 - 2019).

Functions carried out in this sub-module comprise, converting:

- ABS age by sex census data from SA1_16 to TZ16
- Age by Sex census data from SA1_16 to TZ16
- ABS ERP inputs from M00A from SA1/2_16 to TZ16
- DPIEs SHSF(2019) from MB16 to TZ16
- Sydney Water Dwelling 2017-2019 connections from MB16 to TZ16
- TZP16 v1.5 data from TZ11 to TZ16 (for complete spatial coverage)
- Greater Newcastle Dwelling Supply Forecast Data from SA2_16 to TZ16
- Hunter Water Connections from SA2_16 to TZ16
- ABS Building Approvals from SA1_16 to TZ16
- ABS Dwelling Inputs from SA1_16 to TZ16

In the final step of the concordance module, M00x converts input data supplied by DPIE from LGA to SA2, as well as carrying out some additional data manipulation to ensure that the outputs of the concordance files align with control totals for the system.

Inputs into this sub-module comprise DPIE LGA level population projections by age and population projections by age and living arrangement, household forecasts by type, population by type (POPD and PNPD) - all from 2016 to 2046, and ERP from 2016 to 2056. Other data required by M00x comprise area of residential zoned land by Travel Zone and ABS census dwelling data created in M00a.

The key functions of M00x is to convert Population by age, Population by age and living arrangements and Household by type forecasts from LGA to SA2, convert residential area data from TZ11 to TZ16, adjust Population by PNPD, POPD & ERP from M00B to align with control totals and convert ERP data used to create OPD and SPD projections at SA2.

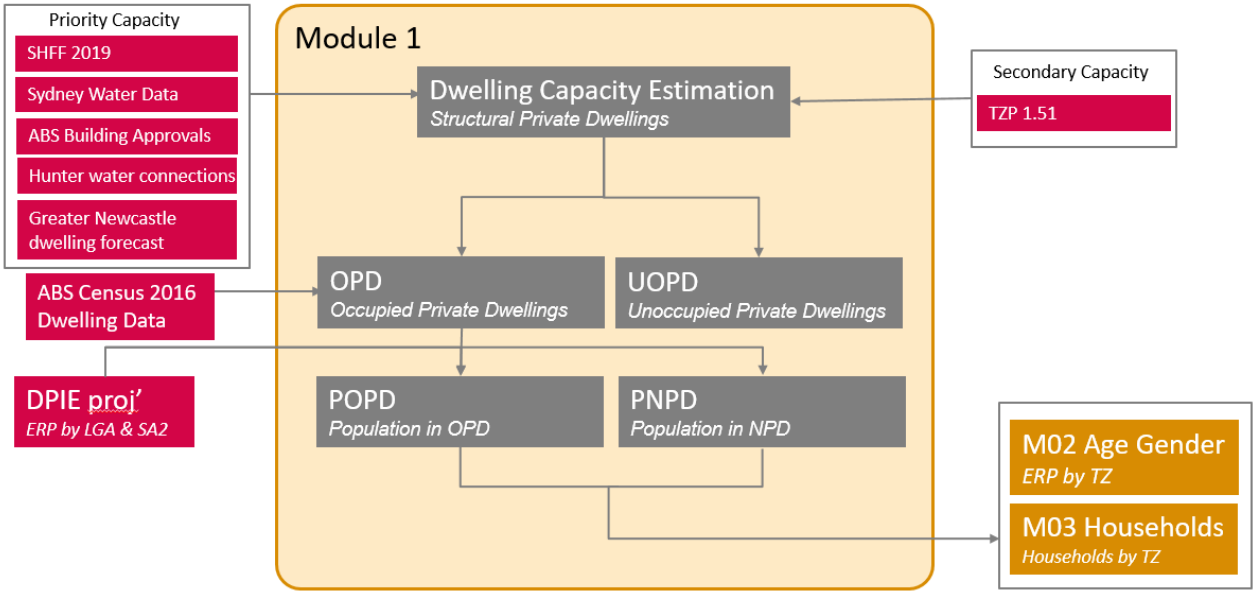
4 Module 1: Population and dwellings

This chapter provides a summary of the revised dwellings and population module of TZP19. This approach adopted in this version of TZP differs from the TZP16 v1.51 projection release in the treatment of private and non-private dwellings.

4.1 Module 1 overview

The diagram below presents an overview of the module and the relationship to the other modules.

Figure 9: Module 1 overview



Source: SGS Economics and Planning, 2020

This module is made up of four components:

- Dwelling Capacity Estimation (Structural Private Dwellings) – Incorporating SHSF forecasts for the Metropolitan area, Greater Newcastle dwelling forecasts, Sydney & Hunter Region Water connections data, Building Approvals and TZP16 v1.51 data to determine dwelling capacity for each travel zone.
- Dwelling Projections (Occupied and Unoccupied Private Dwellings) – Incorporating the capacity estimation. Occupied Private dwellings and Unoccupied Private Dwellings by travel zone are projected by applying occupancy rates from the census to the estimated Structural Private dwellings.
- Population in Occupied Private Dwellings – Combining the Private Dwelling projection and average household sizes by travel zone, the DPIE population projections for persons in OPD are projected at travel zone level.
- Population in Non Private Dwellings – Combining the non-private dwellings projected and historical household sizes, DPIE population projections for persons in NPD are projected at travel zone level.

Adjustments to Methodology in TZP19

Some updates have been made in Module 01 TZP 19 since the previous release of TZP16 v1.51 and the earlier LU16. In previous versions, the former Department of Planning and Environment (DPE) created ERP projections (broken up by POPD and PNPD) at an LGA level. However, in order to ensure that the LGA projections could be disaggregated accurately to a travel zone level, the LGA's geography boundaries were "adjusted".

In TZP19, data received from the Department of Planning, Industry and Environment (DPIE) did not utilise "adjusted LGAs", but rather utilized LGA data concorded to the SA2 level.

DPIE LGA data from 2016 to 2041 for ERP, POPD and PNPD was concorded to SA2 level. The POPD and PNPD proportions derived from the concordance were applied to DPIE's ERP SA2 control totals (unpublished, provided to TPA 2016 to 2056) to create POPD and PNPD estimates to 2041. Beyond this period, the proportions of POPD and PNPD from 2041 are applied to ERP SA2 control totals through to 2066.

Additionally, occupancy rates and household sizes at an SA2 level are set to 2016 census values, though these can be over-ridden by user input. As per Module M01c, the occupancy rates and household sizes are set at TZ level and only take SA2 averages where the values were very small and randomisation is likely affecting the ratios.

To deal with issues related to mismatches in data sets, a "back-up" concordance has been created to ensure a complete concordance of people or dwellings. This back-up is an area based concordance which only occurs if a dwelling-based, or person-based concordance has mismatches in the data. An example of this is when there may be concordance data stating no existing dwelling, though water connections data indicates the presence of a dwelling.

The only exception to this method is the population control totals, which are processed via the POPD & PNPD weighted concordance module. This is to ensure the accurate allocation of population weights into each travel zone, an improvement of the person only concordance.

4.2 Module 1 - Technical overview

This section provides an overview of the 4 sub-modules (M01a, M01b, M01c and M01d) that make up module 1.

The first of these sub-modules, M01a, determines dwelling capacity at a travel zone level drawing on a range of data sources. This sub-module incorporates the most up to date datasets at the time, comprising, ABS Buildings Approval Data (2017-2019), DPIEs SHSF (2019) housing projections along with the Greater Newcastle Dwelling Supply Forecast 2018 from the same source, Sydney Water's dwelling connections stock data aggregated at the Mesh Block level, Hunter Water dwelling connections data and previously sourced data from TZP16 v1.51 (2016-2056).

Sydney Housing Supply Forecast (SHSF)

The Sydney Housing Supply Forecast provides information on where, when, and how many new homes are likely to be built within the city over the next 20 years. It is updated annually to take account of changes in the market, new rezonings and updates to State strategic land use planning in urban renewal and land release precincts.

The forecast is one indicator of whether additional demand can be met within existing planning controls and economic conditions. The forecast also considers current residential developments that are either under construction or approved for development, as well as analysis of likely future development under current zoning and planning controls. Information gathered from local councils and industry is also reflected in the data.

The SHSF data provided by DPIE extends to 2039 and underpins the model significantly, being the major input into the primary dwelling capacity estimation in the first sub-module M01a.

The data is provided at the Mesh Block level, then concorded to travel zone geographies before being fed into the capacity calculation model. After updating years between 2016-19 with data from Sydney Water and ABS Building approvals, SHSF capacity data is the leading input from 2019-2039.

The SHFS covers all 33 LGAs in Greater Sydney Region*, with additional coverage of Newcastle and the Lower Hunter provided by the Greater Newcastle Dwelling Supply Forecast

** Greater Sydney: The Sydney Statistical Division not including Central Coast LGA*

SHSF forecasts, Sydney & Hunter Region Water and Building Approvals inform the additional priority capacity available in each travel zone, while the secondary additional capacity is previously identified in TZP16 v1.51.

Secondary Capacity

Secondary capacity is a “filler” and only utilised when the locked (or User Input) and priority capacity for the travel zones for a given SA2 do not exceed the allocated control total.

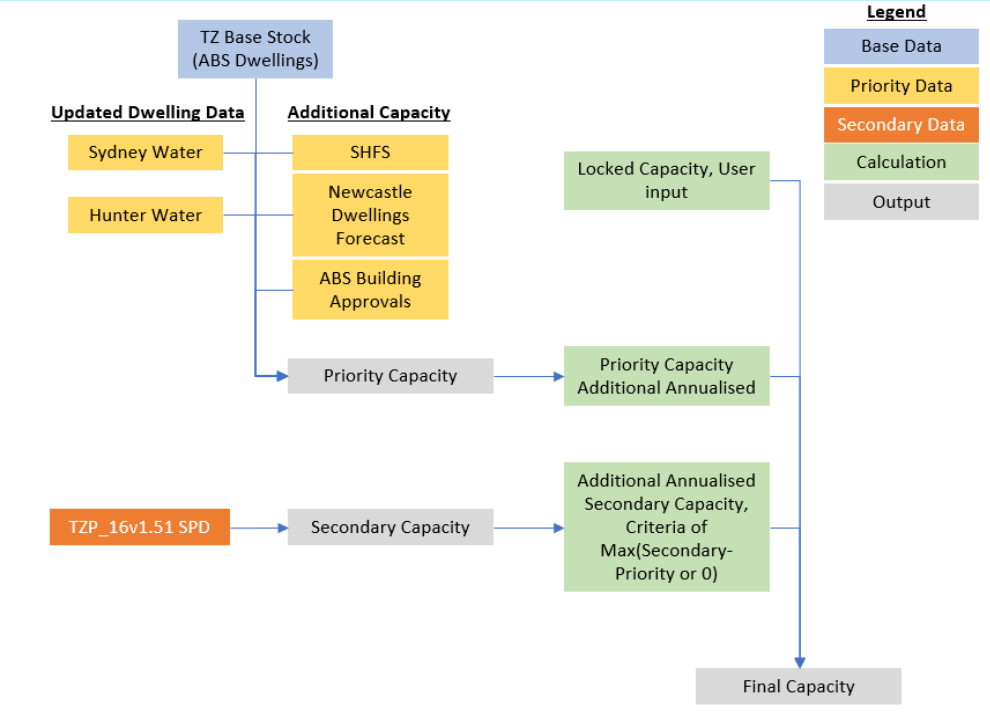
The SHSF is available over a 20 year period, in the case of SHSF 2019 version until 2039. Given the TZP projections extend beyond this period, there is a requirement to allocate the additional dwelling demand post 2039 accordingly.

Secondary capacity is used to allocate any residual population after allocating population using the priority inputs. The secondary capacity dataset for TZP19 is based on the previous distribution of dwellings from TZP16 v1.51. This provides a robust baseline for allocating additional demand without the guidance of a primary data source.

Secondary capacity is an additional supply side dataset utilised when no other primary capacity data source is available, i.e. SHSF. This allows this knowledge to remain as an input into the model, without exceeding the dwelling control totals identified in earlier stages.

The secondary capacity is only utilised when both priority capacity is lower than the control totals and the controls are not completely exhausted for that period. Beyond this, if the SA2 still has not reached the control total, the remaining control total is pro-rated across the travel zones within the SA2.

The figure below outlines the capacity allocation process.



Source: SGS Economics and Planning, 2020

The second sub-module, M01b, distributes the structural private dwelling projections (SPDs) projections by SA2 to travel zone based on the capacity estimates from

M01a. Key inputs into M01b comprise control totals for SPD at SA2 level (estimated based off DPIE SA2/LGA population control totals and census data), available residential land by travel zone (created In M00x using DPIE zoning data), capacity inputs from M01a and capacity calibration (the opportunity to adjust capacity manually to override the previous capacity inputs).

This sub-module has two primary functions being to firstly, review the capacity inputs from M01a and determine if manual adjustments are required, and secondly, to calculate the final dwelling stock (i.e. SPDs) in each travel zone based on dwelling capacity and dwelling control totals by SA2. For 2016 and all projections years, the growth of Structural Private Dwellings (SPDs) is distributed based firstly on the priority capacity. In the case there is a residual of dwelling growth (i.e. there is not enough capacity), the secondary capacity is used to allocate the remainder of the growth to meet the SA2 SPD control total calculated in M00x. If priority and secondary capacities are exhausted any residual capacity is prorated based on shares of the control totals.

Next M01c converts SPDs from M01b to Occupied Private Dwellings (OPDs) and produces Population in Occupied Private Dwellings (POPDs) and Population in Non-private Dwellings (PNPDs) at the TZ level. Inputs into this sub-module comprise estimated POPD and PNPD at SA2 level (from M00x.) as well as OPDs projected within the same module, the SA1 distribution of POPD and PNPD, OPDs and NPDs is sourced from the 2016 census population and housing after concording to travel zone geography.

This module has several key functions. Initially it derives base 2016 household sizes and occupancy rates using SA1 level census data after concording this to TZs in M00b. SA2 averages are used when TZ level ratios are derived from small samples, likely to be impacted by the randomisation of census data. The sub-modules then convert SPDs to OPDs by applying travel zone level occupancy rates to the travel zone level SPD estimates, before benchmarking these initial OPD estimates against the SA2 level control totals.

Once OPDs are calculated by travel zone, the sub-module then multiplies the OPDs with the household size by travel zone to produce the initial POPD estimates which are then benchmarked against the POPD control totals at the SA2 level. In the final calculation, the SA2 level POPD growth is added to the initial POPD estimate. Finally, the module distributes the DPIE forecast for PNPD to TZs using the census distribution.

The final sub-module (M01d) deals with issues arising in the model which yield outputs which are not in line with likely development activity. The changes in this module are entirely contained within SA2 geographies and are outputted via travel zone shifts within the higher geography (SA2). The adjustments in this module target areas where validation checks have not been reached and seek to increase the accuracy of the broader TZP framework. The outputs from this module are structurally the same as those from M01C, only providing the user the ability to introduce travel zone level shifts in OPD, POPD and PNPD (and therefore ERP).

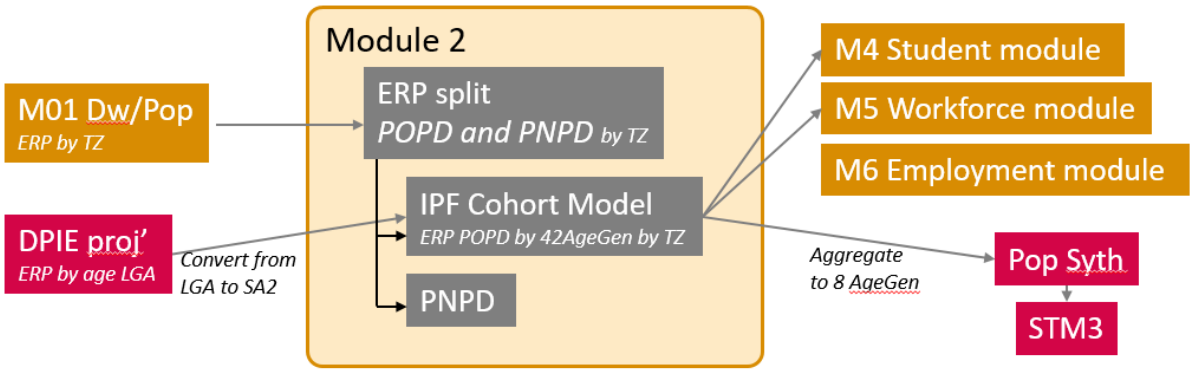
5 Module 2: Age-Sex

This chapter provides a summary of the age-sex module of TZP19. This approach is the same as used for the TZP16 v1.51 projection release.

5.1 Module 2 overview

The following diagram presents an overview of the population by age/sex module and how it interacts with the broader TZP framework.

Figure 10: Module 2: Age sex module approach overview



Source: SGS Economics and Planning, 2020

Estimated resident population (ERP) is comprised of two segments i.e. People in occupied private dwellings (POPD), which accounts for approximately 98 per cent of the population, and People in non-private dwellings (PNPD). This second category consists of people who live in colleges, aged-care facilities, jails and other non-conventional or communal dwelling forms. This segment of the population is not used for trip generation in the STM and is therefore not further disaggregated.

After splitting POPD and PNPD, POPD is disaggregated into 42 age-sex categories for each time period for use in subsequent modules. These 42 categories are also aggregated to 8 age-sex categories for the population synthesiser and STM.

While the objective of the previous module (M01) was an accurate estimate of population levels in each travel zone, M02 takes these values and primarily focusses on their distribution across age-sex categories. As a consequence, this process is almost entirely automated.

The control totals for this module are the POPD values by TZ, which are created in M01. The module starts with base data which uses the census age/sex distribution. For the following 5-year interval, this distribution is used as a starting value and Iterative Proportional Fitting (IPF) is used to adjust this distribution to the age/sex control totals for that period. The resulting distribution then becomes the starting distribution for the next period, and so on.

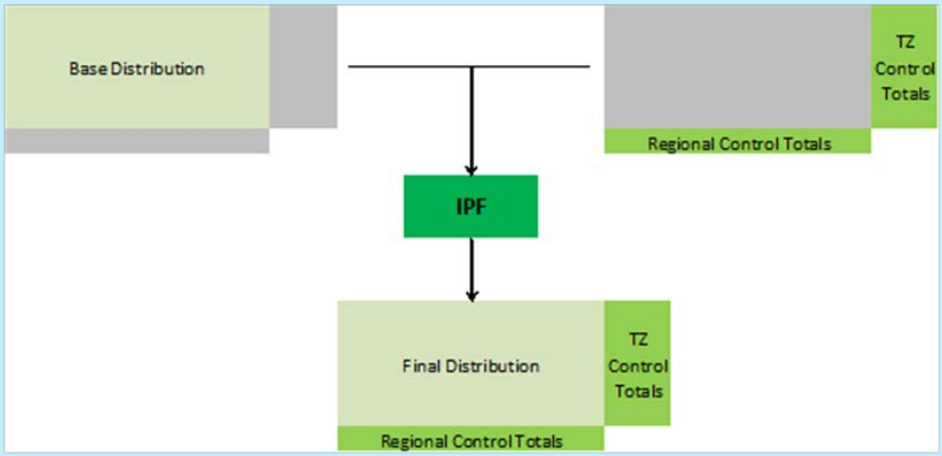
Iterative proportional fitting (IFP) concept overview

IPF is an iterative procedure which aligns known totals to an estimated distribution. In the age-sex module, the total population (POPD) of each travel zone is known, having been estimated previously. Similarly, for each control region (SA2), the total for each age-sex category is known from DPIE population by age-sex projections.

Using these totals, along with an approximated distribution, an iterative process is used to estimate the population in each age-sex category by travel zone. This process is run for every region in each period. For the base period (currently 2016), the IPF starting distribution is approximated using 2016 census data. Future periods align the final distribution of the preceding period as the starting distribution for the IPF procedure.

The IPF method is outlined below. The approach essentially involves a number of iterations where the distribution is aligned to row totals, then column totals and so on until a convergence criterion is achieved. This results in a final distribution.

Figure 11: IPF Procedure



5.2 Module 2 - Technical overview

This section provides a brief overview of how the three sub-modules of M02 (i.e., M02a, M02b and M02c) operate, what they read in, the operations they perform and what they produce.

The first sub-module, M02a, brings in relevant data from various sources and structures them for the IPF process. Key Inputs for this sub-module comprise the age-sex census data by TZ16, which is obtained from M00b. The key function of M02a is to adjust TZs with a very small population to reflect the age-sex structure of the overarching SA2. In the case of small populations, the risk is that the age-sex structure reflected in the raw census data is influenced by ABS randomisation process, which is designed to ensure the confidentiality of the data, and might not be

reflective of current and future age-sex structures. This is very pertinent for green-field areas.

In M02b, an IPF is used to estimate age-sex breakdowns by Travel Zone over time. Implicit in this IPF are four key assumptions. Firstly, for future years, the IPF procedure uses the age-sex distribution of the previous period as a starting point. Second, this approach reflects the fact that at small geographic levels, the age distribution over time is more heavily influenced by migration than by cohort ageing. Thirdly, regional trends in age-sex structure are captured at a TZ level by the IPF procedure. Finally, future growth TZs (which have no historical age-sex distribution) are assumed to have a starting distribution which mirrors the distribution of the overarching SA2.

The key inputs into M02b comprise; POPD control totals by Travel Zone (from M01c), Base year ERP totals by SA2 (again from M01c), Age-sex control totals by SA2 (from M00x) and the base year age-sex distribution by Travel Zone (from M00b)

The module requires several parameter inputs:

- SA2 population forecasts by age from 2016 to 2041, from M00x from DPIE data.
- SA2 population forecasts by age from 2046 to 2056, inferred using linear interpolation of 2036 and 2041 forecasts, and proportionally adjusted to match the POPD control totals by Travel Zone.
- Convergence criteria – the iterative process is complete when the sum of the absolute differences (between estimated regional age-sex and regional age-sex control totals) are below this level.
- Future years – the module will perform the IPF procedure for every 5-year period up to 2056.
- Base year – the module will use the base year 2016.
- ERP_OPD Criterion – Specify the share of a Travel Zone's population that must live in a private dwelling for the TZ specific age-sex distribution to be used. Travel Zones which do not satisfy this criterion will be assigned the SA2 age-sex distribution. This criterion is required for the sub-module to read input data correctly and requires updating if a new regional or TZ structure is adopted.

The final sub-module, M02c aggregates data from the travel zone geography to the SA4 geography for each required output.

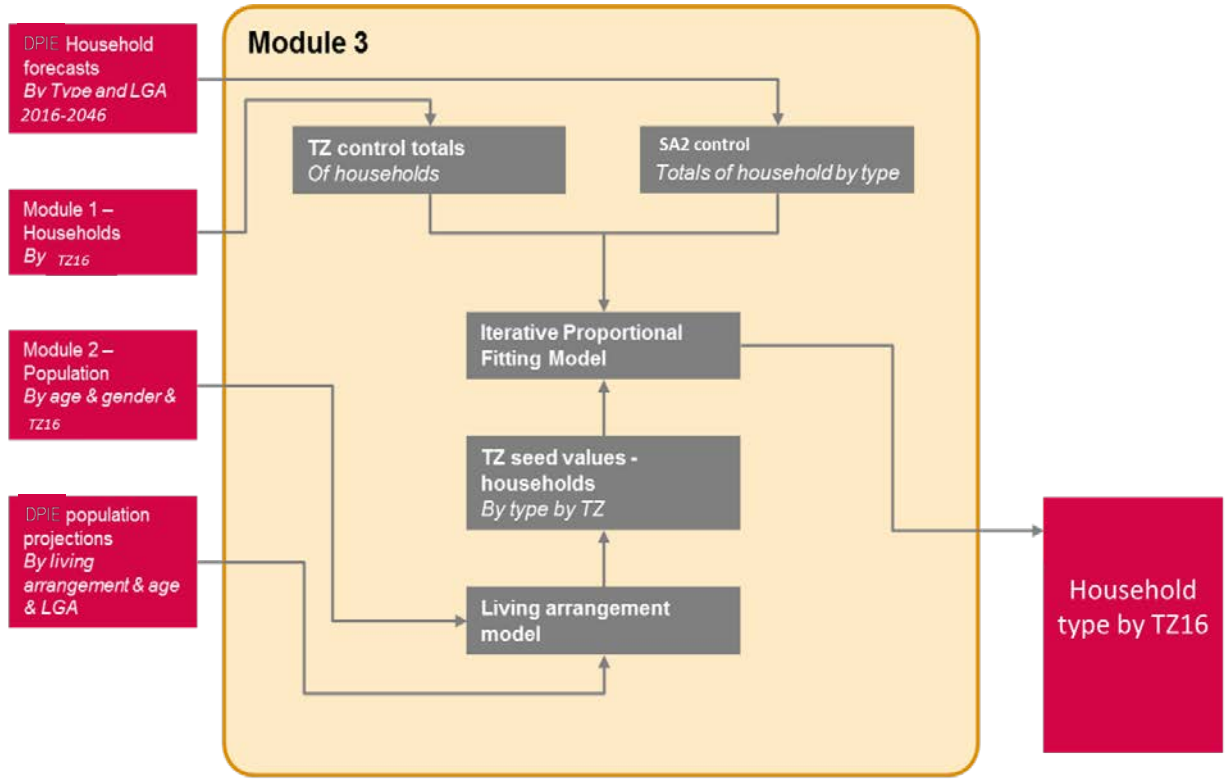
6 Module 3: Household type

6.1 Module 3 Overview

This chapter provides a summary of the household module of TZP19.

The following diagram presents an overview of the module and how it interacts with the TZP framework.

Figure 12: Module 3 - Household by type overview



Source: SGS Economics and Planning, 2020

The primary function of M03, the Household by Type module, is to use the outputs of previous modules, along with DPIE LGA household type and LGA living arrangement projections, to project households by type at TZ level. The control totals for this module are the OPD values by Travel Zone from M01.

The household types projected by this module are: Couples with Children, Couples only, Single parent, Single person categories and the Other types category, which primarily comprises group households.

The inputs into Module 3 specify the household totals at the travel zone level, along with the distribution of household types at the LGA level. Thus, the focus of Module 3 is on the distribution of household total to households by type at the travel zone level. This distribution is achieved using the Iterative Proportional Fitting (IPF) approach explained in Module 2 (Section 5).

For each time period, the IPF approach requires an approximate distribution of household types at the travel zone level as a starting point, or 'seed value'.

6.2 Module 3 - Technical overview

Module 3 comprises three sub-modules. The first (M03a) generates population living arrangement propensities by age and household type. In this sub-module, the OPD

by Travel Zone from Module 1 act as control totals. A key assumption is that only one household type is assumed to represent one dwelling. To convert the population in occupied private dwellings projected by age and living arrangement to a population projection by age and household type, the following table is used.

Table 6: Household groups definition

Population	Household type	Living arrangement
Population in OPDs	Couples with children	Children <15 with 2 parents Child aged 15+ living at home Partnered with children <15 Partnered with children 15+
	Couples only	Partnered with no children at all
	Single parent	Single parent with children <15 Single parent with children 15+ only Single in family living arrangement
	Single person	Living alone
	Group	Single in a group household

Key Inputs into M03a comprise SA2 population forecasts by age and living arrangement 2016-2046 (from M00x, using data supplied by DPIE) and the already mentioned OPD by Travel Zone from Module 1.

The module performs two functions, initially converting the population projection by age and living arrangement, to population by age and household type, and secondly, calculating the SA2 population living arrangement propensities by age and household type for 2016-2046. The DPIE projections that living arrangements is based off extends only to 2046. Projections beyond 2046 are extended by applying forward the growth from the previous 5 year period.

Sub-module M03b estimates the distribution of households by type at the travel zone level for the 2016-2046 period. In order to carry out this function, M03b uses TZ level population projections by age-sex from Module 2.

Key assumptions of this module comprise the assumption that only persons of age 15+ are considered in the Household by Type categories, while in order to convert population projections by household type to household projections the following Household-Population factors are assumed for all travel zones.

Table 7: Household – Population factors

Household type	Scale factor	Assumption
Couples with children	0.5	2 adults per house
Couples only	0.5	2 adults per house
Single parent	1.0	1 adult per house
Single person	1.0	1 adult per house
Group	0.449	Based on average household size from ABS Census

Inputs into M03b include the SA2 population living arrangement propensities by age and household type for 2016-2046 from M03a, the TZ16 population projections by age-sex for the same period from M02b and the Group headship data from the 2016 Census of Population and Housing.

The starting distributions used in this module come from population by age group at the TZ level, for which shares of household type by age group from DPIE SA2 level projections are applied (propensities calculated in M03a). For instance, if 30% of an age group are single parents within an SA2, 30% of the households in all the TZs in that SA2 will be assumed to be single parents.

This sub-module (M03b) performs three important functions. Firstly, M03b converts TZ16 population projections by sex and age to TZ16 population projection by age. Secondly, the sub-module also generates the population by age and household type projections 2016-2046. Finally, M03b estimates the TZ16 distribution of households by type for 2016-2046.

The sub-module M03c creates estimates of the distribution of households by type for the 2016-2056 period. In order to do this, the SA2 household projections by type are extended to 2056 assuming that the SA2 distribution of household types remains fixed from 2046. Linear growth is assumed and then the IPF is run.

Three inputs are required for this sub-module to perform the required operations, these being; TZ16 level household projections 2016-2046 (an output of M01b), SA2 household projections by type 2016-2046 (from M00x, using data supplied by DPIE), and estimates of the TZ16 household distribution by type 2016-2046 (from M03b).

The sub-module performs three functions, first, extending the SA2 household projections by type data to 2056. Second, M03c performs an IPF, using seed values for 2016-2046 from M03b. Finally, M03c performs the IPF procedure for 2046-2056 using seed values from the IPF output of the previous time period.

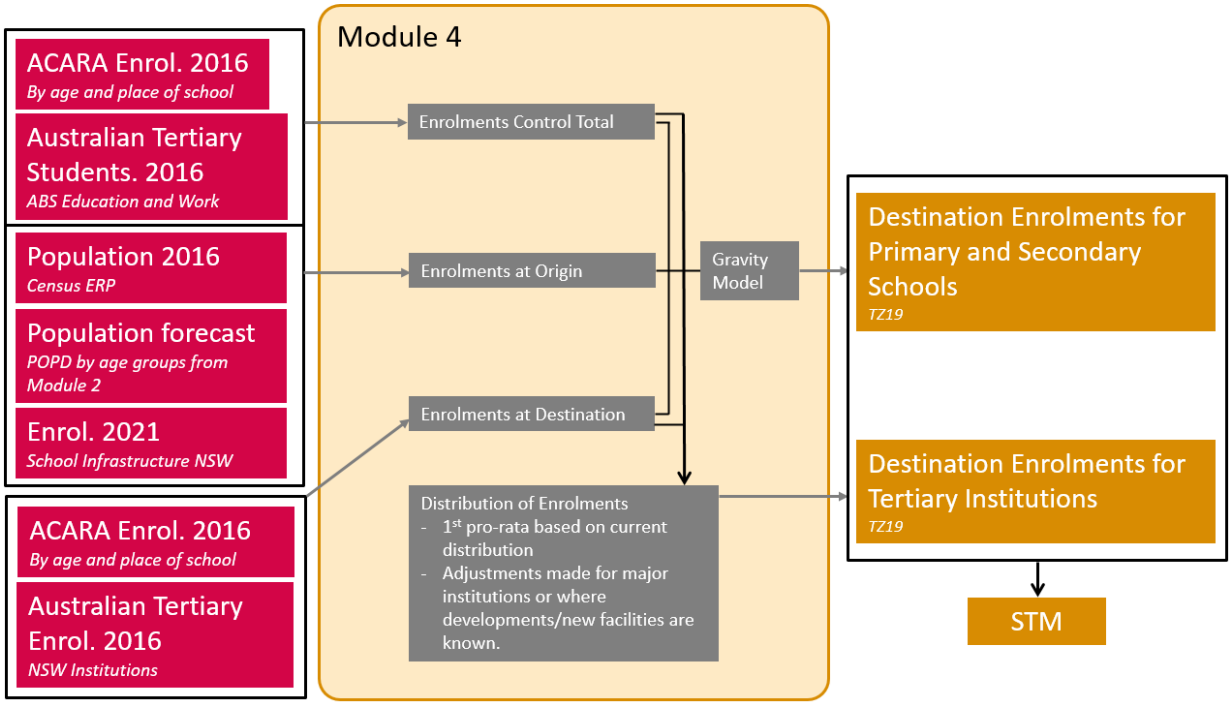
7 Module 4: Students

This chapter provides a summary of the revised students module.

7.1 Module 4 Overview

The primary function of the Students module is to use outputs from other modules to project primary, secondary and tertiary students at both place of origin and place of institution.

Figure 13: Module 4 Student approach overview



Source: SGS Economics and Planning, 2020

7.2 Module 4 - Technical overview

Module 4 transforms age-sex population projections into projections of school and tertiary students by both place of residence and place of study. This is done in six sub-modules (i.e., M04a, M04b, M04c, M04d, M04e and M04f).

The first sub-module, M04a, converts the population by 5-year age group, outputted from module 2, to school and tertiary age-groups. Inputs into M04a comprise age-sex and 5-year age groups projections from M02b. These 5-year age groups are disaggregated into single year age groups, using the age group distribution from the 2016 Census (the shares across the distribution are derived as the proportions of single year age groups within the broader 5-year age groups they belong). The population by single year age group is then aggregated into school and tertiary age groups.

The next sub-module, M04b, sets the state control totals for students at place of usual residence in the base year. The 2016 state control totals for school students are aligned to enrolments data from ACARA, University student numbers are aligned to the ABS Education and Work dataset, while the control totals for VET students are derived from the 2016 Census. The IPF method is used to align census enrolments with the enrolment state control totals. The IPF method adopted here, is the same as

used to produce outputs in Module 2. In M04b, IPF is applied to calculate the age group distributions by education enrolment.

M04c produces estimates of students at place of usual residence at the TZ level. Again an IPF is used to distribute age control totals by institutions. POPD by age group and travel zone totals derived in Module 2 are aligned with the state enrolled resident control totals derived in M04a. This ensures that the total number of enrolled persons by school type for each travel zone is equal to the population total for that travel zone and the institution type.

A number of operations are performed in this module. First, 2016 census data is converted from SA1 to TZ to create the seed values for the IPF. Second, propensities for education types and attendee status within each age group in 2016 are held constant in the forecast years for tertiary enrolments. For school enrolments, propensities in 2021 are adjusted so that the number of students attending government schools align with the enrolments forecast produced by School Infrastructure NSW. Finally, students at the travel zone level are created by applying an IPF which calibrates the seed values from the 2016 census, to the age group control totals in M04a and state control totals in M04b.

Module M04d assigns travel zones and capacities to schools in NSW, forming the place of institutions in each projection year. The current capacity of each school is analysed with input from the school enrolment forecast prepared by School Infrastructure NSW. This is used as a base for determining the capacities of each school. The Department of Education has specific capacity parameters for schools, i.e., primary schools can only allow for a maximum of 1,000 students without any major work being completed; while secondary schools can only allow for a maximum of 2,000 students without major work. These capacities are further restricted to allow a minimum of 10 square metres of play space/green area per child on the school site.

In M04d, a list of existing schools across NSW are used to form the TZ destinations in the base year. Planned future schools are identified by School Infrastructure NSW, while unplanned schools are identified using population growth. A final set of school capacity forecasts by sector (government or non-government) and enrolment type (primary or secondary), at the TZ level then flow into the next module.

In M04e a gravity model is used to estimate the TZ destination enrolments in each future year, using inputs from the preceding modules. The gravity model allocates students to schools based on two factors, (1) a push factor (travel time), and (2), a pull factor (attractiveness of a school, e.g. size and equipment).

The push and pull factors form a propensity, which is calculated for every travel zone to every school combination. A different propensity is calculated for each type of student, i.e. primary government, primary non-government, secondary government and secondary non-government. The propensities are adjusted each year if schools reach capacity to reduce the schools ‘pull’. This approach results in students attending the closest school (within capacity constraints) adjusted by known preference behaviours (i.e. more prestigious schools will draw a wider catchment).

Inputs into this module comprise School capacity forecasts, students at Place of residence and a travel time matrix. The gravity model ‘attractiveness’ factor is calibrated to 2016 using actual Place of Institute (POI) school enrolments from ACARA. The ‘pull’ factor is adjusted for each school so that it pulls just enough students to equal their current enrolments. Students at place of usual residence are then allocated to schools based on the pull and push factors. Finally, the enrolments are capped at a school’s capacity so that schools are not allocated additional students beyond their capacity. Demand is diverted to new schools as they become available in the model.

The final sub-module (M04f) estimates tertiary enrolments at Vocational Education and Training (VET) institutions and Universities under a full-time and part-time split.

Total enrolments at place of institutions are aligned to total students at place of usual residence, as the STM requires that total students at origin equate to total students at destination. Enrolments for potential future tertiary institutions are also projected. Future University and VET campuses are assigned to travel zones along with estimated capacities, based on research and likely geographic locations.

Inputs into the sub-module comprise M04c Enrolments at Origin, VET enrolments at place of institution from National Centre for Vocational Education Research, University enrolments at place of institution from Department of Education, information about future University campuses, and enrolments and employment by industry data from 2016 Census. The module collates the tertiary enrolments data and allocates each institution to a TZ. Tertiary students at place of usual residence are initially distributed to travel zones with tertiary institutions, using propensities drawn from the actual 2016 University and VET enrolments data. Employment by higher education and Destination Zones are converted to the TZ level to develop employment to enrolments ratios for different tertiary institutions. The ratios are then used to distribute total enrolments at tertiary institutions to the associated campuses.

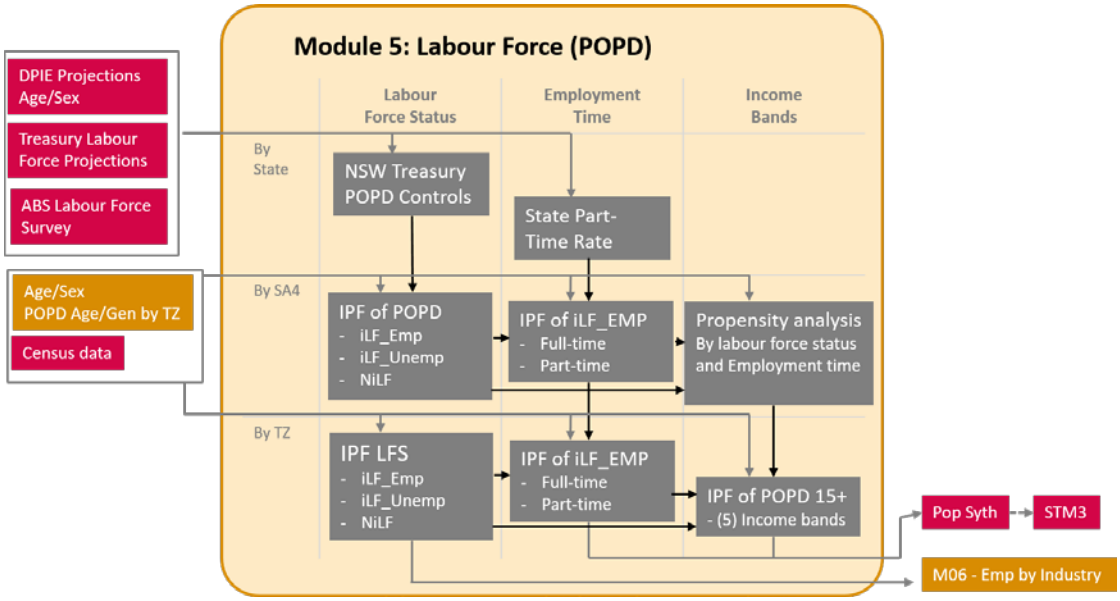
8 Module 5: Workforce segmentation

8.1 Module 5 overview

The primary function of the Workforce module is to use the outputs of prior modules to segment the working age population. This is done in a largely automated manner. The allocation is undertaken at the State level, sub-regional level (SA4) and TZ level. The module also breaks down the data in three stages: Workforce Status (Employed, Unemployed and Not in Labour Force), Employment status (full-time/part-time) and Income Bands.

The following diagram presents an overview of the revised Workforce module and how it interacts with the broader TZP framework.

Figure 14: Module 5 Workforce approach overview



Source: SGS Economics and Planning, 2020

8.2 Module 5 - Technical overview

This module breaks down the working age population (population aged 15+) created in M02, into employment time (part-time, full-time), workforce status (employed, unemployed and not in the labour force) and then into income bands.

The first steps of the module (i.e., done in M05a), is to divide population at the SA4 and TZ level by employment time (i.e., part-time, full-time work). The State-level projection for total workforce comes from the NSW Treasury, however the workforce by part and full-time employment status is created using simple trend analysis.

The next sub-module (M05b) calculates starting distributions for Workforce Time (Full-time/Part-time) and Workforce Status (Employed, Unemployed and Not in Labour Force), and Workforce Incomes at a State, SA4 and Travel Zone level. The starting values are used as inputs to the IPF (scaling) procedures in the latter sub-modules (M05c, M05d and M05e). The purpose of the starting distribution is to ensure each geography is calibrated prior to performing the IPF procedure. After performing the IPF, the estimates for the three geographies (State, SA4 and TZ), are in agreement.

The next sub-module (M05c) performs an IPF for Workforce Status (Emp, Unemp, NiLF) for the State, SA4 and TZ. As a result, the Workforce Status at the TZ level is consistent to the control totals at an SA4 level, which are, in turn, consistent with the

state level control totals. This module initially runs an IPF to derive ERP in OPD by SA4, within each workforce category. Using these as the new regional control totals, a second IPF scales the estimates of workforce segments for all TZs of each SA4.

Next, sub-module M05d performs an IPF to align Workforce by Employment Time (Employed Full-Time, Employed Part-Time) to the State to Workforce Employment Time by SA4, while a second stage within this sub-module aligns Workforce Employment Time by SA4 to Workforce Employment Time by TZ. As a consequence of these adjustments, Workforce Employment Time totals at the travel zone level are consistent to the State control total.

Finally, the last sub-module (M05e) segments POPD who are of working age (15+) into fourteen income bands. Propensities for individuals to fall within each income band are modelled as a function of their workforce characteristics (employed full-time, employed part-time, unemployed and not in the workforce) and real income growth.

For each workforce and employment-time segment, census data is used to determine the propensity of that segment to fall within fourteen census income categories. Assuming a uniform distribution within categories, the fourteen bands are disaggregated to form 38 sub-bands. Combining these propensities with projections of POPD by workforce characteristics results in a preliminary estimate of POPD within each income band. However, this estimate is based on income levels in the 2016 census year, and real wage growth over time will see a shift across income bands. Using an assumed rate of long-term real income growth (currently set as 1.4% in line with the 2015 NSW Intergenerational Report); along with the median earnings of each income sub-band, the shifts across bands are calculated. These shifts are then applied to the preliminary estimate to derive a final income band distribution by SA4.

Adjustments to Methodology in TZP19

A number of adjustments were made to TZP19, which differ from TZP16 v.1.51 The largest adjustment is that Labour Force control totals were not calculated internally in Module 05. Rather they were built off NSW Treasury Labour Force Control totals, from their Long Term Fiscal Pressures Model (LTFP). As such, components of TZP 2016 v1.51 that were used to calculate participation rates and unemployment rates out to 2056 (which were then used to calculate the population Employed, Unemployed and Not in Labour Force were not required. Further detail on this approach can be found in the previous TZP 2016 v1.51 Technical Guide (pg. 68-71).

Additionally, due to delivery timelines of datasets across government agencies, the LTFP, which was released in July 2019 required minor recalibration to factor in the latest DPIE population projections, which were released in December 2019.

9 Module 6: Employment by Industry

9.1 Module 6 Overview

The Employment by Industry module has one key function. Its role is to disaggregate the quantum of jobs by industry at the State level down to an SA3 and travel zone level. This spatial disaggregation is a two-step process, being estimated first by SA3 and then by travel zone.

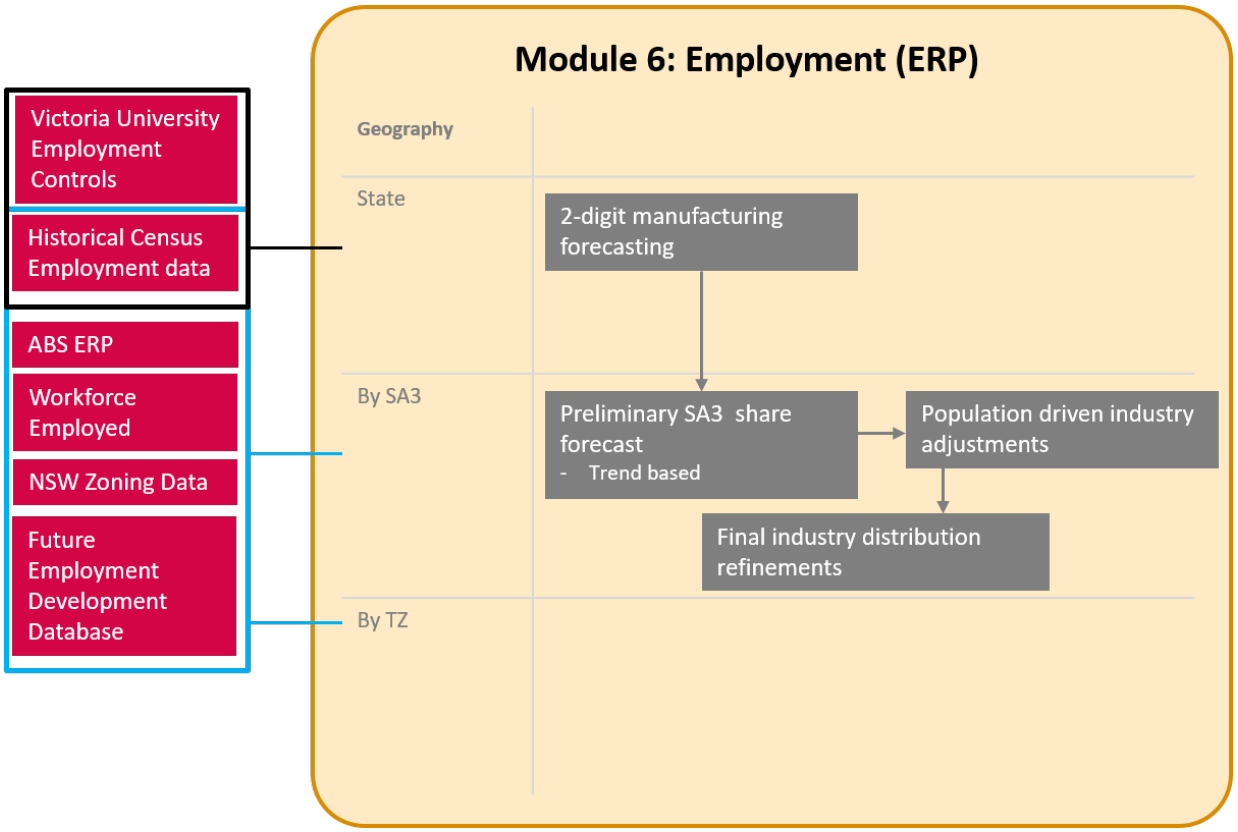
Unlike demographic characteristics, projecting the growth and distribution of employment by industry is more reliant on professional judgement and is influenced by both endogenous and exogenous factors. With this in mind, the design of the modules focuses on the following:

- Automated procedures to produce first-cut estimates (e.g. the total and distribution of employment for individual industries (e.g. Retail) across NSW)
- Logical, transparent and time-efficient methods by which professional judgement can be applied

An important distinction between Module 6 and previous modules is that estimates are not restricted to persons living in private dwellings. This is due to the fact that employment acts as a 'destination' variable and is used as a relative attractor within the STM.

The figure below presents an overview of the revised employment module and how it interacts with the TZP framework.

Figure 15 Module 6: Employment projection approach overview



Source: SGS Economics and Planning, 2020

Adjustments to Methodology in TZP19

A number of adjustments were made to the employment module of TZP19, which differ from TZP16 v1.51. The largest difference is that employment by industry control totals were not calculated within the modules. Rather they were built off VU employment by industry control totals. Further details of the previous approach to create industry control totals can be found in the TZP2016 v1.51 Technical Guide (pg. 85-87)

VU State employment totals were adjusted slightly to ensure consistency with the Workforce control totals integrated in Module 05. The result is that workforce equals employment at the State level, with minor differences to factor in 'net-commutes (difference between in-commutes and out-commutes) at the State level. As a consequence, there are slightly less jobs at the State level than the number of workers (around 25,000), though this gradually reduces to zero by 2036, which is consistent with the decreasing net-commute trend found in Census data between 2006 and 2016.

Another adjustment was the widening of the Future Employment Developments Database to include a wider range of projects. The FEDD methodology established for TZP19 provides a consistent and scalable method of utilising existing planning data and extrapolating it out by employment by industry based on a mix of historical trend and surrounding job proportions.

Additionally, a number of individual travel zones are expected to experience a small uplift in jobs in centres defined as 'Collaboration Areas' by the Greater Sydney Commission. These are minor updates, that draw in a small amount of jobs from surrounding TZs in the SA3 are not significant enough to warrant a separate modelling exercise as outlined in the FEDD.

9.2 Module 6 - Technical overview

Module 6 employs five sub-modules (M06a, M06b, M06c, M06d, M06e) in order to perform the necessary operations required to produce the travel zone industry by employment projections.

The first step within module 6 itself is to disaggregate the 1 digit manufacturing employment projections for NSW from VU to the 2-digit level. This is done in M06a using historical employment data from previous Census years. This task is broken into two steps: first, the share of employment for each 2-digit manufacturing industry is calculated using historical employment data; then the shares of employment at a 2-digit manufacturing level are projected using a simple log-log regression. These shares are then applied to the 1-digit manufacturing projections as determined in the previous module.

In M06b the minimum level of employment required to service population growth for population-serving industries (for SA3s) is derived to create a starting value estimate of population serving employment. This minimum level of employment is defined via an ERP to employment ratio, with the ratios determined by examining historical employment and population data. In contrast, M06c allows the user to compare employment projections to the area of currently zoned employment land. This sub-module computes this area of employment land by both travel zone and SA3. A key input here is the area intersect of travel zones by planning zone obtained via GIS analysis.

M06d brings in the information on population serving employment and SA3 level employment density (created in Modules 6b and 6c respectively), and supplements this with a number of other data sources including; ABS ERP data by SA3, ABS Census data at the SA3 level for employment, a concordance of industries to one of three categories (commercial, industrial and other) and information about known estimates of future employment by travel zone (i.e. the FEDD). In some areas the FEDD will represent growth above that predicted by the base projections. This is particularly likely to be the case in previously undeveloped regions. With the information generated at this step, the state level industry control totals derived from the adjustment of VU data and the disaggregation of the manufacturing industry data to the 2 digit level, are disaggregated down to the SA3 level.

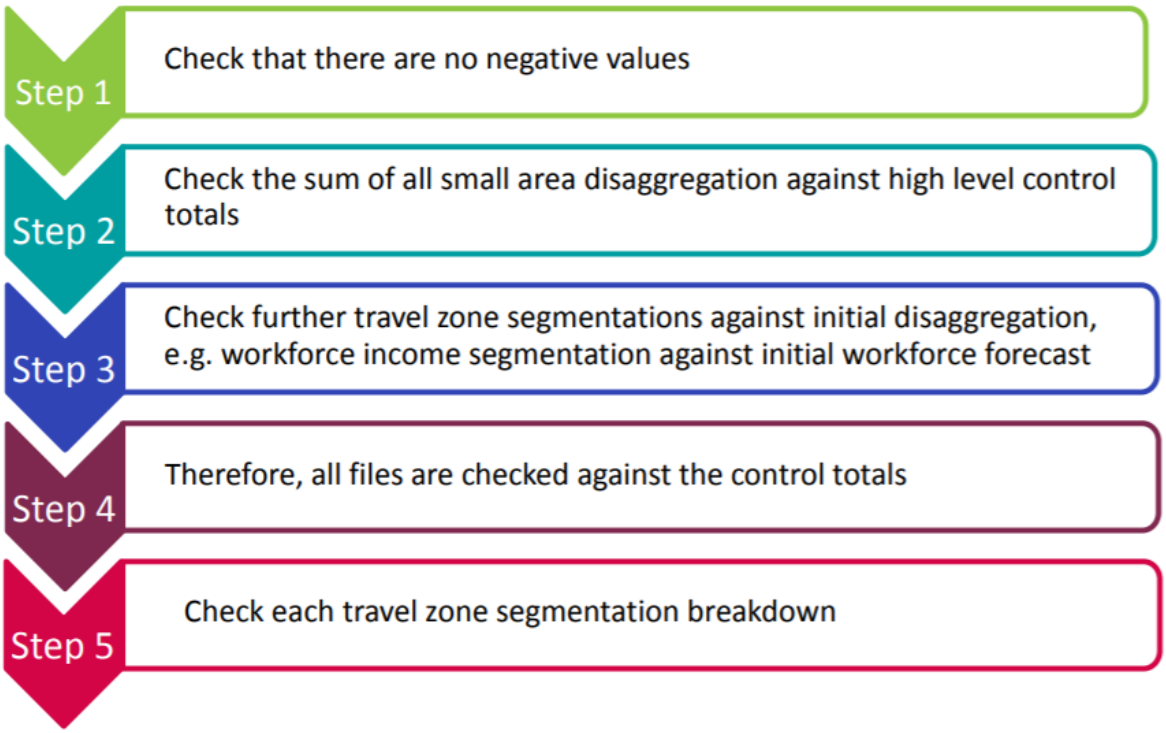
Finally, M06e completes the distribution of employment by allocating the SA3 industry control totals down to the TZ level. The base distribution is defined by census data (for the base year only). This distribution is then augmented by information on planned developments from the FEDD, along with professional judgement. This module completes the work of previous modules, producing the employment projections. This module has two primary components. First, census and FEDD data are combined to derive the base distribution of employment by industry for each SA3. In the second step, previously defined manual calibrations are then used to adjust the base shares. Key inputs here comprise; ABS Census data at the travel zone level (2016), estimates of available land by travel zone (from M06c), SA3 employment by industry projections (from M06d) and known estimates of future employment by travel zone (from the FEDD).

In this final module, census and FEDD data are combined to create an attractor variable which is used to distribute employment by industry across the TZs of each SA3. For each period, the final shares of the previous period are used to calculate an initial employment estimate for each travel zone. For TZs impacted by FEDD developments which have a base projection lower than the growth implied by the FEDD, the projection is adjusted and the SA3 rebalanced to control totals and new shares computed. The module also allows a review of projected total employment for all TZs within the selected SA3, with growth rates and density (jobs/hectare) calculated to ease this review.

10 Model Outputs - Checking and Validation

10.1 Automated checks within the Model

The TZP19 Model has a further Module (MO7) that runs automated quality checks on outputs, to ensure internal consistency. The checks module has three main functions, the negatives checks, control totals checks and validations checks. The negatives check determines whether output files contain any negative numbers. The control totals check which determines whether the DPE control totals for the Sydney GMA area are consistent with aggregated figures in the output files. The validations check further checks for consistency between different sub-geographies.



10.2 Sense Checking and Comparisons

Further sense-checking of the model outputs was also conducted by TfNSW and extensive analysis of the results in comparison to source data and the outputs of the previous projections model.

10.3 Independent Review and Validation

Transport for New South Wales (TfNSW) commissioned Veitch Lister Consulting (VLC) to undertake a review of the TZP19 methodology and to validate the outputs of the TZP19.

The objective of the review was to highlight areas of possible improvement and make recommendations for future iterations of the TZP process.

The review found that:

- TZP is a thorough process relying on a wealth of up-to-date and well-established data sources.

- The TZP process considers most available data sources. The data validation identified a few additional data sources which could inform TZ-level projections for future model updates.
- It uses proven techniques in an appropriate way. The methodology review highlighted a few areas of possible improvements, relating mostly to increased transparency and flexibility of processes.

The data validation assessed the strengths and weaknesses of the TZP19 projections by analysing the level of variability that was captured in the data and whether this variability reflected expectations. The data validation also compared TZP19 forecasts with other projections, where available.

The validation of outputs found:

- The data validation confirmed the strengths of the TZP projection at TZ level dwelling and population (including breakdown by age/household type) forecasts in Greater Sydney. This is due to detailed data inputs for dwellings in Greater Sydney, from multiple data sources.
- The Future Employment Development Database (FEDD) database is a unique and powerful tool to capture local-level developments in jobs. The data validation confirmed the strengths of the TZ level job forecasts.
- Disaggregation via Iterative Proportional Fitting processes is robust.
- TZP is an internally consistent dataset which captures many of the likely dynamics for population and employment in the decades to come.
- The current scope is sufficient for almost all applications and should be able to sustain future modelling developments, including Land-Use and Transport Integration models, and Agent-Based Models.
- The data validation confirmed the strengths of the TZP projections in the following areas, especially for the short/medium-terms:
- TZ-level dwelling and population (including breakdown by age/household type) forecasts in Greater Sydney
- TZ-level job forecasts
- Tertiary student enrolments at destination

The review and validation project concluded that TZP19 is fit for purpose for the transport modelling activities of TfNSW.

11 Further information and feedback

11.1 Download TZP19 Data

TZP19 output datasets are available from the TfNSW Open Data Hub. To download the data, users of the data will need to register and create an account. The data is available in CSV flat file format or MS Excel format. The MS Excel files contain additional notes, cautions and summary tables, as well as summary geographies that are not available in the CSV format.

11.2 More information

A data visualisation and various summary factsheets about TZP19 are available from the TfNSW corporate website.

Spatial files representing the Travel Zone geography (TZ16) are also available from the TfNSW Open Data Hub. Summary information about Travel Zones (geographic units defined by TfNSW, developed for data collection, transport modelling and analysis, and aligned with Australian Statistical Geographical Standard) is also available on the Corporate Website.

To request more information please contact the Land Use Forecasting team at TfNSW using this request form.

11.3 To provide feedback

An issues register is kept for TZP19 to capture any issues found in the TZP dataset or flag new information that could be used for future versions of the projections.

To flag items for the issues register please contact the Land Use Forecasting team at TfNSW using this request form.

11.4 Disclaimer

While all care is taken in producing this work, no responsibility is taken or warranty made with respect to the accuracy of any information, data or representation.

The authors (including copyright owners) expressly disclaim all liability in respect of anything done or omitted to be done and the consequences upon reliance of the contents of this information.

12 Appendix A: Future Employment Development Database (FEDD)

The Future Employment Development Database (FEDD) is a major input into M06d. Figure 23 below shows the projects that are considered in the projection.

Table 8: Summary of future developments database for employment (as of November 2019)

	Project Name	TZ_16 Code
1	Blacktown ACU	[4112]
2	Tamworth UNE	[7585]
3	Westmead University of Sydney	[1018, 1019, 1036, 1037, 1043, 1044, 1045, 1046, 1048]
4	Martin Place	[60, 75]
5	Pitt Street	[97, 115]
6	Barangaroo	[4, 2, 3]
7	Blackwattle Bay	[228, 153, 836, 830, 745, 828, 812, 837]
8	Clarence Correctional Centre	[7739, 7740]
9	Darling Harbour Live And ICC Sydney	[108, 89, 88]
10	Castle Hill	[4533, 4537, 4536, 4526, 4527]
11	Kellyville	[4560, 4559, 4567]
12	Macquarie Park	[1547, 1545, 1539]
13	North Ryde	[1552, 1562]
14	Norwest	[4514, 4512, 4515, 4517]
15	Sydney Olympic Park	[1326, 1328, 1331]
16	Parkes	[7054, 7049]
17	Wagga Wagga	[7328, 7329, 7347, 7352]
18	Bayside West Precincts	[2763, 2713, 2707, 2705, 2699, 2711]
19	Camelia	[1068, 1071, 1091, 1092, 1209]
20	Wilton Growth Area	[3008, 3003, 3012, 3010, 3002]
21	Central to Eveleigh	[224, 222, 270, 268, 216, 132, 146, 208, 215, 223]
22	Enfield Intermodal	[984]
23	Glenfield to Macarthur	[3210, 3213, 3212, 3215, 3219, 3216, 3278, 3279, 3277, 3246, 3247, 3248, 3252, 3253, 3269, 3293, 3295, 3271, 3209, 3217, 3220, 3221, 3222, 3283, 3281, 3292, 3289, 3290]
24	Marsden Park	[3947, 3950, 3956, 3961, 3966, 3967]
25	Marsden Park Industrial	[3962, 3968]
26	Moorebank Intermodal Terminal	[3824]
27	Newcastle CBD	[6350, 6351, 6353, 6355, 6357, 6352, 6358, 6383, 6317, 6394, 6314, 6316, 6313, 6325, 6367, 6369, 6377, 6385, 6337, 6386, 6613, 6612, 6610, 6323, 6303, 6302, 6301, 6360, 6361, 6393, 6359, 6336, 6384, 6457, 6458, 6430, 6432, 6431, 6433, 6425, 6427, 6428, 6200, 6523, 6372, 6539]
28	Northern Beaches Hospital	[2140]
29	Port Botany Expansion	[402]
30	Southern Employment Lands	[262, 264, 265, 266, 267, 287, 263, 330, 289]
31	Western Sydney Airport	[3598, 3609, 3635, 3636]
32	Woolooware Bay	[2914]

33	St Leonards and Crows Nest	[1841, 1832, 1836, 1837, 1842, 1844, 1845, 1912, 1843, 1908, 1910, 1914, 1915, 1838, 1911]
34	Telopea	[1131]
35	Austral SWGA	[3615, 3616, 3621, 3624]
36	Catherine Fields North SWGA	[3663, 3664, 3674, 3675]
37	Catherine Fields SWGA	[3662, 3673, 3681, 3686, 3689, 3690]
38	East Leppington SWGA	[3243, 3676]
39	Gledswood Hills The Crest SWGA	[3687]
40	Leppington North SWGA	[3627, 3630, 3633, 3634, 3655, 3656, 3658]
41	Leppington Stage 1-5 SWGA	[3660, 3666, 3665, 3670]
42	Lowes Creek Maryland SWGA	[3659, 3668]
43	Oran Park SWGA	[3678, 3679, 3680, 3683, 3684, 3685]
44	Pondicherry SWGA	[3672]
45	Rossmore SWGA	[3653, 3654]
46	South Creek West SWGA	[3650, 3651, 3652, 3657, 3669, 3671]
47	Turner Road SWGA	[3691, 3692, 3693, 3694]
48	WSA. 1. Aerotropolis Core	[3612, 3617, 3618, 3622, 3623, 3629]
49	WSA. 2. Agriculture and Agribusiness	[3625, 3626, 3628, 4969, 4970, 4971]
50	WSA. 3. Badgerys Creek	[3608]
51	WSA. 4. Kemps Creek	[3482, 3594, 3599, 3607, 3611]
52	WSA. 5. Mamre Road	[3479]
53	WSA. 6. Northern Gateway	[4967, 4973, 4983]
54	WSA. 7. Rossmore	[3613, 3614, 3619, 3620, 3631, 3632]
55	WSA. 8. South Creek	[3485]
56	WSA. 9. Twin Creeks	[4968]
57	Alex Avenue NWGA	[3911, 3918, 3958, 3959, 3960]
58	Colebee NWGA	[3970]
59	Marsden Park North NWGA	[3931, 3936, 3942, 3945, 3954]
60	Riverstone East NWGA	[3938, 3948, 3971, 3939, 3943]
61	Riverstone NWGA	[3933, 3935, 3940, 3941, 3944, 3946, 3952, 3953, 3972, 3974]
62	Riverstone West NWGA	[3934, 3937]
63	Schofields NWGA	[3925, 3957, 3963, 3969]
64	Shanes Park NWGA	[3965]
65	Tallawong Station NWGA	[3949, 3973]
66	Vineyard NWGA	[4408, 4407]
67	West Schofields NWGA	[3951, 3955, 3964]
68	Box Hill Precinct NWGA	[4423,4424,4426,4428,4429,4430,4431]
69	Cockle Bay Wharf	[90, 91]
70	Oakdale Central Business Hub	[3477]
71	One Carrington Street	[57]
72	University of Western Sydney Innovation Hub	[1057]
73	Eastern Creek Business Hub	[4055]
74	Dexus Quarry West	[4046, 1238]
75	Camden Medical Campus Precinct	[3691]
76	Westmead Hospital CASB	[1045]

77	Central Park Block 4N	[206]
78	Calibre Industrial Park Eastern Creek	[4059]
79	Marrickville Metro Shopping Centre Expansion	[303]
80	Nepean Hospital	[4951]
81	Balranald Mineral Sand Mine	[7382]
82	Hawsons Iron Ore	[7449]
83	Boggabri Coal Mine	[7567]
84	Blacktown Hospital Stage 2	[4109]
85	Imax Mixed Use Redevelopment	[89]
86	Vickery Coal	[7569]
87	Concord Repatriation General Hospital	[715]
88	Watermark Coal	[7569]
89	Mandalong Coal Extension	[6222, 6216, 6219, 6223, 6224]
90	Tahmoor South Coal	[3018]
91	Gosford Hospital Redevelopment	[5331]
92	Maxwell Project	[7006]
93	Berry And Walker Street	[1953]
94	Hornsby Ku-Ring-Gai Hospital	[1626]
95	Coffs Harbour Hospital	[7767]
96	St George Hospital - Acute Services	[2738]
97	The Sandstone Precinct	[42, 43]
98	Angus Place Coal	[7098, 7120]
99	Russell Vale Coal 2	[5610]
100	Spur Hill Underground Coal	[7005]
101	Sunrise NickelCobalt	[7053, 7022]
102	Wallarah 2 Coal	[5144]
103	UTS Blackfriars Precinct	[207]
104	Fairfax Media Warehouse Chollura	[2328]
105	Westfield Parramatta	[1058]
106	Arthur Phillip High School	[1074]
107	Parramatta Square	[1055]
108	Circular Quay - ADPG	[30]
109	Circular Quay - Quay Quarter	[32, 33]

Source: SGS Economics and Planning, 2019

Table 12 provides a summary of the contribution that each FEDD project has had on the final employment outputs. Not all FEDD jobs end up in the final employment dataset of TZP19. This is because the TZP19 model is restricted to its total employment number for each industry across all of NSW. When disaggregating this total job number down to individual TZs, the result is that the FEDD estimate of jobs may be higher than is allowed for that TZ. If all FEDD jobs were given in such a situation, it could draw in too many jobs and negatively affect the trend of other areas. In such a situation, the cell below is marked '100%' in red.

For instance, in 7 Blackwattle Bay, the FEDD contributed up to 48.7% of total jobs in 2036. In 2041 however, there is a '100%' flag. This means that the FEDD was projecting more jobs for Blackwattle Bay in 2041, than could be fit into that area (more FEDD jobs than total jobs would mean it is greater than 100%). As such, the final model could only take in as many FEDD jobs up to its total limit before it affected the employment trends of surrounding TZ's.

Table 9: Contribution of FEDD projects to total jobs (as of November 2019)

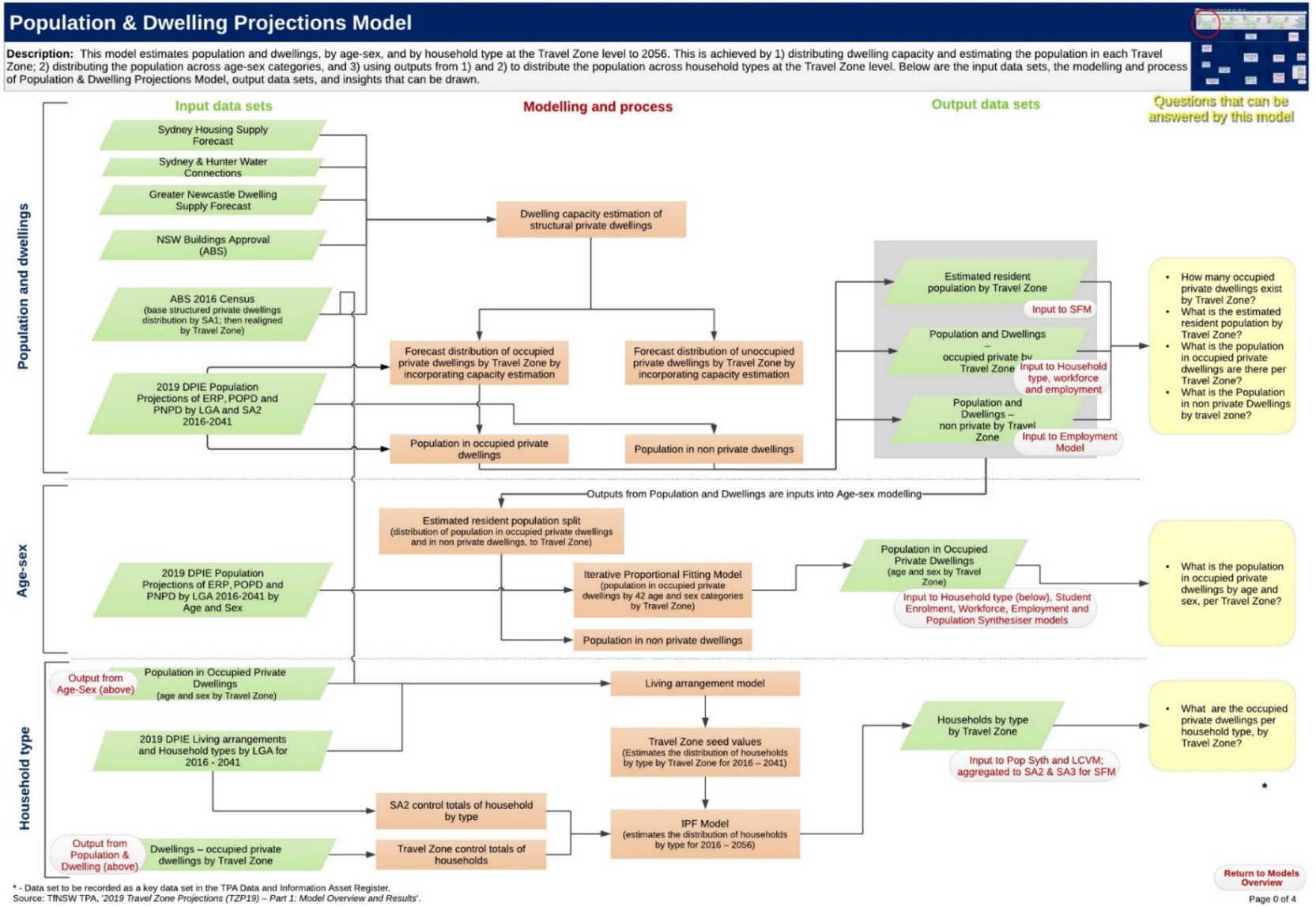
Project	2021	2026	2031	2036	2041	2046	2051	2056	2061	2066
1 Blacktown ACU	15.0%	34.9%	26.3%	20.9%	17.3%	14.6%	13.5%	12.4%	11.0%	10.0%
2 Tamworth UNE	0.0%	4.1%	3.1%	2.6%	2.3%	2.0%	1.9%	1.8%	1.7%	1.6%
3 Westmead University of Sydney	22.3%	39.6%	43.0%	49.0%	49.0%	61.1%	72.0%	65.1%	57.9%	51.9%
4 Martin Place	0.0%	100.0%	100.0%	93.9%	87.3%	80.9%	76.3%	72.2%	67.4%	63.2%
5 Pitt Street	0.0%	94.6%	79.0%	66.2%	56.2%	48.0%	43.1%	39.0%	34.5%	31.0%
6 Barangaroo	100.0%	100.0%	100.0%	98.9%	93.8%	88.7%	84.9%	81.6%	77.3%	73.5%
7 Blackwattle Bay	0.0%	26.8%	23.8%	48.7%	100.0%	100.0%	100.0%	100.0%	100.0%	98.4%
8 Clarence Correctional Centre	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
9 Darling Harbour Live And ICC Sydney	100.0%	100.0%	91.5%	80.6%	72.3%	65.2%	60.1%	56.2%	51.7%	47.8%
10 Castle Hill	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	97.0%	91.4%	86.3%
11 Kellyville	40.6%	37.4%	27.1%	22.2%	17.8%	15.1%	13.4%	12.2%	10.8%	9.7%
12 Macquarie Park	100.0%	100.0%	100.0%	91.0%	83.1%	75.2%	70.3%	66.3%	60.6%	56.1%
13 North Ryde	83.0%	100.0%	100.0%	100.0%	99.4%	92.5%	87.8%	83.9%	78.3%	73.7%
14 Norwest	100.0%	100.0%	100.0%	100.0%	100.0%	98.8%	93.1%	88.6%	82.9%	77.7%
15 Sydney Olympic Park	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.1%	90.4%
16 Parkes	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
17 Wagga Wagga	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
18 Bayside West Precincts	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.6%	96.2%	92.0%	88.2%
19 Camelia	0.0%	58.2%	94.9%	100.0%	100.0%	100.0%	98.9%	95.7%	91.5%	87.7%
20 Wilton Growth Area	83.4%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
21 Central to Eveleigh	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.8%	96.6%	92.2%	87.5%
22 Enfield Intermodal	0.0%	67.9%	57.9%	51.8%	48.4%	44.8%	42.5%	41.6%	38.9%	36.6%
23 Glenfield to Macarthur	100.0%	96.5%	92.1%	92.4%	81.0%	72.8%	67.7%	62.7%	57.2%	52.7%
24 Marsden Park	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	96.4%	91.7%
25 Marsden Park Industrial	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
26 Moorebank Intermodal Terminal	72.6%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.8%
27 Newcastle CBD	31.6%	52.0%	55.2%	53.2%	45.8%	39.8%	36.4%	33.2%	29.4%	26.4%
28 Northern Beaches Hospital	100.0%	100.0%	91.7%	81.9%	74.5%	67.6%	63.3%	58.3%	53.2%	48.9%
29 Port Botany Expansion	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	93.1%	89.2%
30 Southern Employment Lands	89.4%	100.0%	100.0%	97.4%	86.7%	76.3%	70.6%	65.6%	59.1%	54.0%
31 Western Sydney Airport	99.0%	100.0%	99.9%	95.5%	98.3%	98.9%	100.0%	100.0%	100.0%	97.9%

32 Woolooware Bay	0.0%	85.1%	76.2%	70.8%	65.5%	60.8%	59.1%	57.0%	53.9%	51.4%
33 St Leonards and Crows Nest	57.1%	66.9%	71.0%	72.8%	63.4%	55.0%	49.7%	47.5%	42.2%	37.9%
34 Telopea	0.0%	57.9%	72.9%	65.2%	58.8%	54.3%	51.4%	49.2%	46.3%	43.7%
35 Austral SWGA	100.0%	99.3%	96.6%	87.9%	100.0%	100.0%	100.0%	100.0%	100.0%	97.1%
36 Catherine Fields North SWGA	27.1%	100.0%	88.8%	87.5%	66.2%	62.5%	62.0%	70.1%	62.9%	57.5%
37 Catherine Fields SWGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	92.2%
38 East Leppington SWGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
39 Gledswood Hills The Crest SWGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
40 Leppington North SWGA	100.0%	99.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	92.5%
41 Leppington Stage 1-5 SWGA	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	96.6%	87.9%
42 Lowes Creek Maryland SWGA	100.0%	74.6%	92.3%	67.2%	80.7%	100.0%	100.0%	100.0%	100.0%	100.0%
43 Oran Park SWGA	100.0%	100.0%	100.0%	100.0%	96.9%	100.0%	100.0%	100.0%	91.9%	84.9%
44 Pondicherry SWGA	100.0%	100.0%	100.0%	71.0%	77.9%	100.0%	100.0%	100.0%	100.0%	100.0%
45 Rossmore SWGA	100.0%	66.2%	64.6%	58.1%	62.6%	96.4%	100.0%	100.0%	97.7%	91.9%
46 South Creek West SWGA	38.0%	29.8%	27.8%	61.1%	70.1%	100.0%	100.0%	100.0%	100.0%	100.0%
47 Turner Road SWGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.7%
48 WSA. 1. Aerotropolis Core	77.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
49 WSA. 2. Agriculture and Agribusiness	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
50 WSA. 3. Badgerys Creek	27.3%	47.0%	47.0%	45.8%	38.3%	33.5%	32.3%	35.4%	31.9%	29.6%
51 WSA. 4. Kemps Creek	82.1%	91.3%	97.9%	100.0%	100.0%	100.0%	100.0%	100.0%	99.9%	94.8%
52 WSA. 5. Mamre Road	65.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
53 WSA. 6. Northern Gateway	99.6%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
54 WSA. 7. Rossmore	14.0%	100.0%	100.0%	98.8%	85.2%	97.3%	99.9%	100.0%	85.8%	77.5%
55 WSA. 8. South Creek	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
56 WSA. 9. Twin Creeks	26.1%	44.2%	35.6%	31.8%	29.4%	27.7%	27.6%	27.6%	25.1%	23.2%
57 Alex Avenue NWGA	88.2%	81.7%	74.6%	79.2%	78.1%	75.1%	67.8%	67.7%	62.3%	57.8%
58 Colebee NWGA	18.2%	97.7%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
59 Marsden Park North NWGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
60 Riverstone East NWGA	42.9%	88.6%	86.9%	87.8%	90.6%	96.6%	90.7%	90.6%	86.0%	82.0%
61 Riverstone NWGA	100.0%	86.2%	85.0%	80.5%	85.7%	82.7%	76.9%	83.2%	77.7%	73.1%
62 Riverstone West NWGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
63 Schofields NWGA	77.8%	100.0%	100.0%	100.0%	100.0%	99.6%	94.0%	93.3%	87.3%	82.1%
64 Shanes Park NWGA	0.0%	100.0%	97.2%	95.6%	94.8%	93.3%	92.9%	94.4%	88.7%	83.7%
65 Tallawong Station NWGA	65.4%	85.3%	83.5%	82.1%	84.7%	83.7%	80.8%	82.5%	78.9%	75.3%
66 Vineyard NWGA	77.4%	73.5%	74.0%	83.0%	91.2%	90.2%	78.5%	83.1%	74.8%	67.5%
67 West Schofields NWGA	100.0%	100.0%	98.2%	96.0%	98.0%	96.0%	93.6%	95.0%	90.2%	85.7%
68 Box Hill Precinct NWGA	16.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
69 Cockle Bay Wharf	100.0%	100.0%	100.0%	95.4%	87.3%	79.7%	74.1%	69.4%	64.1%	59.4%
70 Oakdale Central Business Hub	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	91.9%	84.1%
71 One Carrington Street	100.0%	100.0%	100.0%	95.6%	88.9%	82.4%	77.8%	73.8%	68.8%	64.5%
72 WSU Innovation Hub	90.1%	97.0%	90.6%	86.3%	83.9%	77.4%	75.0%	72.7%	64.7%	58.4%
73 Eastern Creek Business Hub	100.0%	100.0%	99.3%	95.1%	91.2%	87.5%	86.1%	84.7%	82.1%	79.8%
74 Dexus Quarry West	89.1%	70.3%	60.5%	53.5%	48.3%	43.5%	40.9%	38.7%	35.4%	32.8%
75 Camden Medical Campus Precinct	18.7%	100.0%	85.2%	58.0%	46.1%	44.5%	38.1%	33.4%	29.2%	26.0%
77 Central Park Block 4N	100.0%	100.0%	100.0%	96.1%	90.6%	86.1%	83.0%	80.5%	77.0%	74.1%

78 Calibre Industrial Park Eastern Creek	100.0%	97.8%	91.4%	85.3%	80.1%	74.9%	71.9%	68.8%	64.4%	60.7%
79 Marrickville Metro Shopping Centre Expansion	100.0%	96.2%	84.2%	76.5%	70.6%	65.1%	61.6%	59.2%	56.4%	53.8%
80 Nepean Hospital	37.6%	50.2%	32.6%	22.9%	19.5%	16.4%	13.9%	12.0%	10.4%	9.1%
81 Balranald Mineral Sand Mine	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
82 Hawsons Iron Ore	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%	0.0%
83 Boggabri Coal Mine	100.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
84 Blacktown Hospital Stage 2	85.9%	52.9%	36.3%	27.3%	21.6%	17.9%	15.8%	13.7%	11.8%	10.3%
85 Imax Mixed Use Redevelopment	0.0%	100.0%	100.0%	95.9%	90.4%	85.2%	90.7%	98.2%	100.0%	100.0%
86 Vickery Coal	57.9%	65.8%	44.0%	32.8%	26.7%	22.1%	19.2%	16.6%	14.3%	12.5%
87 Concord Repatriation General Hospital	100.0%	100.0%	90.9%	80.8%	72.1%	66.0%	62.2%	58.9%	54.7%	51.3%
88 Watermark Coal	0.0%	100.0%	97.6%	93.2%	87.5%	83.9%	81.5%	79.3%	76.2%	73.7%
89 Mandalong Coal Extension	61.5%	44.8%	42.5%	33.2%	29.0%	25.9%	23.3%	21.4%	19.8%	18.5%
90 Tahmoor South Coal	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
91 Gosford Hospital Redevelopment	100.0%	91.4%	79.2%	69.9%	62.5%	55.4%	50.2%	46.3%	41.9%	38.2%
92 Maxwell Project	44.4%	27.4%	18.5%	13.8%	11.1%	9.1%	8.0%	6.9%	6.0%	5.2%
93 Berry And Walker Street	45.2%	53.4%	42.2%	36.7%	33.8%	32.0%	30.3%	29.4%	28.1%	26.7%
94 Hornsby Ku-Ring-Gai Hospital	25.5%	15.6%	10.7%	8.2%	6.6%	5.4%	4.7%	4.1%	3.5%	3.1%
95 Coffs Harbour Hospital	92.7%	85.4%	72.4%	61.7%	56.6%	51.2%	48.8%	46.6%	43.4%	40.6%
96 St George Hospital - Acute Services	0.0%	100.0%	95.3%	94.8%	95.6%	97.2%	98.7%	100.0%	100.0%	100.0%
97 The Sandstone Precinct	0.0%	98.0%	72.3%	62.4%	56.3%	51.2%	47.8%	45.0%	41.7%	39.0%
98 Angus Place Coal	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
99 Russell Vale Coal 2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
100 Spur Hill Underground Coal	0.0%	100.0%	82.6%	71.0%	63.4%	57.9%	54.2%	52.2%	49.2%	46.6%
101 Sunrise NickelCobalt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	92.1%
102 Wallarah 2 Coal	91.5%	62.4%	50.8%	41.3%	36.3%	31.1%	28.5%	25.7%	22.3%	19.8%
103 UTS Blackfriars Precinct	0.0%	93.5%	88.1%	85.7%	82.4%	76.7%	73.5%	69.5%	64.4%	59.9%
104 Fairfax Media Warehouse Chollura	42.9%	37.1%	30.9%	24.9%	20.5%	16.6%	14.2%	12.3%	10.4%	9.0%
105 Westfield Parramatta	100.0%	100.0%	100.0%	100.0%	98.9%	93.8%	89.9%	86.2%	81.4%	77.2%
106 Arthur Phillip High School	90.2%	0.0%	100.0%	100.0%	75.7%	57.5%	48.1%	41.3%	34.5%	29.7%
107 Parramatta Square	100.0%	100.0%	97.4%	75.7%	61.5%	50.6%	44.1%	39.2%	34.1%	30.1%
108 Circular Quay - ADPG	100.0%	100.0%	100.0%	96.1%	90.6%	86.1%	83.0%	80.5%	77.0%	74.1%
109 Circular Quay - Quay Quarter	100.0%	97.8%	91.4%	85.3%	80.1%	74.9%	71.9%	68.8%	64.4%	60.7%

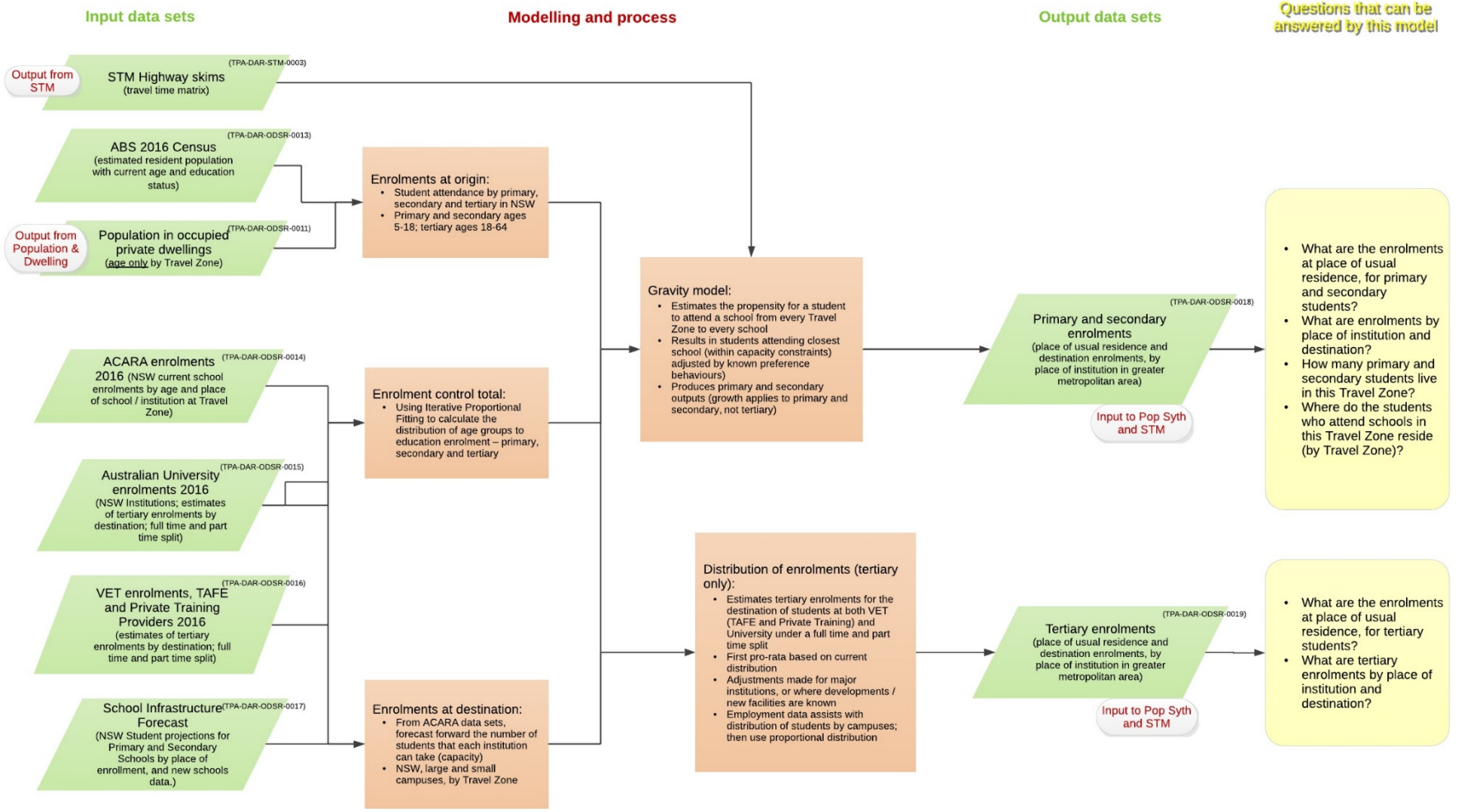
Source: SGS Economics and Planning, 2020

13 Appendix B: Travel Zone Projections 2019 Process Maps



Student Enrolment Projections Model

Description: This model uses outputs from the Population & Dwelling Projections model (population in occupied private dwellings – age and sex), to estimate student enrolments for primary, secondary and tertiary education, by place of residence and place of institution at the Travel Zone level to 2056. Below are the input data sets, the modelling and process of the Student Enrolments Projections Model, output data sets, and insights that can be drawn.

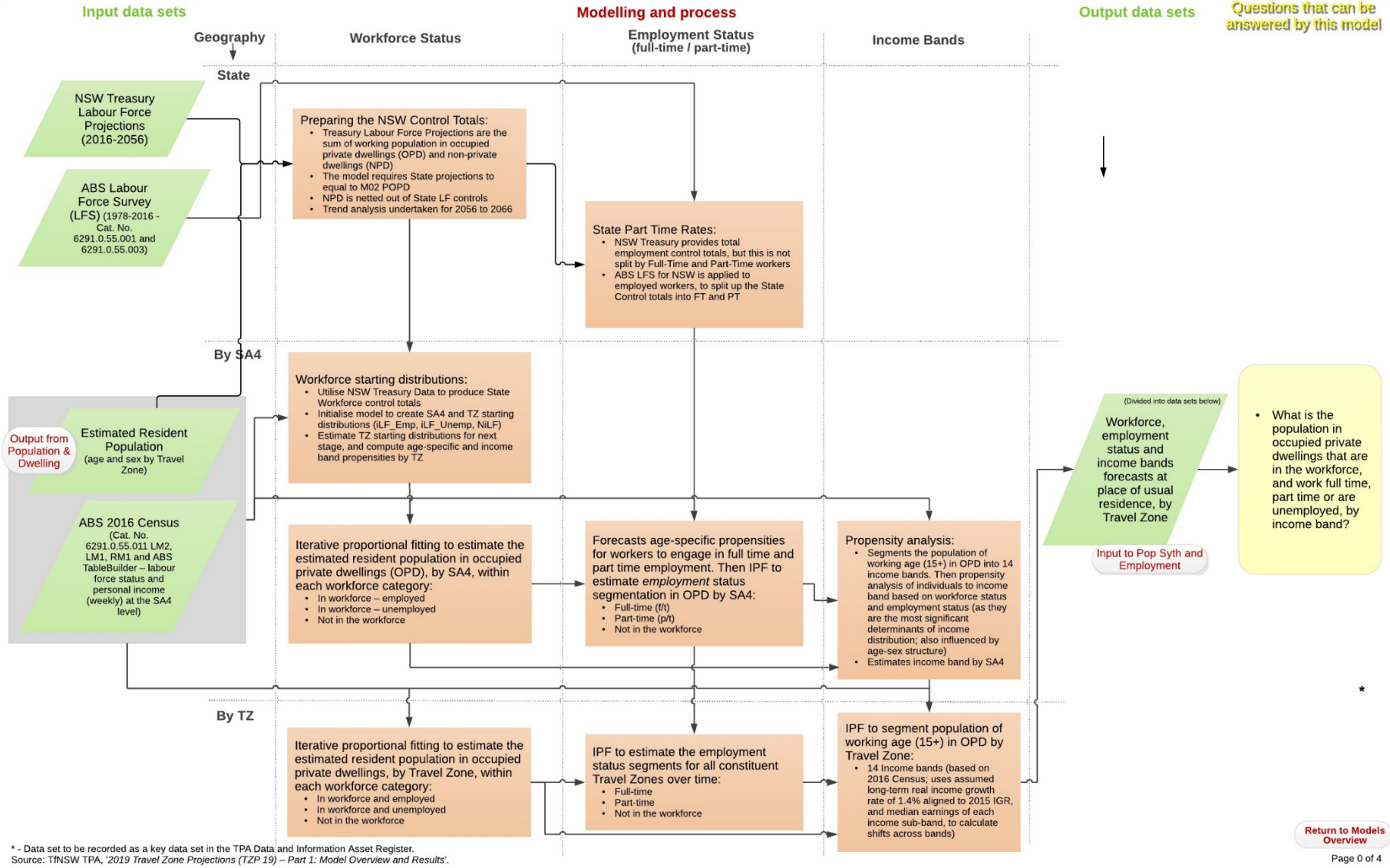


* - Data set to be recorded as a key data set in the TPA Data and Information Asset Register.
Source: TfNSW TPA, *'2019 Travel Zone Projections (TZP19) – Part 1: Model Overview and Results'*.

Return to Models Overview

Workforce Projections Model

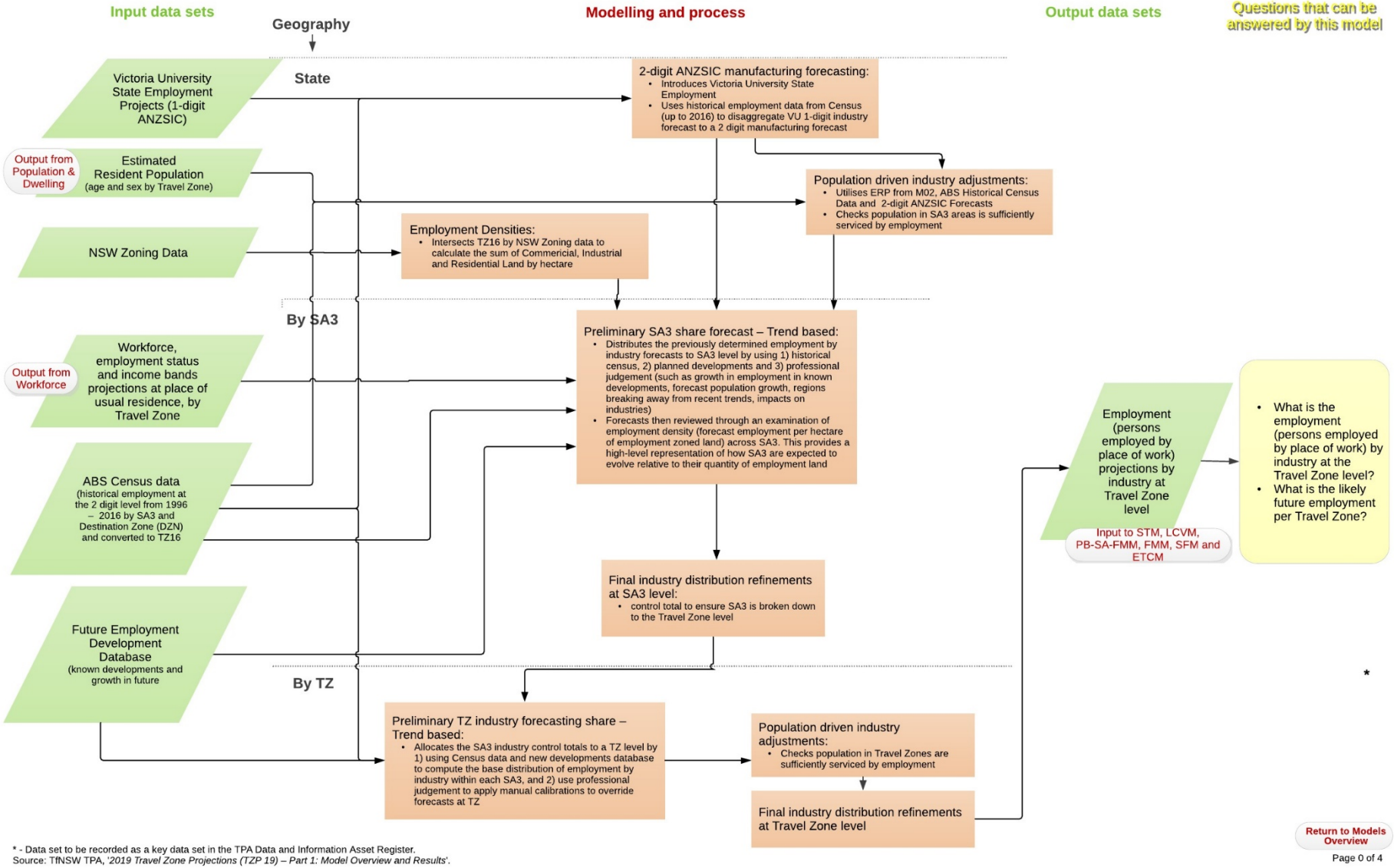
Description: This model uses outputs from the Population & Dwelling Projections Model to estimate various segmentations of the working age population at 3 geographic scales: NSW, SA4s and Travel Zones to 2056. The population is broken down by workforce status: Employed (a.k.a 'Workforce'), Unemployed and Not in the Labour Force (NiLF). Employed persons are disaggregated further by employment status (employed full-time or part-time) and income bands. Below are the input data sets, the modelling and process of Workforce Projections Model, output data sets, and insights that can be drawn.



* - Data set to be recorded as a key data set in the TPA Data and Information Asset Register.
Source: TfNSW TPA, '*2019 Travel Zone Projections (TZP 19) – Part 1: Model Overview and Results*'.

Employment Projections Model

Description: This model is used to produce employment projections by industry, at the Travel Zone level to 2056. It has 2 major functions: 1) the total employment (persons employed by place of work) by industry is projected for the NSW, and 2) the spatial distribution within each industry is projected based on a variety of factors, at geographies SA3 and Travel Zone. *Note: As estimating the growth and distribution of employment by industry is reliant on professional judgement and influenced by endogenous and exogenous factors, the modules are designed to automate first-cut estimates, then apply professional judgement to obtain 2nd cut final estimates.* Below are the input data sets, the modelling and process, output data sets, and insights that can be drawn.



* - Data set to be recorded as a key data set in the TPA Data and Information Asset Register.
Source: TfNSW TPA, '*2019 Travel Zone Projections (TZP 19) – Part 1: Model Overview and Results*'.

14 Appendix C: Table of Assumptions

Module	Assumption
M01a - Capacity Estimation	SHSF data assumed to have the highest degree of certainty - assigned to priority capacity
	TZP16v1.51 assumed to have a lower degree of certainty - assigned to secondary capacity
M01b - Dwelling Forecasting	Structural Private Dwellings (SPD) are calculated by applying the base year SPD to ERP ratio to the DPIE's ERP control total at SA2 level for all forecast years;
	Occupied Private Dwellings are calculated by applying base year OPD to POPD ratio to the previously calculated POPD control totals at SA2 level across all forecast years.
M01c - Population by Travel Zone	Persons in occupied private dwellings are calculated based on 2016 household sizes. HH sizes can be adjusted if they fall outside of a reasonable range.
M02a/b - Age by Gender IPF	SA1 Census data used to inform base distribution of POPD by age by sex at travel zone level
	Due to randomisation of small numbers in census data, travel zones with a base estimate below 20 POPD in any category are assigned the distribution of its encompassing SA2. This is particularly relevant for future growth zones, which have no historical data available
	Base year to run the IPF is 2016
	To ensure that PNPD does not influence the IPF results (i.e. POPD by age by gender), travel zones with an ERP/OPD ratio less than 50% are assigned a seed distribution equal to the encompassing SA2
	For each future year, the IPF procedure uses the age-sex results of the previous period as the seed distribution
M03a - Living Arrangement Propensities	POPD by TZ forecast transformed to reflect living arrangement using the DPIE estimates of persons by SA2 by living arrangement.

M03b - Calculating seed values	Group household propensity/scale factor is calculated using the Family/Household Reference Person Indicator - Relationship in Household figures from the 2016 census.
M03c - IPF	Base year to run the IPF is 2016
	For each future year, the IPF procedure uses the household results of the previous period as the seed distribution
M04a_1	School Infrastructure and ACARA school enrolment data concorded to Travel Zones.
M04a_2	The single age distribution derived from the 2016 Census data is applied to the population forecast by 5 year age groups to obtain the school age groups.
M04b	The 2016 Census age by education attendance is used as seed values in the IPF to obtain enrolment control totals by institution type
M04c - Students at Origin	The 2016 distribution of school attendance is applied to the age group forecast from 2016-2066
	Where there is no base data input in the initial distribution of persons, the regional distribution is applied. This accounts for growth areas where there is no precedent of population.
	Base year to run the IPF is 2016
	For each future year, the IPF procedure uses the results of the previous period as the seed distribution
M04d - Students at Destination	School capacity for primary schools is assumed to 1,000 students and secondary schools 2,000 students
M04e	Capacity of the secondary schools adjusted in future years to assist the model run.
	2016 travel times are used for future years implying there are no improvements to school access in the future

M04f – Tertiary Students	Employment by higher education industries and Destination Zones are converted to the TZ level to develop employment to students ratios for different tertiary institutions. The ratios are then used to distribute total enrolments at tertiary institutions to the associated campuses. Enrolments for potential future tertiary institutions are also projected.
M05a – State Part-Time Rate and Unemployment Rate	NSW Treasury Labour Force Totals provide State level control totals. Consequently, only an overall part-time rate for the State was required. Upper limits assumed for NSW was 50%, which is a median figure of previous upper limits of age-sex cohorts from TZP 2016 v1.51. The long term unemployment rate of 5% is used as an assumption for future years beyond 2022, following Treasury's common planning Assumption.
M05b/c/d- Starting Distributions and IPF	SA1 Census data was used to inform base distribution for all labour force segments at Travel Zone level
	Due to randomisation of small numbers in census data, Travel Zones with a base estimate below 20 POPD in any category are assigned the distribution of its SA2. This is particularly relevant for future growth zones, which have no historical data available
	For each future year, the IPF procedure uses the labour force status results of the previous period as the seed distribution
M05e - Income Segmentation	Due to randomisation of small numbers in census data, travel zones with a base estimate below 20 POPD in any income category are assigned the distribution of its encompassing SA4. This is particularly relevant for future growth zones, which have no historical data available
	Assumed real income growth rate of 1.4%. This is the long term gross national income growth rate forecast in the 2015 NSW Intergenerational Report.
	For each future year, the IPF procedure uses the labour force status results of the previous period as the seed distribution

M06a – 2-digit Industry Forecasting	ANZSIC categories were maintained at their employment shares prior to 2006 and then interpolated between Census periods between 2006 and 2016.
M06b – Population Serving Employment Ratios	For six population servicing industries, a maximum ERP/Emp ratio (growth) is specified. These are estimated in M06c_1, and the resulting limits are as follows: - Construction: 38.9 - Retail Trade: 324 - Accommodation and Food Services:140.0 - Rental, Hiring and Real Estate Services: 517.5 - Education and Training:37.0 - Health Care and Social Assistance:32.1
M06d – SA3 Industry Forecasting	SA3 industry control totals are adjusted to blend together the census base projections for each industry with employment numbers estimated for the FEDD at an SA3 level. Not all FEDD jobs could be filled for each SA3 before affecting the trends of other SA3s.
	SA3 employment totals were also adjusted to ensure that they aligned with population growth trends. As such, manual adjustments were required to ensure that declines in population saw an appropriate decline in employment. This is most notable in regional SA3s.
M06e - TZ Industry Forecasting	In the absence of additional information, Travel Zone employment shares (of their encompassing SA3) are assumed to remain the same as the base year (i.e. 2016)
	All travel zone assumptions contained within the 'Future Employment Developments Database' are adopted.

15 Appendix D: Output Files

15.1.1.1.1 Data Source of Output Files

Table 1. Source location for Outputs CSV file data

File name	Source module	Excel sheet/notes
1.1 Structural Private Dwellings_TZ.csv	M01b	Final SPD Forecast
1.2 Occupied Private Dwellings_TZ.csv	M01c	Final OPD Forecast
1.3 Population Occupied Private Dwellings_TZ.csv	M01c	Final POPD Forecast
1.4 Population Non Private Dwellings_TZ.csv	M01c	Final PNPD Forecast
1.5 ERP_TZ.csv	M01c	Final POPD Forecast Final PNPD Forecast
1.6 ERP_SA3.csv	M01c	Final POPD Forecast Final PNPD Forecast
1.7 Population Non Private Dwellings_SA3.csv	M01c	Final PNPD Forecast
2.1 Age by Sex 5 Year Age Groups (0-100) _TZ.csv	M02c	R Automatically generated
2.2 Age Groups (15-64+) _TZ.csv	M02c	R Automatically generated
2.3 Age by Sex 5 Year Age Groups (15-64+) _SA4.csv	M02c	R Automatically generated
3.1 Household Type_TZ.csv	M03c	R Automatically generated
3.2 Adjusted SA2 Household Type.csv	M03a	SA2 LAProp 2016-2046
4.1 Primary and Secondary School students PUR_TZ.csv	M04c	Summary_P&S_OUTPUT
4.2 Primary and Secondary School students POI_TZ.csv	M04d – School students POI interpolation	(R automatically generated) Summary_P&S OUTPUT)
4.3 Tertiary Students PUR_TZ.csv	M04c	Summary_T_Output
4.4 Tertiary Students POI_TZ.csv	M04f	Output_FINAL
5.1 Labour Force_TZ.csv	M05e	TZ16 IPF Output

5.2 Labour Force Part Time Full Time_SA4.csv	M05e	TZ16 IPF Output summed to SA4
5.3 Labour Force Part Time Full Time_TZ.csv	M05g	TZ16 IPF Output
5.4 Labour Force Income Segmentation_TZ.csv	M05h	TZ16 IPF Output
6.1 Employment SA3 Forecast.csv	M06d	Employment forecast
6.2 Employment TZ Forecast.csv	M06e	Employment forecast

16 Appendix E: Employment Allocation Model

16.1.1 Employment Allocation Model

In TZP16 v1.51, the Journey to Work (JTW) dataset was used to provide the basis for small area employment projections. The JTW dataset allocates employment data (ABS Census 2016) obtained at a Destination Zone (DZN) level to Travel Zones (TZ).

This dataset was created by SGS Economics and Planning and supplied to Transport for NSW.

Due to issues inherent in census data, such as undercount or poor self-reporting accuracy, the JTW data is recalibrated to align with the Labour Force Survey (adjusted to reflect Place of Work (POW) rather than Place of Usual Residence (PUR) at a State level).

The following information provides a brief description of the methodology used to convert DZN data to TZ data, as found in the JTW dataset.

16.1.2 Building the conversion tables

To obtain the estimated number of jobs within a TZ, estimates are initially prepared at the ABS Mesh Block level which is a lower geography than TZ. Mesh Blocks usually align with the TZ geography and are designed by the ABS to represent a small area of relative demographic homogeneity.

Where a TZ and Mesh Block boundaries align, TZs are a summation of the constituent Mesh Blocks. Where ABS Mesh Blocks do not align exactly with a Travel Zones, spatial area within Mesh Blocks overlapping with Travel Zones are used to estimate the size of the Travel Zone.

The ABS publish estimates of the count of dwellings at the Mesh Block level (ABS 2074.0), employment estimates however, are more complex, as this data is not available. To obtain these estimates of employment at a Travel Zone level, it is necessary to build a model that utilises Mesh Block land use categories, in combination with employment by ANZSIC category and occupation (i.e. DZN data).

The allocation process involves separating jobs according to ANZSIC category and grouping to represent occupation (Blue Collar, White Collar – Low Skilled, White Collar – High Skilled).

These jobs are then allocated to a Mesh Blocks within the DZN according to their associated land use category (i.e. Residential, Parkland, Commercial, Primary Production, Industrial etc).

The process involves a “50/30/20” hierarchical split, as detailed in Table 13. 50% of jobs are allocated to the first set of Mesh Block Categories, the following 30% of jobs are allocated to the second set and the final 20% are allocated to the final set.

A process is then undertaken to identify yes or no if that Category and Occupation is to be associated with the respective Mesh Block category (through a 1 or 0 identifier as shown in Table 13. Once this Mesh Block allocation is complete, a Mesh Block to TZ concordance then creates employment at a TZ level.

Example: 50% of Blue Collar Jobs in Example Industry #2 are allocated to Industrial Mesh Blocks. The next 30% are distributed across Industrial Mesh Blocks a second time. The final 20% are allocated evenly across Mesh Blocks with Commercial, Industrial Agricultural and Other land use categories.

Table 10: example of employment allocation model (example industry)

	Example Industry #1			Example Industry #2		
	Blue Collar	White Collar (Low Skilled)	White Collar (High Skilled)	Blue Collar	White Collar (Low Skilled)	White Collar (High Skilled)
1st Allocation	50%	50%	50%	50%	50%	50%
Residential						
Commercial		1	1		1	1
Industrial	1	0		1	0	
Education		0			0	
Hospital/Medical		0			0	
Agricultural		0			0	
Transport		0			0	
Parkland		0			0	
Water		0			0	
Other		0			0	
2nd Allocation	30%	30%	30%	30%	30%	30%
Residential	1	1	1		0	
Commercial	1	1	1		1	1
Industrial	1	1	1	1	0	

Education	1		0			0						
Hospital/Medical	1		0			0						
Agricultural	1		0		0			0				
Transport	1		0					0				
Parkland			0					0				
Water			0					0				
Other			0					0				
3rd Allocation	20%		20%		20%	20%		20%		20%		
Residential	1		1		1			0				
Commercial	1		1		1	1		1		1		
Industrial	1		1		1	1		1		1		
Education	1		1		1			0				
Hospital/Medical	1		1		1			0				
Agricultural	1		1		1	1		1		1		
Transport	1		0					0				
Parkland			0					0				
Water			0					0				
Other	1		1		1	1		1		1		

Source: SGS Economics and Planning, 2018

17 Appendix F: Important cautions and notes for TZP19 users

17.1.1 Important considerations

The TZP19 dataset represents one view of the future aligned with the NSW Government's Common Planning Assumptions and population and economic projections. Please note:

- The projections present a small area geography, long-term (forty year) view of future patterns of population, dwellings, workforce and employment across NSW.
- The projections are not government targets.
- The projections rely on best available information as at December 2019 (i.e. prior to the COVID19 pandemic). Caution is recommended for use – particularly for the 2021-2026 period due to changed migration patterns.
- Following the release of TZP19, TfNSW will work with NSW Government Agencies to prepare scenario outputs and guidance for users that will take into account the COVID19 global pandemic. The best information will be used once available for these scenarios.
- The TZP projections are not based on specific assumptions about future new transport infrastructure, but do take into account known land-use developments underway or planned, and strategic plans.
- The TZP dataset is primarily designed for strategic-level transport modelling purposes.
- Due to the rapidly changing nature of development across Sydney, in particular in the Western Parkland City, there may be new development projects not reflected in the projections.
- The preferred years for modelling using TZP19 are 2016, 2026, 2036 and 2056.

17.1.2 Limitations/Cautions

Travel Zone Projections are a strategic state-wide dataset and caution should be exercised when considering results at detailed breakdowns.

- The TZP19 outputs represent a point in time set of projections (as at December 2019, pre-COVID19).
- Travel Zone (TZ) level outputs are projections only and should be used as a guide. As with all small area data, aggregating of travel zone projections to higher geographies leads to more robust results.
- As a general rule, TZ-level projections are illustrative of a possible future only.
- Caution is advised when comparing TZP19 with the previous TZP16 v1.51 due to differences linked to changes in geographical classifications, the inclusion of 2016 Census inputs, addition of new data sources for the most recent years, and adjustments to methodology.
- Particular caution is advised for areas in Regional NSW affected by new Special Activation Precincts (Wagga Wagga, and Parkes) as assumptions have been made about these Precincts proceeding and generating jobs numbers based on NSW Government planning documents from September 2019.
- Employment estimates in the base year (2016) may not align with published ABS Census results as they are adjusted for Census undercount.

- The Future Employment Development Database (FEDD) is a point-in-time projection dataset compiled in late 2019. It presents the number of jobs expected from major projects and plans identified in publicly-available planning documents. The scope of project coverage within the FEDD is focused on large projects because of their impact on employment at the local level. The FEDD contains significant caveats because:
    - revisions to projects and plans occur on an ongoing basis
    - job estimates found in planning documentation are often optimistic or 'best case' scenarios and require adjustment;
    - job types identified in planning documentation tends to favour the ability of a project to attract white-collar knowledge workers. As such, the FEDD tends to skew towards knowledge intensive employment, such as Professional, Scientific and Technical Services.
    - project data for many projects is incomplete or contain discrepancies about the number, type and timing of project jobs. and
    - limited planning documentation about projects beyond a 20-year time horizon.
- FEDD inputs to TZP19 were tempered where necessary using professional judgement to ensure a reasonable balance between population and employment emerges in future years.
- Users can ascertain whether a particular Travel Zone is impacted by a FEDD project from the employment projections summary spreadsheet, which notes the relevant FEDD project number. Users can request more information about the specific assumptions related to a project's size and timing.
- Some TZ-level adjustments are made to employment outputs to correct known issues with ABS small area employment data (e.g. Mesh Block classifications, Destination Zone employment data, etc).

17.1.3 Alignment with DPIE population projections released December 2019

- TZP19 Estimated Resident Population (ERP) outputs align with DPIE's Estimated Resident Population (ERP) control totals for the State and by SA2 and LGA.
- Population in Occupied Private Dwellings (POPD) and Population in Non Private Dwellings (PNPD) added together in TZP19 align with DPIE's ERP at the SA2 and LGA level.
- More detailed breakdowns of the population dataset, such as by age and sex may not align perfectly due to minor differences in modelling approach and the use of spatial concordances.
- TZP19 projections for Occupied Private Dwellings vary from DPIE's Implied Dwellings projections because they are different measures of dwellings. In the TZP model, Occupied Private Dwellings are broken down by household type using living arrangement definitions in the ABS Census of Population and Housing.

17.1.4 Changes from previous TZP methodology

The method used to produce TZP19 is different to TZP16 version 1.51 in several respects, reflecting advances in land-use forecasting techniques and better demographics and policy insights. Key methodology changes include:

- Extension of area coverage from the Sydney Greater Metropolitan Area (Greater Sydney, Newcastle, Central Coast, Lower Hunter, Wollongong and Illawarra) in TZP16 to include all areas across NSW in TZP19.

- Use of updated input datasets such as DPIE 2019 Population Projections and DPIE 2019 Housing Supply Forecast Monitor.
- Alignment of the TZ workforce projections at the State level to assumptions made about labour force participation rates in NSW Treasury's Intergenerational Report and DPIE's 2019 age and sex distributions for NSW population.
- Incorporation of NSW employment forecasts by industry produced by the Victoria University Employment Forecasts (VUEF) Model that used NSW Treasury's employment projection for NSW. This change occurred with oversight and peer review by the CPAG Economy and Employment Technical Sub Group that includes key agencies such as NSW Treasury, DPIE and GSC.

Inclusion of a more comprehensive Future Employment Development database (FEDD), that supplies information about key projects and plans that may impact on employment at the local level.