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J Lange and J. Franzon

### Geographic access and spatial clustering of section 90 pharmacies - 1990 to 2014: an exploratory analysis

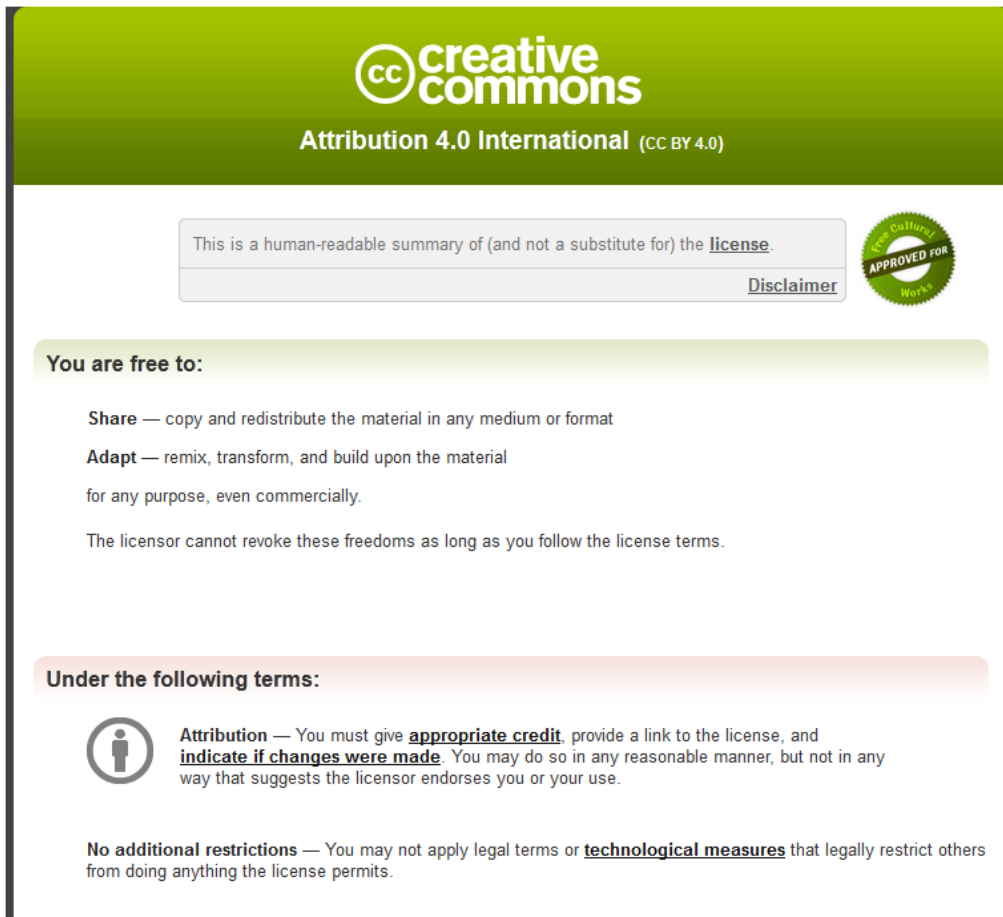
Canberra, Commonwealth of Australia, Department of Health

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Report for the Department of Health

# Geographic Access and Spatial Clustering of Section 90 Pharmacies - 1990 to 2014: An Exploratory Analysis

March 2016

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# 1. Executive Summary

This report addressed a series of research questions relating to geographic access and the spatial clustering of pharmacies (approved under section 90 of the *National Health Act 1953*) in addition to other research questions based on pharmacy location. Data was provided from the Department of Health for analysis, based on pharmacies operating at 30 June for three snapshot periods: 1990, 2007 and 2014. Key findings from the exploratory analysis undertaken have been detailed below:

- a. The completeness and detail provided in pharmacy street address data requires further attention. Although 94.13% of pharmacy addresses were able to be geocoded to a street address with an acceptable level of locational accuracy, extensive data cleaning in addition to the manual geocoding of 943 pharmacy addresses was required. It is recommended that the validation of pharmacy address data (at the time of capture) be considered a priority area for future improvements to ensure policy decisions and research activities are based on the most correct and accurate data;
- b. Despite Australia's increasing population over the three snapshot periods, the total number of pharmacies in 2014 was slightly less than the total number of pharmacies in 1990. Of note was the decline in pharmacy numbers (565) from 1990 to 2007 at a time when Australia's population increased by 6 million from 1991 to 2006. Further analysis is recommended into the potential factors contributing to this decline;
- c. Population to Pharmacy Ratios (ratios) calculated for the three snapshot periods showed an increase from 1990 to 2007 in line with the decline in the number of pharmacies from 1990 to 2007. Ratios continued to increase from 2007 to 2014 in Rural Pharmacy Maintenance Allowance (RPMA) ineligible locations (PhARIA Category 1), while a decrease in these ratios for pharmacies in eligible RPMA locations (PhARIA Categories 2-6) was realised between 2007 to 2014;
- d. Straight line distances measured between pharmacy locations increased from 1990 to 2014. Similar findings were realised when measuring average distances by road to the next nearest pharmacy and average distances by road to the next nearest five pharmacies. When road distance calculations between pharmacies were considered from an urban and non-urban perspective, a decrease in average distances in non-urban areas was observed from 2007 to 2014 while an increase was experienced in urban areas. However, these results should be treated with caution since geocoding accuracy may influence the outcome of these findings. The decline in pharmacy numbers from 1990 to 2007 also needs to be acknowledged with respect to these findings;
- e. Analysis of pharmacy locations by socioeconomic status was undertaken using Australian Bureau of Statistics (ABS) Socio-Economic Indexes for Areas (SEIFA) data for the census year most closely aligned to the three pharmacy snapshot periods. Although findings at a small area level suggested some relationship may exist, further analysis proved inconclusive. A more comprehensive study into this potential relationship is recommended; and
- f. The presence/absence of pharmacies within ABS urban centres/localities (UCLs) across the three snapshot periods were considered, with certain locations explored in more detail. Broad findings are indicated below:
  - 221 pharmacies in 2014 were located within a UCL that had no pharmacy in 1990. Of these pharmacies, 151 (68.33%) were located in RPMA eligible locations (PhARIA Categories 2-6);
  - In 2007 there were 5 UCLs identified that no longer had a local pharmacy in 2014;
  - There were 25 UCLs with one or more pharmacies in 1990 that had no pharmacy as at 30 June 2014. Of these UCLs, 24 had populations less than 2,600 persons; and

- 
- There were 926 non-urban UCLs identified without a local pharmacy. However, the bulk of these locations (87.33%) comprised populations of less than 1,000 persons. Of the remaining 856 non-urban UCLs with local access to one or more pharmacies, 614 were identified as single pharmacy locations.

Although the above key findings provide some insight into geographic access and spatial clustering of section 90 pharmacies over time, there may be other factors beyond the scope of this research report influencing these outcomes and therefore, warrant further investigation. These findings would also benefit from a more in-depth analysis of spatial clustering in addition to further consideration regarding the concept of service access, which extends beyond measures of geographic distance and proximity.



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## 2. Background

The Australian Population and Migration Research Centre (APMRC) incorporating GISCA (The National Centre for Social Applications of GIS) was engaged by the Commonwealth Department of Health (the 'Department') to address a series of research questions relating to the geographic access and spatial clustering of pharmacies (approved under section 90 of the *National Health Act 1953*) in addition to other research questions based on the location of pharmacies across Australia. Each of the research questions proposed were based on analysis of pharmacies over time for three snapshot periods: 30 June 1990; 30 June 2007; and 30 June 2014. Geographical Information Systems (GIS) spatial analysis techniques were applied to consider the specific location based questions proposed by the Department.

Location has played an important role in the dissemination of government funding to section 90 pharmacies ('pharmacies') under the Rural Pharmacy Maintenance Allowance (RPMA) and other rural allowances administered by the Department. Over the snapshot periods there have been a selection of spatial indices used by the Department to administer incentive programs with the intent of achieving equitable access to health and medical services across Australia. Key indices used from 1990 to 2014 have been detailed below.

The Rural, Remote and Metropolitan Areas Classification (RRMA) used ABS Statistical Local Areas (SLA) to arrive at a seven level classification system developed to address social justice and economic issues facing non-metropolitan Australians (Hugo et al., 1997). The index was derived from five partial indices, four utilised straight line distance calculations from SLA centroids to the nearest urban centre based on a four level population hierarchy. The fifth partial index was based on a 'personal distance factor' which considered population density. A seven-step process followed, incorporating the standardisation of all five partial indices to arrive at a final index classification for all SLAs within Australia (Aylward et al., 2001). RRMA was used widely by the Department in the early 1990's.

In 1998/1999, the Accessibility/Remoteness Index of Australia (ARIA) was developed by the University of Adelaide as a joint project with the (then) Department of Health and Ageing. ARIA is a purely geographic index that quantifies remoteness in non-metropolitan Australia by measuring the distance travelled by road from populated localities to four levels of service centres based on different urban centres population sizes. Road distance measures were then transferred to a 1 kilometre (km) square grid to permit the generation of a remoteness score for any location in Australia. ARIA+ 2001 was a revision of the ARIA index undertaken by the University of Adelaide which resulted in number of enhancements to its structure and method of calculation, including the addition of a fifth level of service centre. ARIA+ continues to be updated on a five-yearly basis to coincide with Australian census releases and has been used by the Australian Bureau of Statistics since 2001 to derive Remoteness Areas (RA) for the dissemination of various social and demographic statistics. In recent times, RA has been applied by the Department for various grant incentive programs. However, for the purpose of the dissemination of grant funding to pharmacies, a customised version of the ARIA index has been used.

Pharmacy ARIA (PhARIA) was developed by the University of Adelaide in collaboration with the Department of Health and Aged Care and the Pharmacy Guild of Australia in 2000/2001. PhARIA was specifically designed to provide a comprehensive, standardised measurement of remoteness for pharmacies throughout Australia. PhARIA is a composite index, which incorporates measurements of geographic remoteness (represented by ARIA+), with a measurement of professional isolation (represented by the road distance to the five closest pharmacies). Each of these two components contributes equally to the final PhARIA score. The combination of these two components results in a continuous variable with values ranging from 0.00 - 12.00, with zero representing those areas that are most accessible to a pharmacy and 12 representing those areas that are most remote/isolated from a pharmacy. Table 1 describes each of these components and shows how each component contributes to the PhARIA value range.

Table 1: Components of the PhARIA

Remoteness Component	Distance Measure	Description	Value Range	Weighting
Physical	ARIA+ Level A	Road distance to the nearest population centre with 250,000 people or more*	0 – 1.2	50%
	ARIA + Level B	Road distance to the nearest population centre with 48,000 to 249,999 people*	0 – 1.2	
	ARIA + Level C	Road distance to the nearest population centre with 18,000 to 47,999 people*	0 – 1.2	
	ARIA + Level D	Road distance to nearest population centre with 5,000 to 17,999 people*	0 – 1.2	
	ARIA+ Level E	Road distance to nearest population centre with 1,000 to 4999 people*	0 – 1.2	
Professional	Pharmacies	Average road distance to the 5 nearest pharmacies	0 - 6	50%
<b>PHARIA Value Range</b>			<b>0 - 12</b>	

\* Urban centre boundaries and populations sourced from the Australian Bureau of Statistics

PhARIA values are subject to adjustments in some geographic regions through the application of spatial rules which were developed with the Department and the Pharmacy Guild of Australia to achieve a final PhARIA value. Spatial rules were applied to take into account the influence large urban centres can have on outlying areas as well as localities comprising a large number of pharmacies. The three spatial rules of the PhARIA utilise the application of a 'buffer zone' around a populated centre so that any location positioned within that zone will receive the same index score as that populated centre. These zones comprise a 30 km radius around the external boundary of major centres (greater than 250,000 population), and a 10 km radius around the external boundary of remaining population centres of 18,000 or more. A further refinement was included to ensure that all urban centres with a large number of existing pharmacies were classified as highly accessible. The "8 pharmacy rule" provides that centres with 8 or more pharmacies are reclassified into PhARIA Category 1 regardless of their location given nearby locations have excellent access to a selection of pharmacies and also to ensure incentive payments are not given to areas where a cluster of pharmacies exist. Table 2 outlines the classification of the PhARIA value ranges after the application of spatial rules and the '8 pharmacy' rule. Figure 1 shows the interpolated PhARIA populated locality scores as a 1km square grid surface after the 13,000+ populated localities (that comprise the PhARIA) have been categorised into the six PhARIA value ranges.

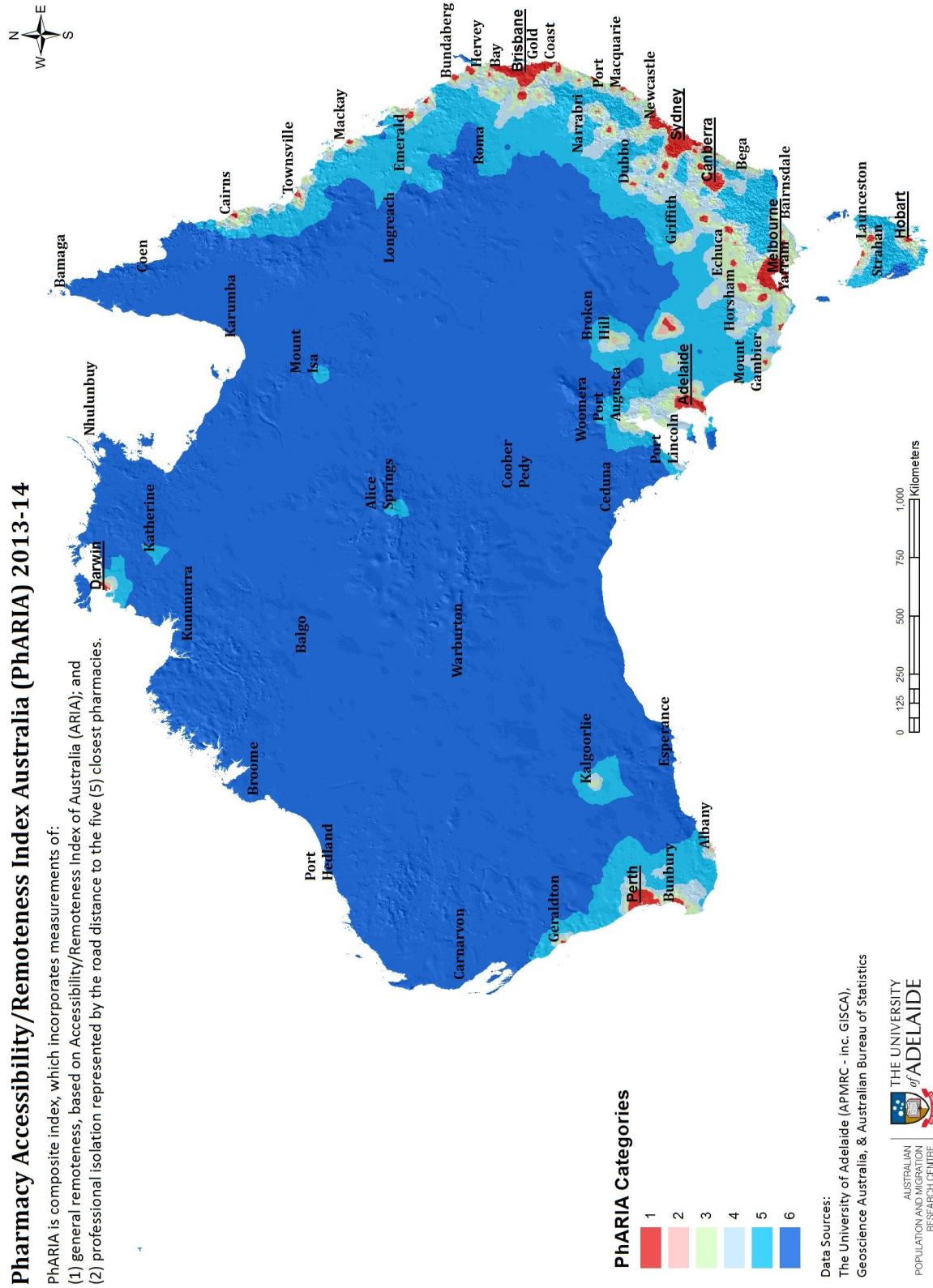
Table 2: PhARIA categories and value ranges

Category	PHARIA Value Range	Eligibility
1	0 – 1	Ineligible for payment
2	>1 – 2	Eligible
3	>2 – 4	
4	>4 – 6	
5	>6 – 9	
6	>9 – 12	

Although the Department has more recently transitioned a number of its workforce incentive programs away from specific spatial indices like Pharmacy ARIA to more generalised indices such as RA (and during 2015 to the Modified Monash Model which is based on RA), the PhARIA continues to be used by the Department for administration of the RPMA and for the pharmacy reporting component of the Productivity Commission Report on Government Services (RoGS). This report has therefore incorporated PhARIA data as part of the analysis, utilising the PhARIA classification corresponding with the most recent snapshot period being 2013/14.

The authors wish to note that this report is not intended to provide opinion or assessment on the different models and spatial indices used for the attraction and retention of health workers to rural and remote communities. Such an investigation would be better serviced by an independent assessment of the applicability of each spatial index and its capacity to provide for the equitable dissemination of government funding to address health workforce shortages in certain locations, especially those outside of urban areas. Should such a review/assessment be conducted, APMRC would welcome any opportunity to contribute or provide comment towards the findings of such a review.

Figure 1: PhARIA 1km interpolated surface – 2013/14



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### 3. Introduction

The research tasks proposed by the Department are listed below:

1. Geocode all pharmacy addresses for analysis and report on the accuracy of the pharmacy address data;
2. Calculate the population to pharmacy ratios by State/Territory for PhARIA Category 1 and PhARIA Categories 2-6 for each of the snapshot periods (based on the 2013/2014 PhARIA);
3. Calculate the number of pharmacies located within 10m, 100m, 200m, 1km, 5km and 10km by straight line distances (as the crow flies) in urban and non-urban areas;
4. Calculate the average road distance from each pharmacy to the next closest pharmacy in urban areas and non-urban areas;
5. Calculate the average road distance to the nearest five pharmacies in urban and non-urban areas;
6. Analyse the relationship between the location of pharmacies and socio-economic status;
7. Analyse and report on any UCL that had no pharmacy in 1990 but had one or more pharmacies as at 30 June 2014
8. Analyse and report on any UCL that had a pharmacy/pharmacies on 30 June 2007 but had no pharmacy as at 30 June 2014;
9. Analyse and report on any UCL that had one or more pharmacies in 1990 but had no pharmacy as at 30 June 2014; and
10. Analyse and report on non-urban access to pharmacies, highlighting areas with a single pharmacy in 2014.

Analysis outputs not included in this report but have been provided separately to the Department include:

- Geocoded pharmacy address data for all three snapshot periods for future research opportunities; and
- Updated and cleaned road network based on required adjustments to the PSMA dataset purchased by the Department for this report.

Datasets used to derive the report's research outcomes were:

- Australian Bureau of Statistics, Census for Population and Housing (enumerated population counts), 1991, 2006, 2011 and associated census geography;
- Australian Bureau of Statistics - Socio-Economic Indexes for Areas (SEIFA), 1991, 2006, 2011;
- Department of Health, Pharmacy Addresses for 1990, 2007 and 2014;
- Geoscience Australia, GEODATA TOPO 250K Series 3 Road and Ferry Dataset, 2006;
- PhARIA localities and interpolated 1km grid, 2013/14; and
- PSMA Transport and Topology Road Network, 2015

All geocoding<sup>1</sup> was undertaken at the University of Adelaide using Pitney Bowes 'Spectrum on Demand' geocoding software, leveraging the 2015 Australian Geocoded National Address File (G-NAF). Geocoded pharmacy addresses were subsequently re-projected into the following for all analysis calculations:

- Coordinate System: Oz Lamberts GDA94
- Projection: Lambert Conformal Conic

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<sup>1</sup> Geocoding is a term used for assigning geographic coordinates to address data for identifying a specific location on the Earth's surface.

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## 4. Analysis

Each of the ten research task findings are detailed below. Large tables have been provided separately as appendices, with summary tables included within the body of this report.

### Research Task 1: Geocode all pharmacy addresses for analysis and report on the accuracy of the pharmacy address data

The Department provided 16,055 pharmacy addresses for analysis across three snapshot periods. These comprised:

- 30/06/1990: 5,584
- 30/06/2007: 5,014
- 30/06/2014: 5,457

For inclusion in each of the snapshot periods, pharmacies were required to have an approval start date prior to 30 June in 1990, 2007 and 2014 and an approval end date on or after 30 June 1990, 2007 and 2014.

Of the records provided, extensive address cleaning was undertaken by APMRC and the Department to ensure the maximum number of pharmacies could be incorporated into the analysis. This included 934 records requiring manual address verification using supplementary data sources to assign an accurate street address. Table 3 provides a summary of the geocoding accuracy achieved to a street address by snapshot year after data cleaning and manual address verifications were complete.

Table 3: Geocoding results

<b>Geocoding Results</b>	<b>Records</b>	<b>%</b>
House Address - Exact Match	12,253	76.32%
House Address - Close Match	1,450	9.03%
Street Intersection	1,409	8.78%
Manually Geocoded	930	5.79%
Manual Geocoded - Estimate	4	0.02%
Street Centroid	8	0.05%
Postcode Centroid	1	0.01%
<b>Total</b>	<b>16,055</b>	

Of the 16,055 pharmacy records provided for analysis, 16,049 were assessed as suitable for inclusion in the analysis as indicated in Table 4. Given the number of addresses requiring verification in addition to the number of addresses manually geocoded, the quality of the address data captured for pharmacies requires improvement.

Table 4: Pharmacy records included for analysis

Geocoding Results by Snapshot Year	Geocoding Accuracy		% Included
	Included	Excluded	
1990	5,579	5	99.91%
2007	5,014	0	100.00%
2014	5,456	1	99.98%
<b>Total</b>	<b>16,049</b>	<b>6</b>	<b>99.96%</b>
<b>Grand Total</b>	<b>16,055</b>		

Recommendations for improving the recording of pharmacy address information are listed below:

- Validation of address information at the time of data collection. Use of a free-text field to record addresses with no automated or manual checks in place at the time of collection can result in spelling errors, missing address information, and incorrect street numbers, names, and postcodes;
- Some addresses were entered as a shopping centre name with no other accompanying address information. The ability to accurately assigning geographic coordinates reduces when key address information such as street numbers, street names, and suburbs are absent;
- Repeated address information was present in different address fields, some of which were inconsistent (e.g. Street Name = “123 Main Street”; Street Type = “Road”); and
- Avoiding the use of abbreviations in street names can improve matching accuracy. Examples of this include:
  - ‘Crcl’ instead of ‘Circle’;
  - ‘The Cntr’ instead of ‘The Centre’;
  - ‘Plza’ instead of ‘Plaza’;
  - ‘Sh’ instead of ‘Shop’; and
  - Other placename abbreviations which should otherwise have been expressed in full (e.g. FTG instead of Ferntree Gully).

## Research Task 2: Calculate the population to pharmacy ratios by State/Territory for PhARIA Category 1 and PhARIA Categories 2-6 for each of the snapshot periods (based on the 2013/2014 PhARIA)

Population to Pharmacy Ratios (ratios) have been calculated for the RoGS for a number of years. These statistical measures indicate the ratio of pharmacies to the total population by State/Territory and PhARIA categories (2013/14).

The ratios were calculated using geocoded pharmacy address data for each of the snapshot periods. Australian census data was applied using ABS enumerated population counts at a small area level (Collection District and Statistical Area 1), excluding populations with no geographic location (e.g. Migratory, Offshore and Shipping). Population counts were matched to the nearest Australian census year for the three snapshot periods (i.e. 1991, 2006, and 2011) and then grouped by RPMA eligibility – PhARIA Category 1 (ineligible) and PhARIA Categories 2-6 (eligible), utilising the 2013/14 PhARIA 1km interpolated surface for the allocation of PhARIA categories.

Unlike the population to pharmacy ratios produced for the RoGS in recent years which applied usual resident population counts, enumerated population counts were used in this report since usual resident population counts were not available at small area levels for 1991. For this reason, population

to pharmacy ratios for this research task will differ from the population to pharmacy ratios featured in the RoGS.

Figure 2 indicates the population to pharmacy ratios for the three snapshot periods, indicating a general increase from 1990 to 2014, with greater increases in the ratios for pharmacies in PhARIA Category 1 compared with PhARIA Categories 2-6. Notably, the ratios have become more equitable over time between PhARIA Category 1 and PhARIA Categories 2-6. Tables 5 and 6 offer a comparison of the ratios by State/Territory for the three snapshot periods, with Appendix 1 (provided separately), offering additional statistical calculations.

Figure 2: Population to pharmacy ratios by PhARIA categories (2013/14)

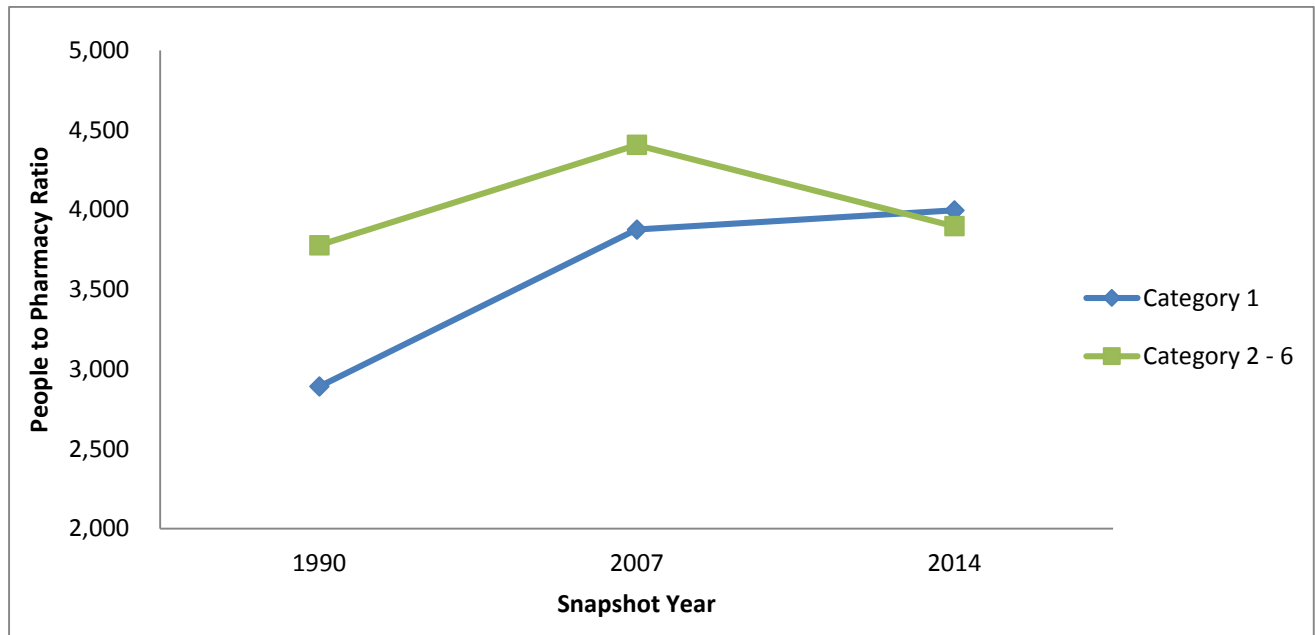


Table 5: Population to pharmacy ratios by PhARIA Category 1 (2013/14)

State/Territory	People per Pharmacy by PhARIA Category 1		
	1990	2007	2014
ACT	3,774.80	5,575.19	5,008.13
NSW	2,775.34	3,734.01	3,847.53
NT	4,955.21	4,511.80	4,687.78
Qld	2,684.12	3,831.25	4,086.07
SA	3,072.55	3,812.08	3,744.94
Tas	2,667.92	3,378.99	3,310.23
Vic	3,026.91	4,120.60	4,213.63
WA	3,115.25	3,780.22	3,954.00
Other	-	-	-
<b>Total</b>	<b>2,891.98</b>	<b>3,876.81</b>	<b>3,996.77</b>



[Table 6: Population to pharmacy ratios by PhARIA Categories 2-6 \(2013/14\)](#)

State/Territory	People per Pharmacy by PhARIA Categories 2-6		
	1990	2007	2014
ACT	-	-	-
NSW	3,611.92	4,287.40	3,670.00
NT	9,553.09	11,204.45	9,958.87
Qld	3,798.17	4,450.03	4,148.55
SA	3,526.94	3,590.39	3,180.47
Tas	3,871.37	3,908.63	3,220.87
Vic	3,627.19	4,727.12	3,935.14
WA	3,922.21	4,135.98	4,003.09
Other	-	-	-
<b>Total</b>	<b>3,772.72</b>	<b>4,400.95</b>	<b>3,892.64</b>

For the majority of States/Territories, the PhARIA Category 1 ratios in Table 5 (with the exception of the Northern Territory), have all increased from 1990 to 2007, whilst the trend from 2007 to 2014 is less apparent. The ratios for PhARIA Categories 2-6 in Table 6 have also increased from 1990 to 2007, although a decrease is apparent in all States/Territories from 2007 to 2014. When considering these results, it should be noted there was a decline in the number of pharmacies (565) from 1990 to 2007 (Table 7) despite an increase in population (6,000,241) from 1991 to the 2006 (Table 8), warranting further investigation.

[Table 7: Pharmacies by State/Territory](#)

State/ Territory	Pharmacy Snapshot Year		
	1990	2007	2014
ACT	74	58	72
NSW	1,989	1,719	1,820
NT	25	26	33
Qld	1,042	992	1,087
SA	444	401	439
Tas	151	134	149
Vic	1,367	1,175	1,282
WA	487	508	574
Other	-	1	1
<b>Total</b>	<b>5,579</b>	<b>5,014</b>	<b>5,456</b>

Table 8: Enumerated population by State/Territory

State/ Territory	Census Year		
	1991	2006	2011
ACT	279,335	323,361	360,585
NSW	4,826,320	6,538,848	6,956,343
NT	69,373	190,926	233,763
Qld	2,364,713	3,891,560	4,453,239
SA	1,121,479	1,511,573	1,593,227
Tas	293,471	475,559	488,488
Vic	3,605,052	4,926,010	5,350,322
WA	1,252,330	1,952,948	2,274,900
Other	766	2,295	3,476
<b>Total</b>	<b>13,812,839</b>	<b>19,813,080</b>	<b>21,714,343</b>

**Research Task 3: Calculate the number of pharmacies located within 10m, 100m, 200m, 1km, 5km and 10km by straight line distances (as the crow flies) in urban and non-urban areas**

Geocoded pharmacy locations were used to calculate the straight line distance (as the crow flies) to the nearest pharmacy. Distance calculations for each pharmacy were then grouped into distances of less than 10 metres, 100 metres, 200 metres, 1 kilometre, 5 kilometres and 10 kilometres. Figure 3 shows the percentage of pharmacies within each of the distance categories, indicating that over the three snapshot periods, there has been a reduction in the percentage of pharmacies located in all distance categories, with the exception of the 10 metres or less category.

All pharmacy distance measures were subsequently categorised into urban and non-urban areas to account for the greater pharmacy concentrations in more populated locations. For the purpose of this report, urban areas were derived using the ABS UCL boundaries and associated population counts from the 2011 census. UCL boundaries were then grouped based on population counts in accordance with the following ARIA+ Service Centre population breakpoint categories:

- Category A – ABS UCL population counts of 250,000 persons or greater
- Category B – ABS UCL population counts of 48,000 to 249,999 persons.

Once the 2011 UCLs were assigned to Category A and B, all pharmacy locations within these boundaries were combined to represent an 'urban' boundary. A 2km straight line distance buffer was then applied to all urban boundaries to identify pharmacies likely to be providing pharmaceutical services to these major Category A and B urban centres, but were located just outside this urban boundary. These manual adjustments were considered necessary to identify and review instances (for example) where UCL boundaries created along a major road did not exclude a pharmacy located on the opposite side of the road where the urban boundary existed. Manual adjustments were very minor, applied to 0.31% of all pharmacies analysed across the three snapshot periods.

Figure 3: Percentage of pharmacies by straight line distances 1990-2014

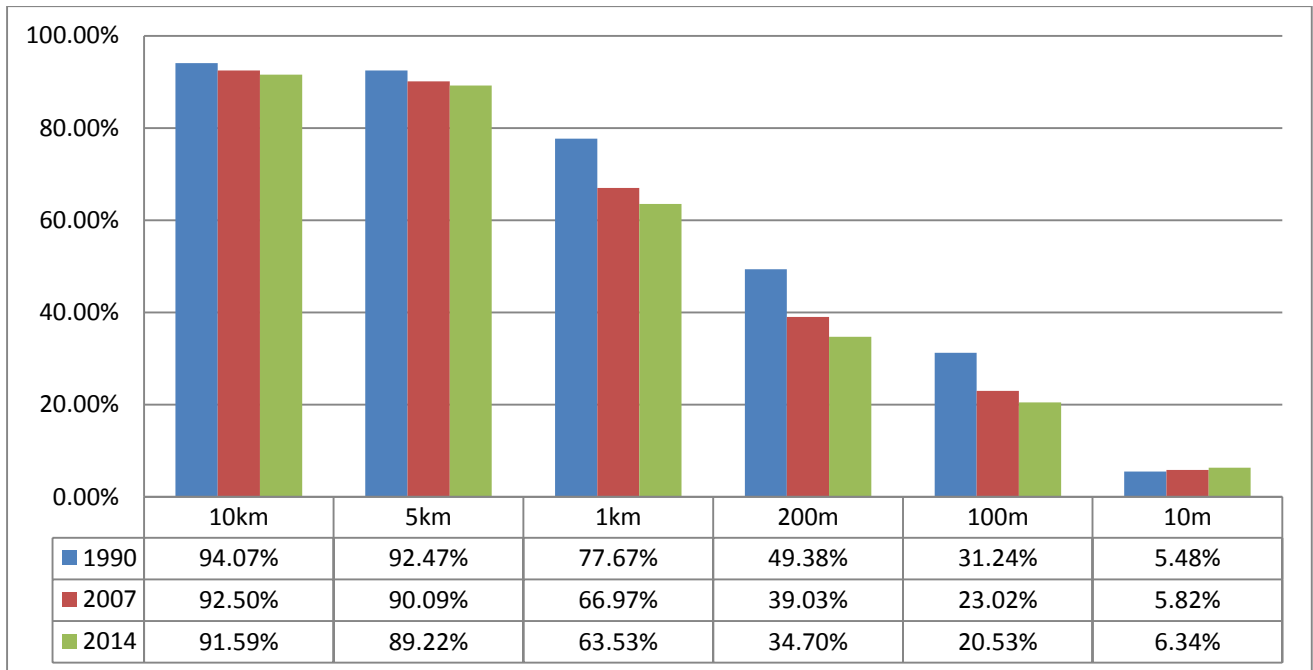
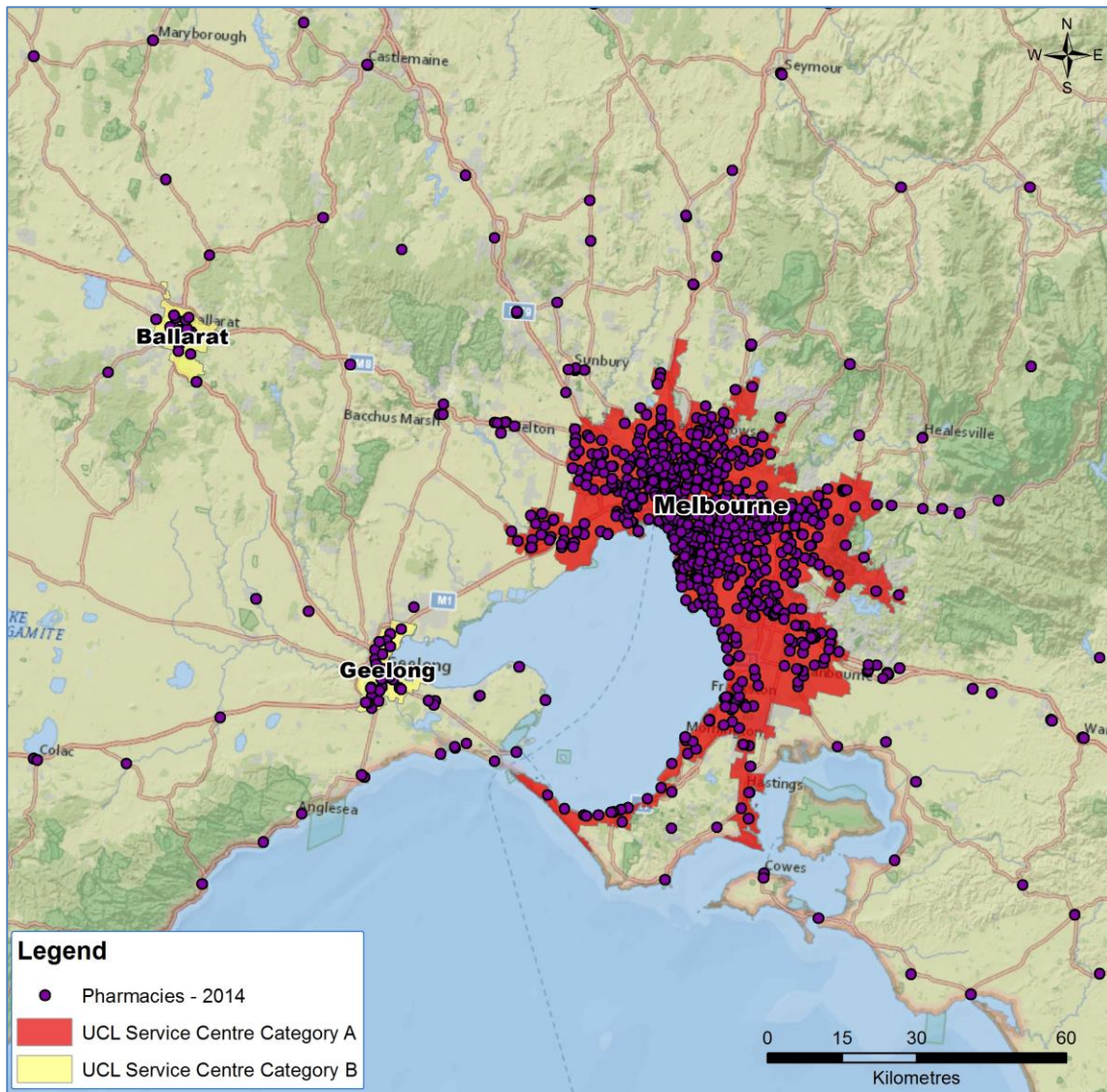


Figure 4 indicates the 2014 pharmacy locations with the 2011 UCL boundary for Melbourne and the Category B UCLs of Ballarat and Geelong (as an example) to highlight the difference between Category A and B urban centres and to contrast urban and non-urban areas. Throughout this report, the urban boundary rational described above will be applied for general analysis and the reporting of all distance calculations. Category A and B boundaries will only be reported separately in the appendices as supplementary data to the analysis.

As Table 9 indicates, over 99% of all pharmacies are located within 5km of the next nearest pharmacy in urban areas with populations of 48,000 or greater, while the non-urban areas comprise 60-70% of all pharmacies within a 5km distance. Broadly, these results suggest that the straight line distances between each pharmacy has increased between 1990 and 2014 (represented as a decline in the percentage of pharmacies), despite the proportion of pharmacies located 10 metres or less from the next nearest pharmacy slightly increasing since 1990. This finding within the 10 metre distance category is likely to be affected by the quality of the geocoded pharmacy address information, which becomes less of an issue as the distance measure increases. To this end, these results should be interpreted with caution (e.g. two pharmacies geocoded to the same shopping centre location will most likely be located at the same latitude and longitude despite being physically located up to 200 metres apart, dependant on the size of the shopping centre). Appendix 2 provides more specific calculations for each of the three snapshot periods, including distance calculations reported separately by Category A and Category B boundaries.

Figure 4: Example of UCL urban boundary (Cat A and B) within Victoria



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; National Geographic et al., Base Map, 2015

Table 9: Percentage of pharmacies to the next nearest pharmacy based on straight line distances grouped by urban/non-urban areas

	<=10 Metres			<=100 Metres		
Snapshot Year	Urban	Non-Urban	All Areas	Urban	Non-Urban	All Areas
1990	6.44%	2.41%	<b>5.48%</b>	32.12%	28.43%	<b>31.24%</b>
2007	7.22%	1.47%	<b>5.82%</b>	25.65%	14.82%	<b>23.02%</b>
2014	8.27%	1.09%	<b>6.34%</b>	23.79%	11.66%	<b>20.53%</b>
	<=200 Metres			<=1 Kilometre		
Snapshot Year	Urban	Non-Urban	All Areas	Urban	Non-Urban	All Areas
1990	50.46%	45.93%	<b>49.38%</b>	82.77%	61.31%	<b>77.67%</b>
2007	41.95%	29.98%	<b>39.03%</b>	73.56%	46.52%	<b>66.97%</b>
2014	38.61%	24.06%	<b>34.70%</b>	70.74%	43.90%	<b>63.53%</b>
	<=5 Kilometres			<=10 Kilometres		
Snapshot Year	Urban	Non-Urban	All Areas	Urban	Non-Urban	All Areas
1990	99.39%	70.29%	<b>92.47%</b>	99.95%	75.19%	<b>94.07%</b>
2007	99.47%	60.93%	<b>90.09%</b>	100.00%	69.21%	<b>92.50%</b>
2014	99.62%	60.94%	<b>89.22%</b>	100.00%	68.71%	<b>91.59%</b>

#### Research Task 4: Calculate the average road distance from each pharmacy to the next closest pharmacy in urban and non-urban areas

Road distances offer a more realistic measure of service accessibility compared with straight line distances which fail to consider geographical barriers (e.g. waterways) that may increase a person's journey time. Using the urban/non-urban boundaries described in Research Task 3, a detailed road network which included ferry routes but excluded tracks (e.g. 4WD tracks) was used to analyse the distance from a given pharmacy to the next closest pharmacy across Australia. No weightings were applied to these distance calculations.

Extensive data cleaning was undertaken to prepare the road network for distance calculations, including assistance received from PSMA to resolve the misalignment of major roads crossing State/Territory borders. Supplementary road and ferry routes utilising 2006 Geoscience Australia spatial datasets were applied to arrive at a detailed road network considered suitable for calculating distances to all pharmacies across Australia. Of the total number of pharmacies geocoded for analysis, one pharmacy from 1990 and two pharmacies from 2007 and 2014 were excluded from this research task due to their location on Australian islands which were not able to be connected to the Australian mainland by road/ferry routes. These locations were King Island and Christmas Island.

Table 10 indicates the summary results when comparing distances (in metres) over the three snapshot periods. Table 11 indicates the count of pharmacies by urban, non-urban, and all areas (when no urban boundary was considered). Appendix 3 offers more specific calculations for each of the three snapshot periods.

Table 10: Average road distance to the next nearest pharmacy by urban/non-urban areas

Snapshot Year	Average Distance to the Next Nearest Pharmacy (m)		
	Urban	Non-Urban	All Areas
1990	710	13,813	<b>3,822</b>
2007	907	17,472	<b>4,936</b>
2014	951	16,876	<b>5,229</b>

Table 11: Count of pharmacies by urban/non-urban areas

Snapshot Year	Pharmacy Counts		
	Urban	Non-Urban	All Areas
1990	4,253	1,325	<b>5,578</b>
2007	3,793	1,219	<b>5,012</b>
2014	3,989	1,465	<b>5,454</b>

Although calculations at smaller distances between clustered pharmacies are more likely to be affected by geocoding accuracy (as discussed in Research Task 4), these findings indicate for urban centres, the average distance to the next nearest pharmacy had increased from 1990 to 2014. The increase in average distance to the next nearest pharmacy was also prevalent in non-urban areas, however there was a slight decrease in average distance from 2007 to 2014. When considering these results in reference to the count of pharmacies over the three snapshot periods, the increase in average distance from 1990 to 2007 coincides with a decrease in the number of pharmacies for the same period. Interestingly, the increase in pharmacy counts from 2007 to 2014 did not result in a decrease in the average distance in urban centres, unlike the non-urban areas where the average distance decreased.

## Research Task 5: Calculate the average road distance to the nearest five pharmacies in urban and non-urban areas

Leveraging the professional isolation concept of the PhARIA, road distances from a given pharmacy to the next nearest five pharmacies were calculated. Similarly to Research Tasks 3 and 4, road distance calculations for each pharmacy located within and outside the urban UCL boundaries were utilised. Table 12 indicates the results from this grouping for the three snapshot periods with further calculations provides separately in Appendix 3.

These findings provide further support regarding the earlier findings (in Research Task 4) whereby an increase in the average distance to the nearest five pharmacies from 1990 to 2014 was observed within both urban and non-urban areas. Given the increase in pharmacy numbers from 2007 to 2014 (Table 10), the average distance to the nearest five pharmacies continued to increase from 2007 to 2014 in urban areas, whilst decreasing in non-urban areas.

Table 12: Average road distance to the next nearest five pharmacy by urban/non-urban areas

Snapshot Year	Average Distance to the Nearest Five Pharmacies		
	Urban	Non-Urban	All Areas
1990	1,482	31,228	8,548
2007	1,801	36,566	10,256
2014	1,851	34,753	10,689

These findings in conjunction with the findings from Research Task 4 suggest the spatial clustering of pharmacies between 1990 and 2014 has reduced in urban areas. Access to pharmacies in non-urban areas appears to have improved from 2007 to 2014 with the average distance to the nearest pharmacy and nearest five pharmacies both reducing over this period. However, further consideration is recommended beyond the scope of this report to determine if other factors are contributing to these findings.

## Research Task 6: Analyse the relationship between the location of pharmacies and socio-economic status

The ABS provides a measure of socio-economic conditions by geographic area based upon selected census variables for each census. The Socio-Economic Indexes for Areas (SEIFA) offers a relative ranking of geographic areas to determine differing levels of social and economic wellbeing across Australia (ABS, 2013).

For this research task, the SEIFA Index of Relative Socio-Economic Disadvantage (IRSD) for the census year most closely aligned to each of the three snapshot periods was used to determine if there was a relationship between pharmacy locations and socio-economic status. Deciles (representing the distribution of SEIFA scores into ten equal groups) were used to compare pharmacy counts across the three different snapshot periods, with the lowest scoring 10 percent of all areas given a decile number of 1 (most disadvantaged) and the highest scoring 10 percent of areas given a decile number of 10 (least disadvantaged). Please refer to the ABS website for more detailed information regarding SEIFA.

To consider pharmacy location in reference to SEIFA-IRSD, all geocoded pharmacies were aggregated to the smallest spatial area possible (Collection Districts (CD) for 1991 and 2006, Statistical Area 1 (SA1) for 2011) to coincide with the SEIFA IRSD deciles by area. As Table 13 indicates, for all three snapshot periods, the proportion of pharmacies in each SEIFA-IRSD decile at the CD/SA1 level of census geography was consistently highest in the most disadvantaged areas and lowest in the least disadvantaged areas. The distribution remains consistent over all three snapshot periods, with no significant difference in the proportion of pharmacies within each decile. However, when pharmacies were aggregated to a larger spatial unit (Statistical Local Area (SLA) for 1991 and 2006, and Statistical Area 2 (SA2) for 2011), this pattern was not evident (Table 14). In 1990, although there were lower counts of pharmacies in the most disadvantaged decile based on SLA/SA2 spatial units, the proportion of pharmacies in the lowest group of deciles was still relatively high. By 2014, the proportion of pharmacies in each decile was much more even, with similar numbers in each disadvantage category.

Table 13: Aggregated pharmacies by IRSD decile at CD/SA1 spatial units

SEIFA IRSD Decile by CD/SA1	Number and Percentage of Pharmacies					
	1990		2007		2014	
1 - most disadvantaged	914	16.8	790	16.1	899	17.3
2	905	16.6	763	15.6	814	15.7
3	729	13.4	610	12.4	652	12.6
4	621	11.4	528	10.8	566	10.9
5	522	9.6	467	9.5	477	9.2
6	454	8.3	390	8.0	450	8.7
7	388	7.1	382	7.8	372	7.2
8	327	6.0	335	6.8	426	8.2
9	302	5.5	369	7.5	327	6.3
10 - least disadvantaged	291	5.3	269	5.5	210	4.0
<b>Total</b>	<b>5,453</b>	<b>100.0</b>	<b>4903</b>	<b>100.0</b>	<b>5193</b>	<b>100.0</b>

Table 14: Aggregated pharmacies by IRSD decile at SLA/SA2 spatial units

SEIFA IRSD Decile by SLA/SA2	Number and Percentage of Pharmacies					
	1990		2007		2014	
1- most disadvantaged	400	7.3	203	4.0	644	11.8
2	997	18.3	545	10.9	567	10.4
3	722	13.2	531	10.6	618	11.3
4	698	12.8	602	12.0	591	10.9
5	564	10.3	535	10.7	496	9.1
6	423	7.8	556	11.1	550	10.1
7	390	7.2	516	10.3	483	8.9
8	404	7.4	534	10.7	522	9.6
9	594	10.9	536	10.7	492	9.0
10- least disadvantaged	261	4.8	455	9.1	484	8.9
<b>Total</b>	<b>5,453</b>	<b>100.0</b>	<b>5013</b>	<b>100.0</b>	<b>5447</b>	<b>100.0</b>

With respect to the construction of SEIFA, small geographic areas are more prone to variation given each person has a greater impact on the area's SEIFA score compared with a larger spatial unit. SEIFA scores are also not provided for some CD/SA1 spatial units because of low population counts or poor quality data (ABS, 2013b). This is why the total pharmacy counts for Tables 13 and 14 are not equal. It may also be possible that in the smaller spatial unit areas, the IRSD is partially reflecting the commercial vs residential character of many of these small areas. The larger geographic units (SLA/SA2) generally equate closely to local council areas, or significant divisions thereof, and are therefore more meaningful in terms of neighbourhood characteristics. To this end, a more comprehensive analysis is recommended.



## Research Task 7: Analyse and report on any UCL that had no pharmacy in 1990 but had one or more pharmacies as at 30 June 2014

This research task considers changes to pharmacy locations across Australia between 1990 and 2014. The ABS UCL dataset based on the 2011 census was used to represent populated locality areas for the identification of pharmacy location changes.

The UCL dataset comprises whole SA1 spatial units to represent areas of concentrated urban development for the dissemination of statistics from the Australian Census (ABS, 2011b). As outlined in the ABS Statistical Geography Fact Sheet, “For 2011, there are 1839 Urban Centres and Localities covering all of Australia, with no gaps or overlaps. There are 684 Urban Centres, 1,128 Localities, and 27 Special Purpose UCLs covering Remainder of State/Territory, Migratory – Offshore – Shipping and No usual address. Centres that cross a state or territory border (e.g. Mulwala – Yarrowonga, Gold Coast – Tweed Heads) are considered to be the same UCL, but are split along that border.” (ABS, [No Date]). The UCL boundaries (excluding Remainder of State/Territory, Migratory, Offshore, Shipping, and No Usual Address) were used and comprised 1,812 UCLs. A spatial join was applied to determine the number of pharmacies located within each of the 1,812 UCL boundaries for 2011. Comparisons were then made between both time periods, identifying 221 pharmacies within 213 UCLs which did not have a pharmacy in 1990.

Analysis by PhARIA 2013/14 category indicated 31.67% of pharmacies within these UCLs were PhARIA Category 1. The next highest proportion was PhARIA Category 3 (23.08%), with a relatively even distribution amongst PhARIA Categories 4, 5, and 6 as indicated in Table 15.

Table 15: Count of 2014 pharmacies in UCLs without pharmacies in 1990 by PhARIA category

<b>PhARIA Category</b>	<b>Pharmacy 2014 Count</b>	<b>Pharmacy (%)</b>
1	70	31.67
2	17	7.69
3	51	23.08
4	26	11.76
5	31	14.03
6	26	11.76
<b>Total</b>	<b>221</b>	

Analysis using the urban/non-urban boundaries (as detailed in Research Task 3) indicated that the majority of the pharmacies in question were located within a non-urban UCL (populations of less than 48,000 persons). When average road distances to the next nearest pharmacy were considered (based on the Research Task 4 methodology), the 221 pharmacy locations had larger average distances to the next nearest pharmacy in all categories (urban, non-urban and all areas) when compared with Table 10. The four pharmacies within urban areas (as indicated in Table 16) were either located near the edge or within 2km of an urban UCL boundary. Of the 213 UCLs identified, 84.5% comprised a 2011 enumerated population of less than 2,000 persons as detailed in Appendix 4.

Table 16: Count and average road distance of 2014 pharmacies in UCLs without pharmacies in 1990 by urban/non-urban areas

<b>UCL Population Categories</b>	<b>Pharmacy Count</b>	<b>Average Road Distance to the Next Nearest Pharmacy (m)</b>
Urban	4	9,576
Non-Urban	216	35,844*
All Areas	221	60,942

\*Distance calculations exclude Christmas Island pharmacy which was unable to be connected to mainland Australia by ferry/road.

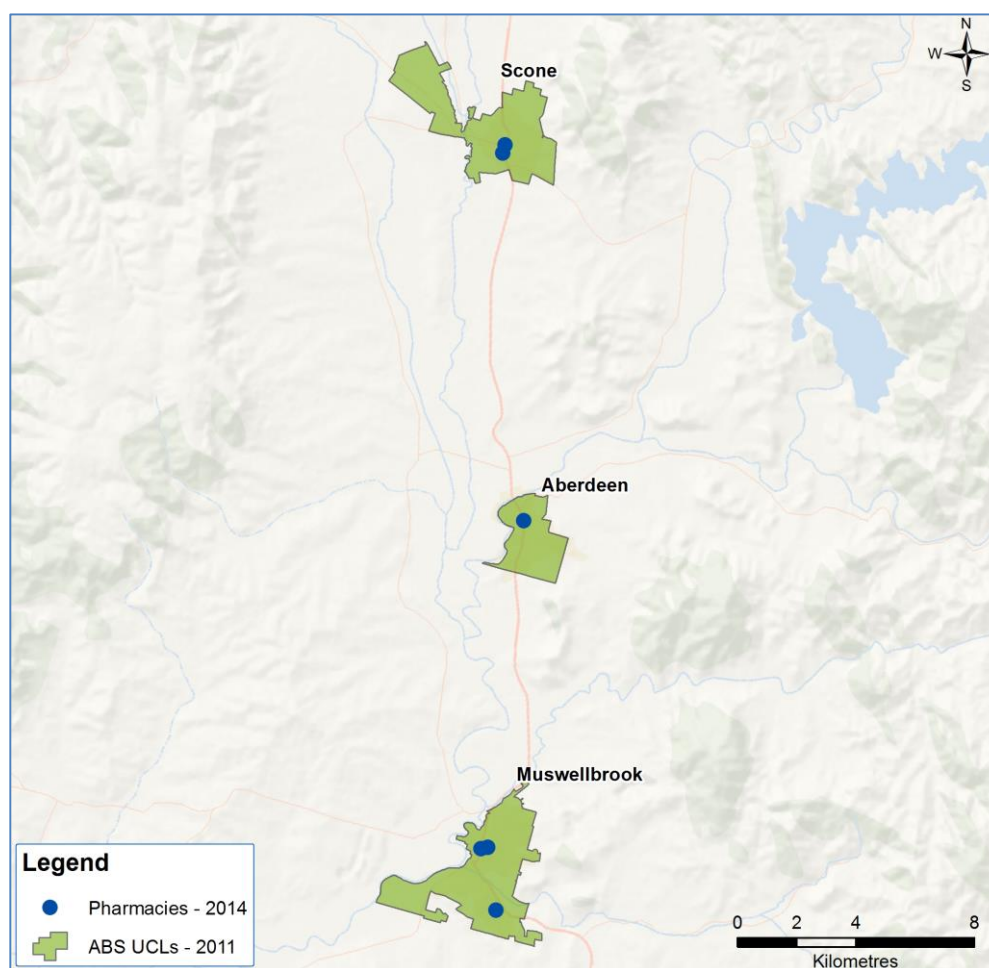
A selection of the 2013 UCLs (feature below) were examined in more detail, including UCLs representing locations with the largest and smallest enumerated populations (Ellenbrook, WA and Warooka, SA). Other locations selected represent a cross section of the PhARIA categories and States/Territories. For a complete listing of the 213 UCLs identified, please refer to Appendix 4.

#### **Aberdeen (New South Wales) PhARIA Category 3 (2013/14)**

Aberdeen is located north-west of the Central Coast and Newcastle. Scone is 10km to the north and Muswellbrook 7km to the south of Aberdeen (straight line distances) as indicated in Figure 5. The UCL boundary and population count for Aberdeen has remained relatively consistent over time (1991 = 1,796; 2006 = 1,752; 2011 = 1,880). Nearby Scone has grown in UCL area over time, incorporating the locality of Satur in 2006, with the population increasing from 4,292 in 1991 (including Satur) to 5,181 in 2011. Muswellbrook, has also increased from 10,156 in 1991 to 11,300 in 2011.

Based on the three snapshot periods, there were no pharmacies located in Aberdeen in 1990 and 2007. There were six pharmacies located in Scone and Muswellbrook in 1990 which reduced to four in 2007, before increasing to five in 2014. Given the population size of Muswellbrook and its proximity to Aberdeen and Scone, the pharmacy in Aberdeen may potentially service these two locations in addition to the local Aberdeen community. Aberdeen and Scone are PhARIA Category 3 while Muswellbrook is a PhARIA Category 2.

Figure 5: Aberdeen UCL (NSW)



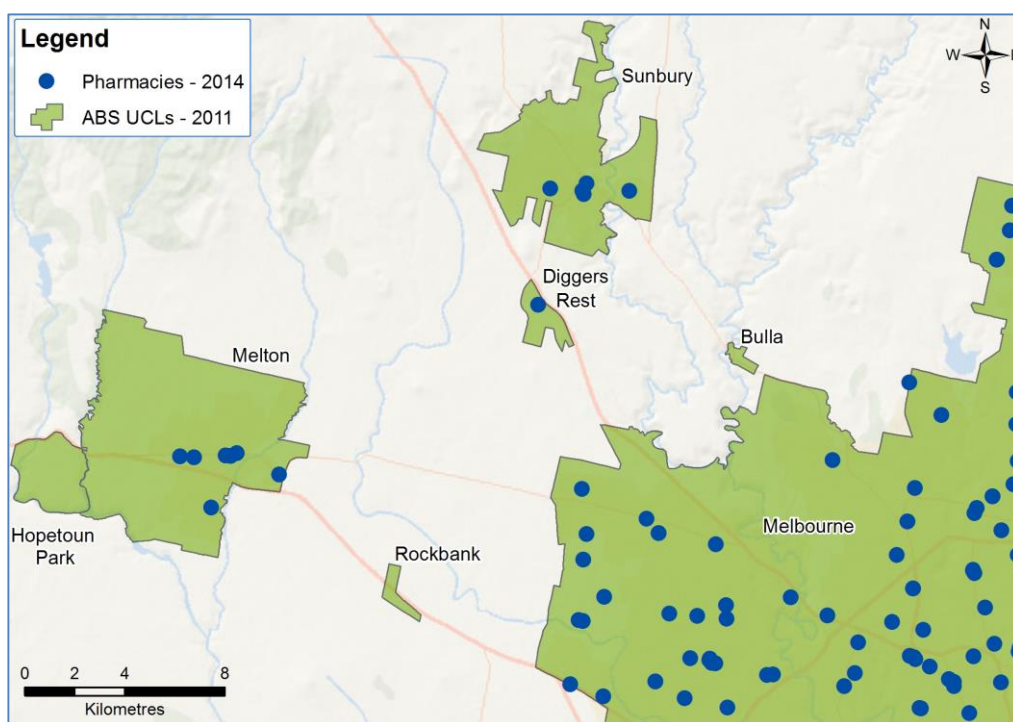
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Diggers Rest (Victoria) PhARIA Category 1 (2013/14)**

Located to the north-west of Melbourne between Melton to the south-west and Sunbury to the north as depicted in Figure 6, the population of Diggers Rest has remained relatively stable over the three snapshot periods ranging from 1,620 in 1991 to 1,650 in 2011. In contrast, the surrounding populations for Melton (9km straight line distance) and Sunbury (4km straight line distance) and Melbourne (3.5km straight line distance to the Melbourne UCL boundary), have notably increased.

Located along the Calder Freeway and given the proximity of Diggers Rest to these surrounding UCLs, it is likely that Digger's Rest is also servicing the surrounding UCL populations and potentially, persons bypassing this UCL when travelling north-west from Melbourne. Diggers Rest and the surrounding UCLs mentioned above are PhARIA Category 1 (2013/14), positioned within the Melbourne 30km spatial buffer.

Figure 6: Diggers Rest UCL (Vic)



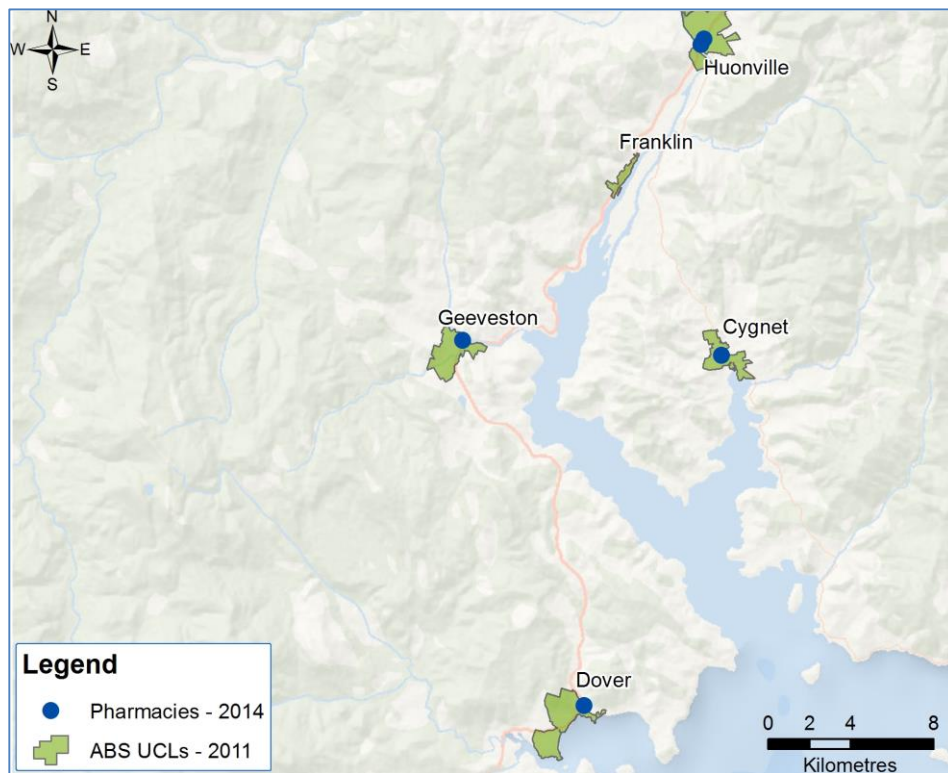
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

#### **Dover (Tasmania) PhARIA Category 4 (2013/14)**

Dover is located to the south-west of Hobart and is the most southern 2011 UCL in Australia, with Cygnet, Franklin, Geeveston and Huonville located nearby as indicated in Figure 7. Given its coastal location, road distances were calculated to the nearest UCL of Geeveston (21.31km) followed by Franklin (31.8km). The population of Dover has remained relatively stable over time, despite a slight decline from 522 in 1991 to 420 in 2011. Nearby Geeveston has also remained stable but experienced a small decline from 829 in 1991 to 623 in 2011 which may be in part due to the reduced land area of the UCL from 2006 to 2011.

For all three snapshot periods, the nearest pharmacy by road distance to Dover was located in Geeveston. There were no pharmacies located in Frankston, with the next nearest two pharmacies based in Huonville, located 39km by road from Dover. Dover is a PhARIA Category 4 (2013/14), while Geeveston, Franklin and Huonville are PhARIA Category 3 (2013/14).

**Figure 7: Dover UCL (Tas)**



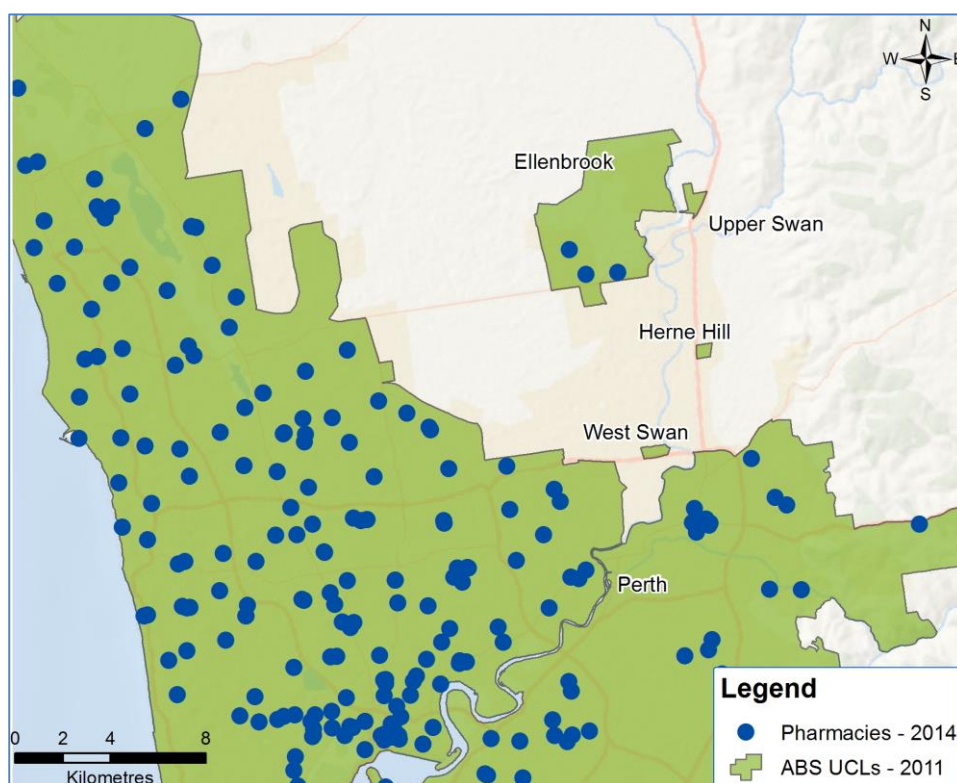
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Ellenbrook (Western Australia) PhARIA Category 1 (2013/14)**

Ellenbrook is located north of Perth, 6.5km (straight line distance) from the Perth UCL boundary (Figure 8). Ellenbrook was not a UCL in 1991 based on the ABS criteria. In 2006, the population for Ellenbrook was 11,659. In 2011, the UCL population more than doubled to 25,215, although the UCL boundary also increased during this time.

As at 30 June 2007, there were two pharmacies located within this UCL, increasing to three as at 30 June 2014, coinciding with an increased population in this location. Ellenbrook is a PhARIA Category 1 (2013/14), positioned within the Perth 30km spatial buffer.

Figure 8: Ellenbrook UCL (WA)



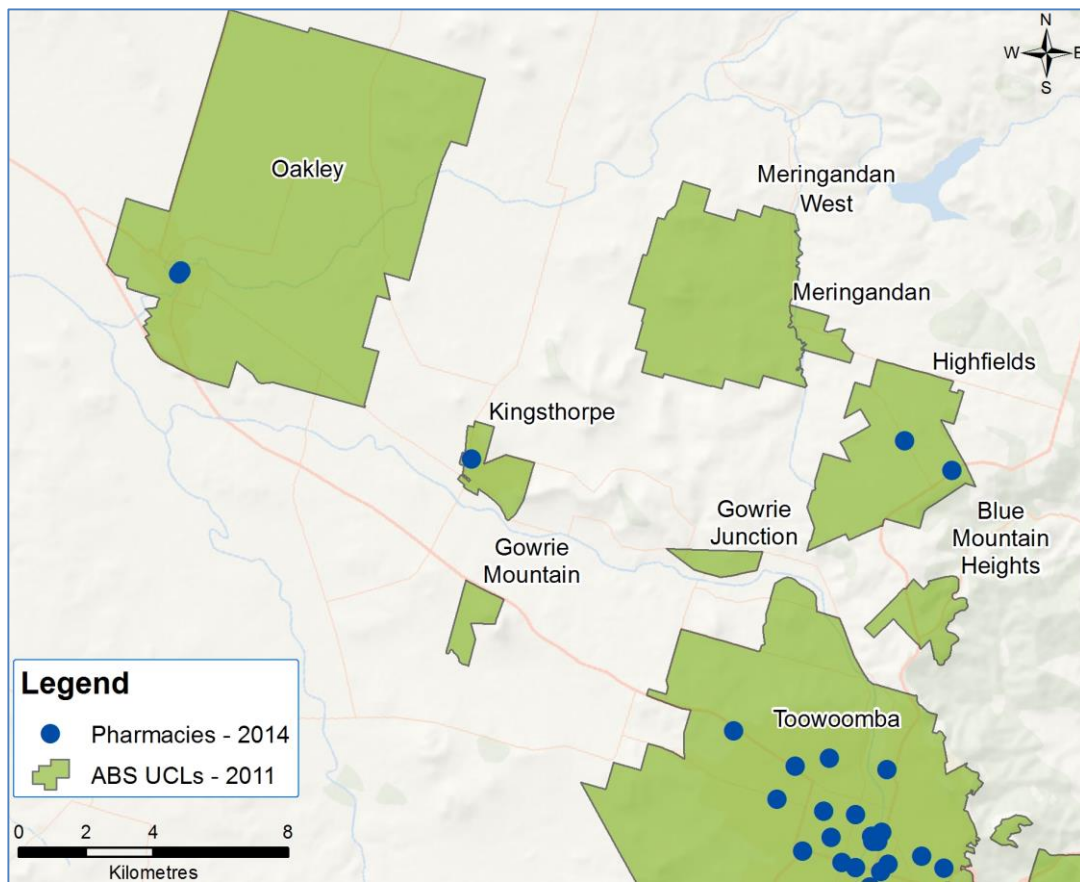
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Highfields (Queensland) PhARIA Category 1 (2013/14)**

Located west from Brisbane, Highfields is north from Toowoomba and surrounded by a number of smaller UCLs including Gowrie Junction and Blue Mountain Heights. North-west from Highfields are the larger UCLs of Oakley and Meringandan West, as depicted in Figure 9.

In 1991, the Highfields UCL population was 1,397, rising to 2,708 in 2006 and 7,721 in 2011. Notably, Toowoomba grew from 75,973 in 1991 to 96,710 in 2011. The majority of pharmacies in this region were located in Toowoomba (29 in 1990) and this number has remained consistent over time (28 in 2007, increasing to 30 in 2014). There were two pharmacies positioned in Highfields during 2007 and these remained located in Highfields in 2014. Highfields is a PhARIA Category 1, positioned within the Toowoomba 10km spatial buffer.

Figure 9: Highfields UCL (Qld)



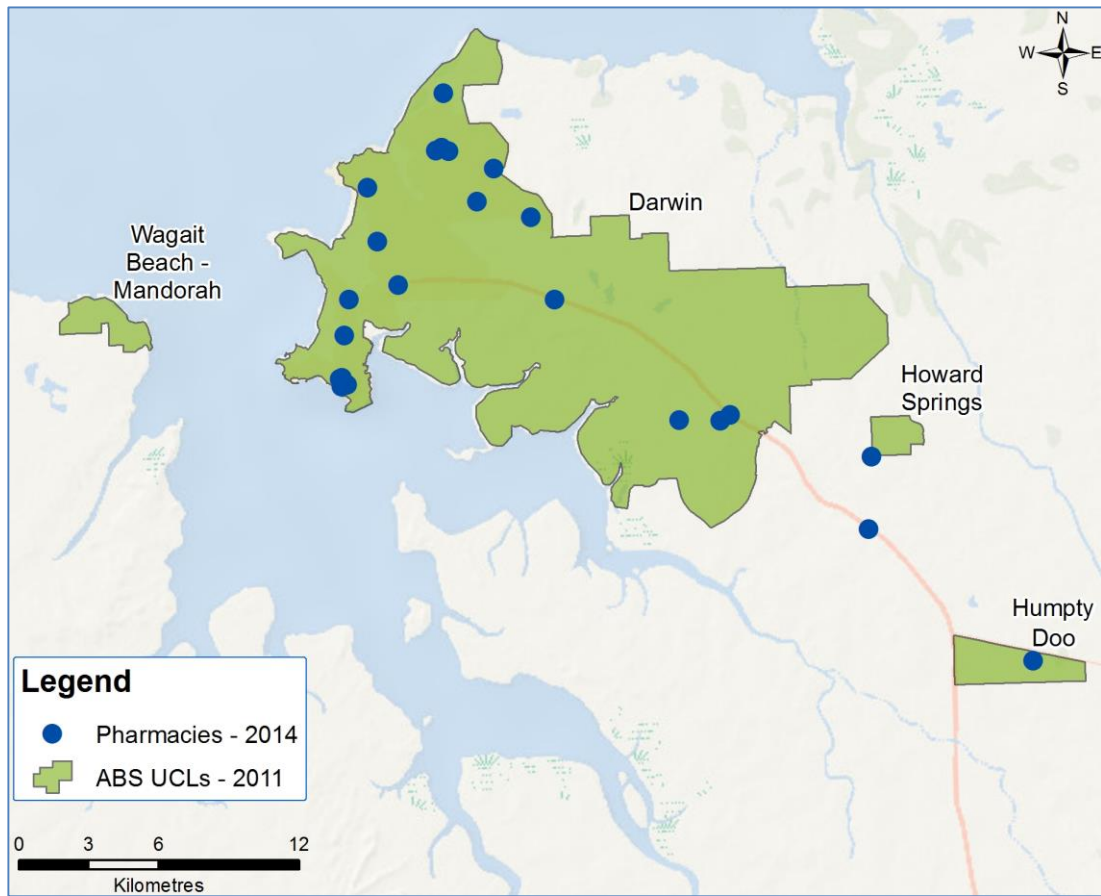
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Humpty Doo (Northern Territory) PhARIA Category 3 (2013/14)**

Humpty Doo is located 11km (straight line distance) from the 2011 Darwin UCL. Nearby UCLs include Howard Springs to the north-west (8km straight line distance), with Wagait Beach-Mandorah located on the opposite side of the harbour (97km by road), as featured in Figure 10. The combined UCL populations in this region have increased from 76,169 in 1991 to 112,436 in 2006. Since 2006, the UCL population has remained relatively consistent with a population of 112,736 in 2011. Not surprisingly, Darwin comprises the bulk of this population (98.61% in 2011).

Pharmacies in this region have increased from 15 in 1990 to 19 in 2007 and 25 in 2014. Humpty Doo did not feature as a UCL until 2006 and there were no pharmacies based within the 2006 UCL boundary for the 1990 snapshot period. There has been one pharmacy located in Humpty Doo during 2007 and 2014. The UCL area of Humpty Doo reduced dramatically from 2006 to 2011, which makes analysis of the population change over time problematic.

Figure 10: Humpty Doo UCL (NT)



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

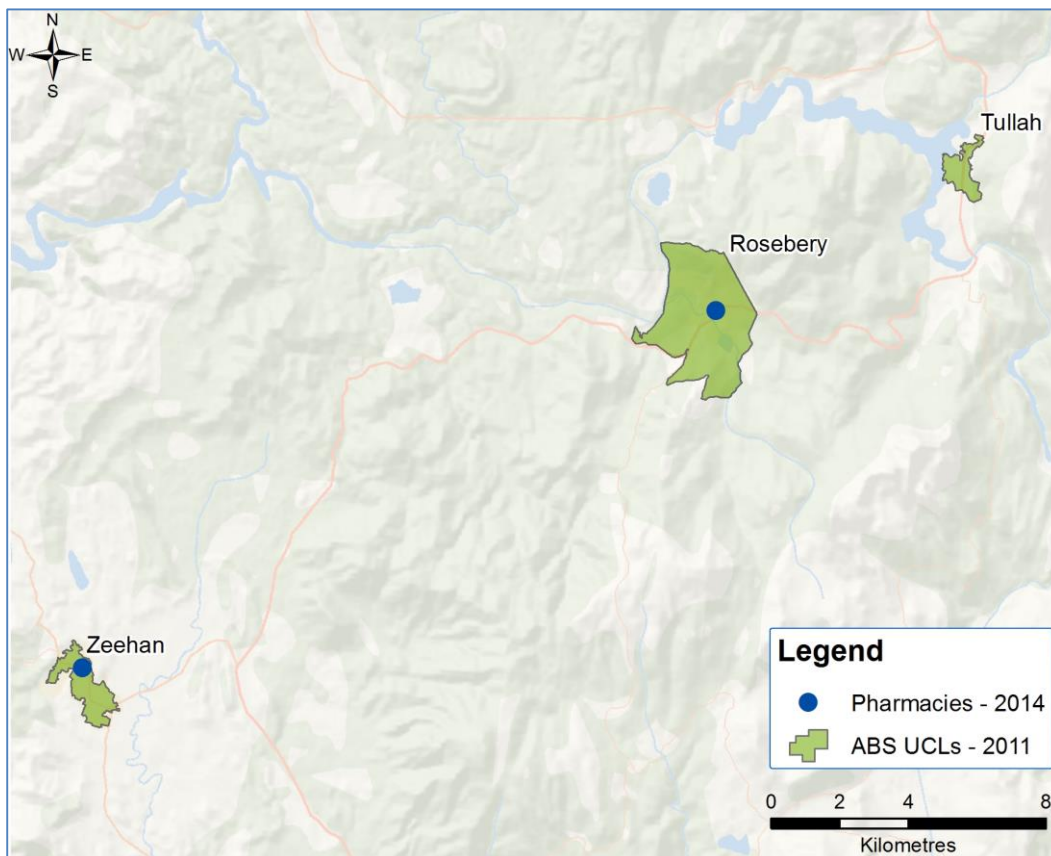
### **Rosebery (Tasmania) PhARIA Category 5 (2013/14)**

Rosebery is located towards the north-western coast of Tasmania, with Tullah 8km to the north-east and Zeehan 20km to the south-west (straight line distances) as depicted in Figure 11. Rosebery is the largest of these three UCLs, but has experienced population decline from 1,635 in 1991 to 993 in 2011. The UCLs of Tullah and Zeehan have also experienced declining populations over the three snapshot periods, despite a small population increase in Tullah from 207 in 2006 to 252 in 2011. The 1991 population of Tullah was 721.

There were no pharmacies located in these three UCLs for 1990 and 2007. In 2014 there were two pharmacies, one located in Rosebery and one in Zeehan. All three UCLs are PhARIA Category 5 (2013/14).



Figure 11: Rosebery UCL (Tas)



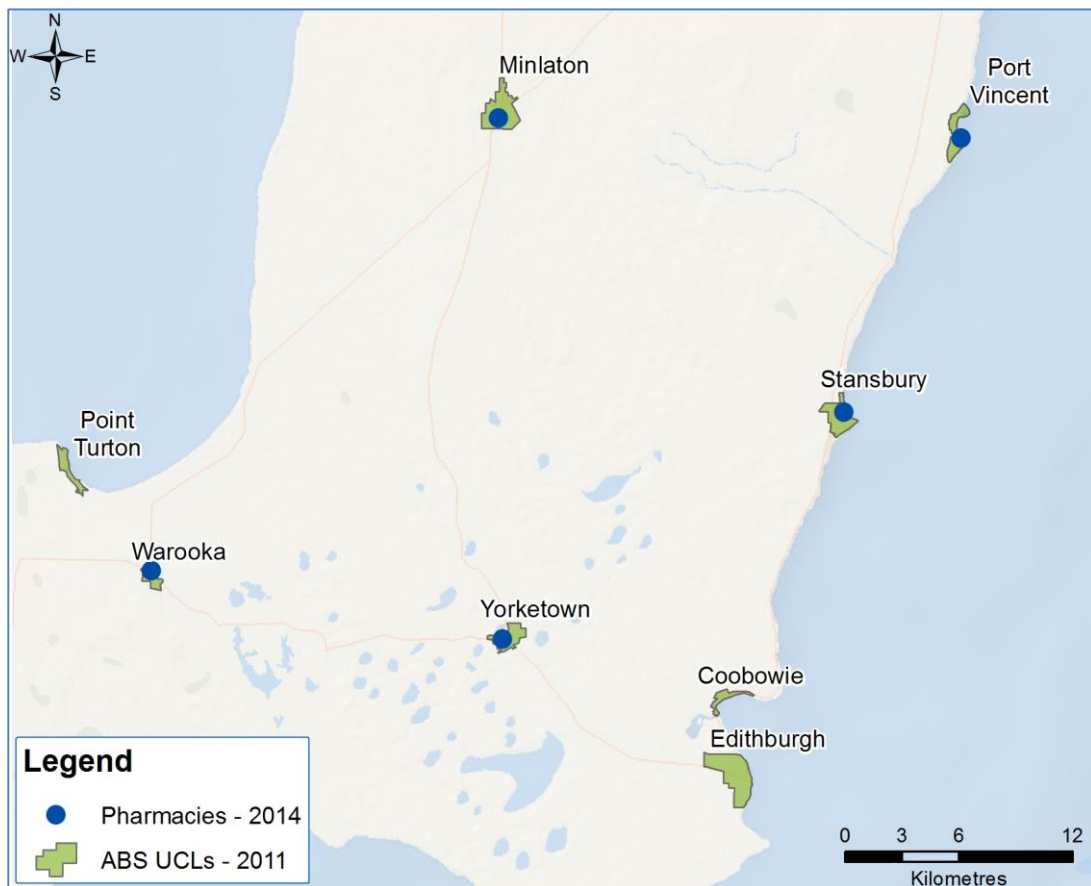
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Warooka (South Australia) PhARIA Category 5 (2013/14)**

Located 6.5km from Port Turton, 18km from Yorketown, and 30km from Edithburgh (straight line distances), the Warooka UCL population has remained relatively stable over time (237 in 1991 and 202 in 2011). The nearby UCLs of Port Turton and Edithburgh appear to have similarly stable populations across the three snapshot periods (with the exception of Port Turton which did not feature as a UCL in 1991). Yorketown comprises the larger population amongst these nearby UCLs (674 in 2011). Further away are the UCLs of Minlaton and Port Vincent as illustrated in Figure 12.

Amongst the 8 UCLs within this region, there were two pharmacies in 1990 located in Minlaton and Yorketown, with a third pharmacy established during 2007 in Port Vincent. In 2014, there were five pharmacies positioned in this region, one within each of the following UCLs: Minlaton, Port Vincent, Stansbury, Warooka, and Yorketown. Warooka was a PhARIA Category 5 for 2013/14.

Figure 12: Warooka UCL (SA)



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

Based on the analysis of UCL populations, PhARIA categories, pharmacy counts, and the average road distances to the next nearest pharmacy, these results suggest that the areas where no 1990 pharmacies were located, pharmacies in 2014 were present within UCLs that were predominantly non-urban or where UCL population growth was increasing thereby necessitating the establishment of new pharmacies. The average distance to the next nearest pharmacy was higher than the average distances realised in Table 10 across all non-urban areas suggesting pharmacies have been established in locations where geographic access was previously limited. Although individual examples from 8 of the 213 UCLs were explored in greater detail, further analysis is recommended to verify the patterns/trends identified.

### Research Task 8: Analyse and report on any UCL that had a pharmacy/pharmacies on 30 June 2007 but had no pharmacy as at 30 June 2014

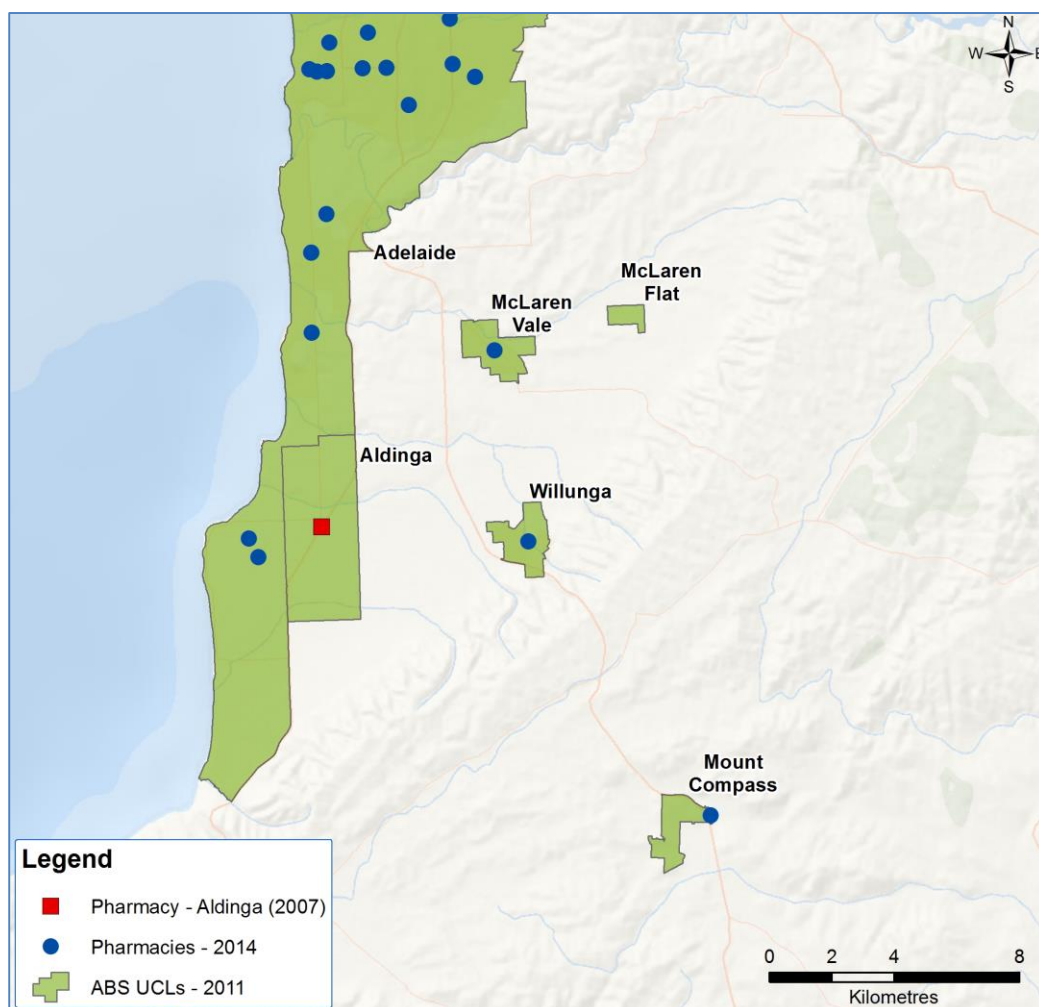
This research task considered changes to pharmacy locations between 2007 and 2014. As detailed in Research Task 7, changes in the location of pharmacies were analysed using the ABS UCL 2011 boundaries.

Similarly to Research Task 7, a spatial join was applied to determine the number of pharmacies within each of the 1,812 UCL boundaries having one or more pharmacies in 2007 that no longer had a pharmacy in 2014. These UCLs were: Aldinga (SA); Dampier (WA); Perisher Village (NSW); Snowtown (SA); and Tintenbar (NSW). Further analysis of these locations has been provided below. It should be noted within the context of this research task there was an overall increase of 442 pharmacies from 2007 to 2014, of which 55.66% of the 442 pharmacies were located in non-urban areas.

### **Aldinga (South Australia) PhARIA Cat 1 (2013/14)**

Aldinga became a locality (in accordance with the ABS UCL definition) in 2011 with a population of 447. Aldinga adjoins the southern section of the Adelaide 2011 UCL boundary as indicated in Figure 13. Aside from 2007, there was no pharmacy within the Aldinga boundary in 1990 or 2014. The nearest two pharmacies in 2007 were located 2km to the west in the southern section of the Adelaide UCL (within the suburb of Aldinga Beach) and Willunga 6.5km to the east (straight line distances). In 2014, two pharmacies were located at Aldinga Beach, and one remained in Willunga. Aldinga was a PhARIA Category 1 for 2013/14, positioned within the Adelaide 30km spatial buffer.

Figure 13: Aldinga UCL (SA)



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Dampier (Western Australia) PhARIA Category 6 (2013/14)**

Located towards the northern half of Western Australia on a small peninsula near Karratha, this UCL had one pharmacy in 1990 and 2007. Despite the UCL boundary expanding from 2006 to 2011 which had the potential to increase enumerated population counts, a decline in population was observed as indicated below:

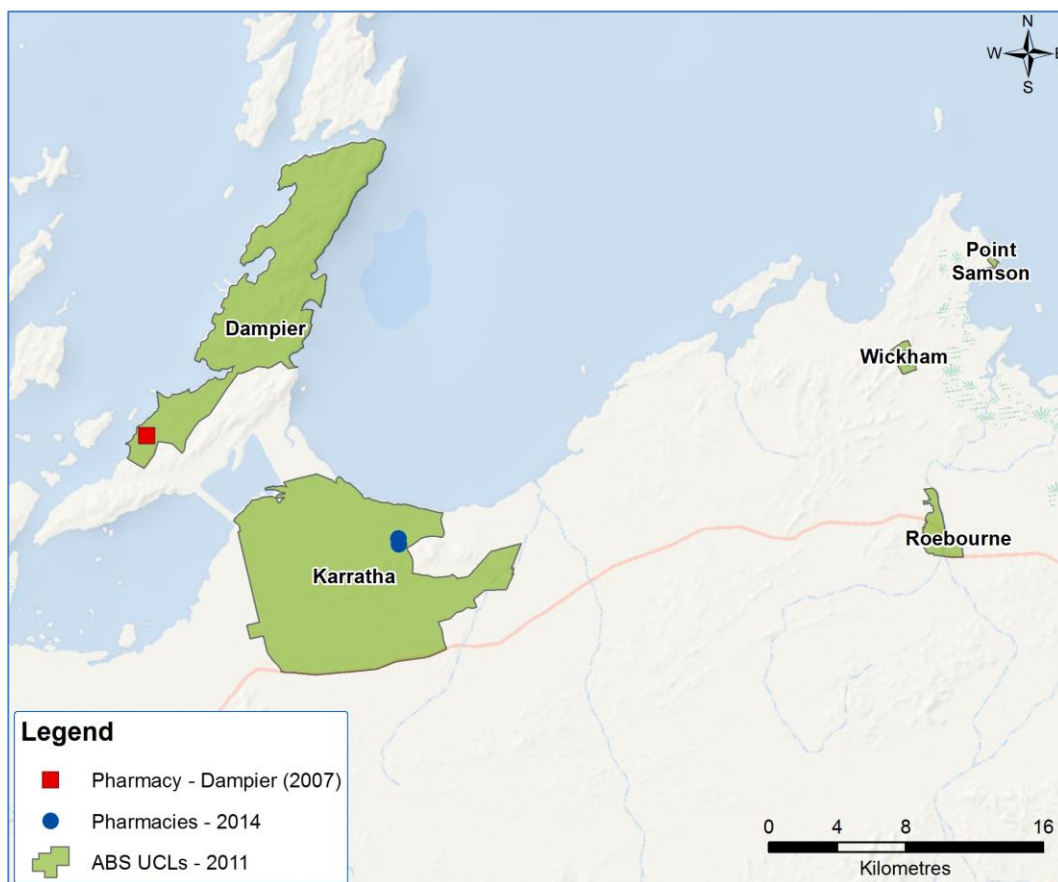
- 1991 = 1,819
- 2006 = 2,012
- 2011 = 1,803

The next nearest UCL is Karratha, positioned 5km (straight line distance) between the nearest edges of the Dampier and Karratha UCL boundaries. In contrast, Karratha has experienced an increase in population over time (notably in 2011) although this may be in part to an adjustment to the UCL boundary for 2011:

- 1991 = 11,313
- 2006 = 13,265
- 2011 = 20,058

Pharmacy numbers (2) for Karratha have remained constant for all three snapshot periods. Straight line distance to the nearest pharmacy in Karratha from the 2007 Dampier pharmacy location is 16km. Dampier was a PhARIA Category 6 for 2013/14. Figure 14 indicates the location of the 2011 UCL boundaries for Dampier, Karratha, Port Samson, Roebourne and Wickham.

**Figure 14: Dampier UCL (WA)**



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Perisher Valley (New South Wales) PhARIA Category 5 (2013/14)**

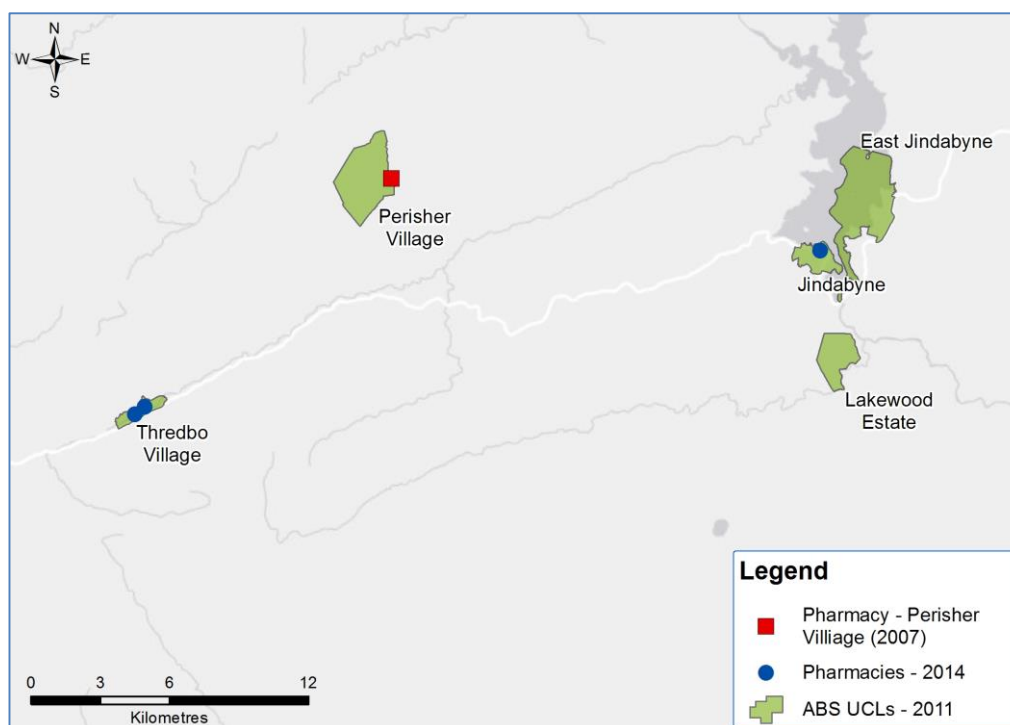
Located in the snowy mountains, Perisher Valley and the surrounding areas are popular winter holiday destinations. Nearby UCLs are Jindabyne and Thredbo Village which are 31.79km and 61.65km by road (based on distances between 2007 pharmacy locations). East Jindabyne and the Lakewood UCLs are also nearby, but there were no pharmacies located within these UCLs for any of the three snapshot periods. Given a potential visitor increase in population during the winter peak snow season, the enumerated population count indicated in Table 17 may not provide an accurate representation of the population reliant on pharmacy services at these locations.

Table 17: Enumerated Populations within Perisher Valley and Nearby UCLs

UCL	Enumerated Population		
	1991	2006	2011
Jindabyne	4,604	4,401	4,166
Perisher Village	1,719	2,027	2,010
Thredbo Village	2,065	3,172	2,876

Perisher Valley (PhARIA Category 5) had a local pharmacy in 1990 and 2007. Nearby pharmacies located in Thredbo Village (PhARIA Category 5) and Jindabyne (PhARIA Category 4) remained constant for all three snapshot periods, with the exception of Jindabyne where the pharmacy count went from two in 1990 to one in 2007. In 2014, the number of pharmacies in Thredbo Village increased from one to two with the new pharmacy trading under the same name as the pharmacy previously located in Perisher Valley, suggesting a pharmacy relocation to Thredbo Village occurred between 2007 and 2014 instead of a decrease in pharmacy services to this region. Figure 15 indicates the location of the 2011 UCL boundaries for Perisher Valley and the nearby UCLs of Jindabyne, Thredbo Village, East Jindabyne and Lakewood.

Figure 15: Perisher Valley UCL (Vic)



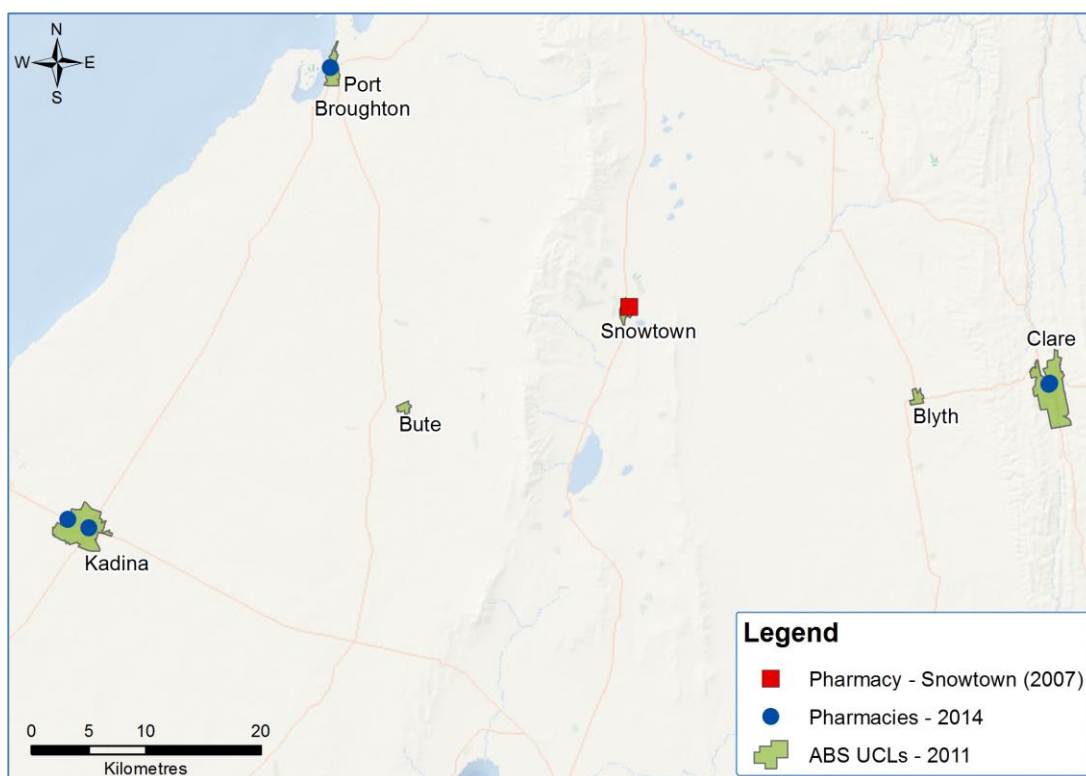
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Canvas/World Light Grey Base Map, 2015

### **Snowtown (South Australia) PhARIA Category 4 (2013/14)**

Located 37km west from Claire and 49km north-east from Kadina (straight line distances), this UCL had one pharmacy in 1990 and 2007. The UCL population has slightly declined over time from 433 in 1991, to 399 in 2006 and 386 in 2011. In contrast, the UCL populations of Claire and Kadina have all increased since 1991. The nearby UCL of Bute (21km straight line distance to the south-west of Snowtown) had a relatively stable population from 1991 to 2011, although there was a slight population decline experienced over this period from 275 to 246 with no pharmacy present in this location for all three snapshot periods. However, Port Broughton UCL comprised a pharmacy for all three snapshot periods over which time the UCL population increased from 678 in 1991 to 1,013 in 2011.

In 2014, the nearest pharmacies to Snowtown were Port Broughton, 33km and Claire, 36km (straight line distances). Snowtown is a PhARIA Category 4 along with Bute and Port Broughton, while the larger populations of Kadina and Claire were PhARIA Category 3 (2013/14). A map of this location features in Figure 16.

**Figure 16: Snowtown UCL (SA)**



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Tintenbar (New South Wales) PhARIA Category 2 (2013/14)**

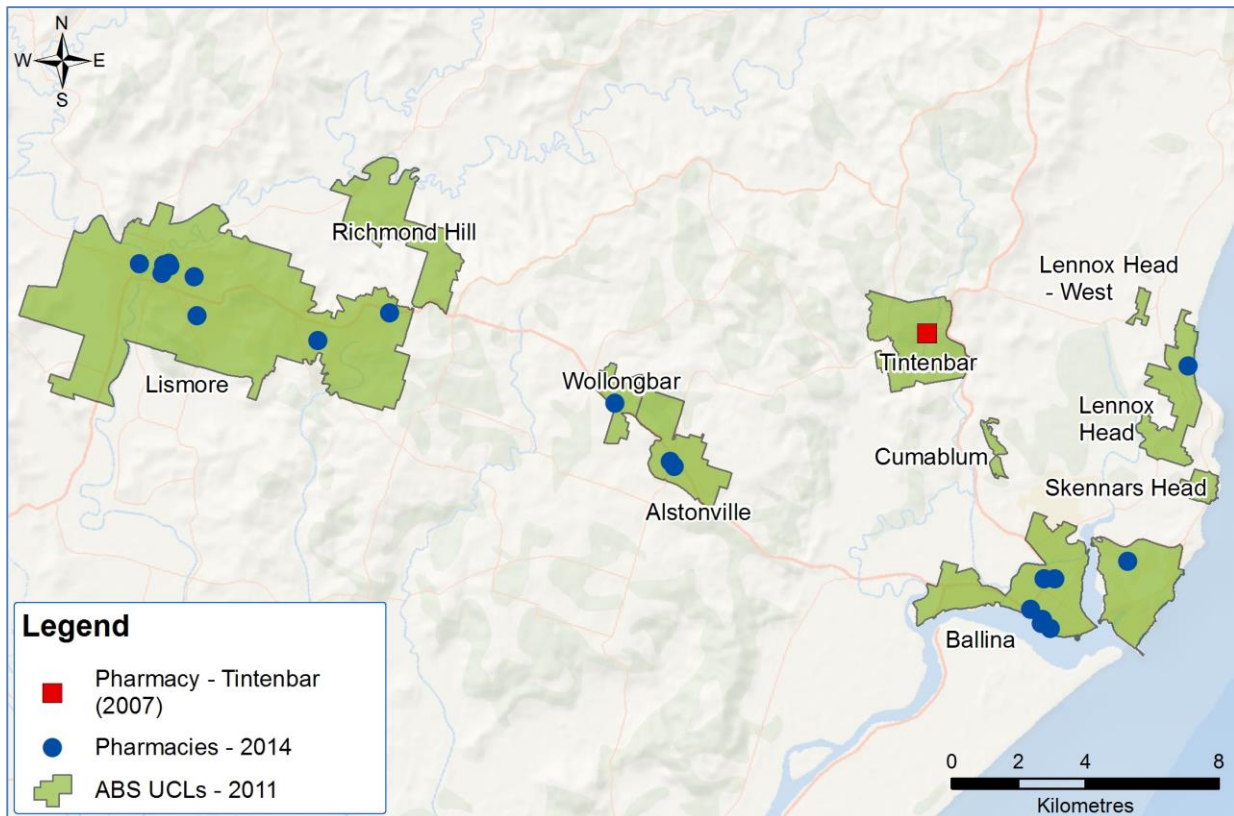
Located to the east of Lismore, Tintenbar is surrounded by a number of UCLs as indicated in Figure 17. The Tintenbar UCL comprised a pharmacy in 2007 but there were no pharmacies operating in 1990 and 2014. In 2014, there were 12 pharmacies within a 10km radius of Tintenbar, with the next nearest pharmacy located 8km to the east in Lennox Head (straight line distance).

Tintenbar did not feature in the ABS UCL dataset until 2011 (population in 2011 was 456). The combined populations of the nine nearby UCLs featured in Figure 17 for 2011 was 60,109, with

Lismore comprising 46.30% of this combined population. These UCLs have experienced population growth from 1991 when the combined population was 49,782 (although the UCLs of Cumablum, Lennox Head-West, Richmond Hill, and Skennars Head did not feature in 1991) while the count of pharmacies (21) in this region has remained constant for all three snapshot periods.

Tintenbar is PhARIA Category 2 (2013/14). Given the population of Lismore, a 10km PhARIA spatial buffer surrounds Lismore and includes Alstonville, Richmond Hill, and Wollongbar (PhARIA Category 1) while the “8 pharmacy rule” applies to Ballina (PhARIA Category 1).

Figure 17: Tintenbar UCL (NSW)



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

Based on the exploratory analysis undertaken for the five UCLs of Aldinga (SA); Dampier (WA); Perisher Village (NSW); Snowtown (SA); and Tintenbar (NSW), there are a number of possible reasons why pharmacies in these five UCL locations for 2007 were no longer operating at 30 June 2014. Some potential influencing factors may be the low PhARIA classifications and other pharmacies located close by (in the case of Aldinga and Tintenbar). Possible reasons for no pharmacies in Snowtown and Dampier in 2014 may be due to small local populations while nearby pharmacies existed in larger populated areas. Reasons for the change observed regarding the Perisher Valley example appears to be the result of a relocation of this pharmacy to a nearby UCL rather than a decrease in pharmacy services to the region.

## Research Task 9: Analyse and report on any UCL that had one or more pharmacies in 1990 but had no pharmacy as at 30 June 2014.

This research task considered changes to pharmacy locations between 1990 and 2014. As detailed in Research Task 7, changes in the location of pharmacies were analysed using the ABS UCL 2011 boundaries.

Similarly to Research Task 7, a spatial join was applied to determine the number of pharmacies within each of the 1,812 UCL boundaries for 2011 that had one or more pharmacies in 1990 but had no pharmacies in 2014. Comparisons were then made between these time periods, identifying 25 UCLs, of which 24 have populations less than 2,600 persons as indicated in Table 18. This finding may be influenced by small local UCL populations which may challenge the financial viability of pharmacies at these locations. However, there are some UCLs where population growth has been experienced over time, namely Beaconsfield Upper, Beerwah, Mission Beach, Wyee Point, and Yallourn North. These locations have been explored in more detail (below).

Table 18: UCLs with one or more pharmacies in 1990 but without a pharmacy in 2014

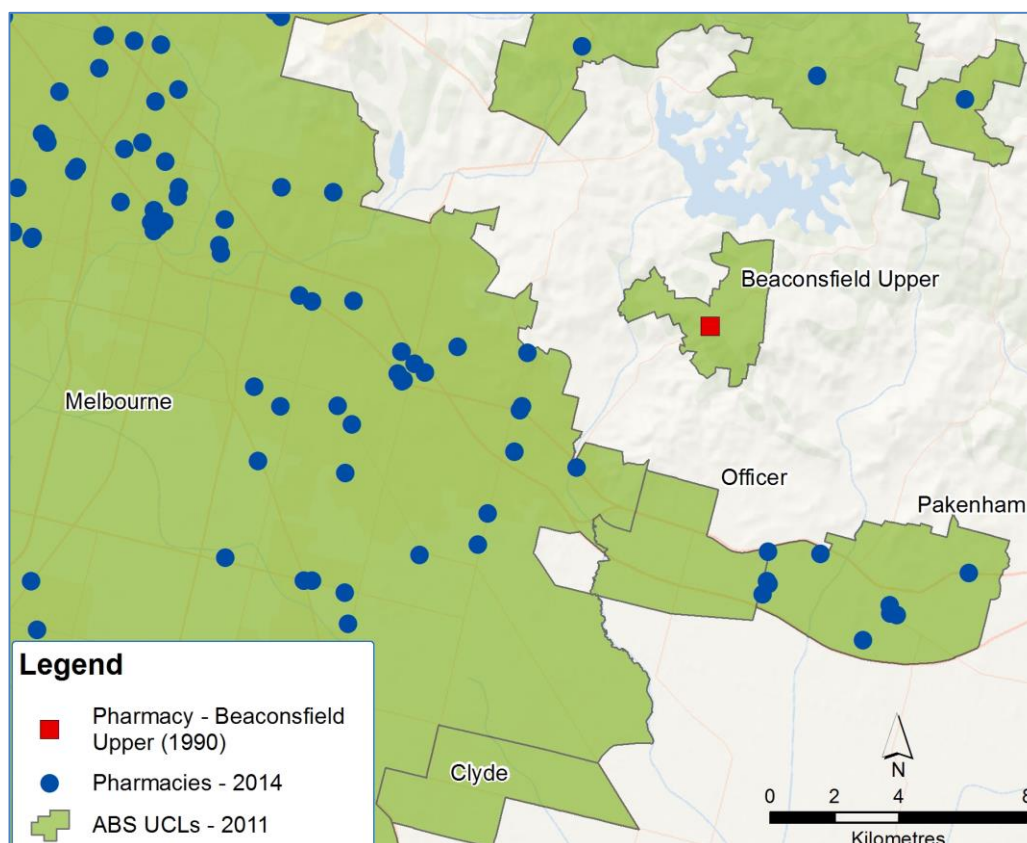
UCL 2011	State/Territory	1990 Pharmacy Count	UCL Enumerated Populations		
			1991	2006	2011
Beaconsfield Upper	Victoria	1	825	1,415	2,161
Beerwah	Queensland	2	1,092	1,617	4,326
Bodalla (L)	New South Wales	1	323	300	287
Dampier	Western Australia	1	1,819	2,012	1,803
Emmaville (L)	New South Wales	1	377	236	315
Falls Creek (L)	Victoria	1	Not defined as UCL	2,619	2,503
Hall (L)	Australian Capital Territory	1	303	296	316
Jabiru (L)	Northern Territory	1	1,741	1,848	1,849
Lismore (L)	Victoria	1	324	262	283
Mallala (L)	South Australia	1	585	714	732
Manangatang (L)	Victoria	1	300	275	257
Mission Beach (L)	Queensland	1	815	879	1292
Morgan (L)	South Australia	1	447	397	305
Mount Hotham (L)	Victoria	1	Not defined as UCL	2,573	2,460
Omeo (L)	Victoria	1	274	276	282
Penshurst (L)	Victoria	1	485	441	456
Perisher Village (L)	New South Wales	1	1,719	2,027	2,010
Seville East (L)	Victoria	1	Not defined as UCL	614	666
Snowtown (L)	South Australia	1	433	399	386
Stanhope (L)	Victoria	1	550	497	467
Stanwell Park	New South Wales	1	1,081	1,365	1,327
Tangambalanga (L)	Victoria	1	319	425	423
Wyalkatchem (L)	Western Australia	1	409	329	311
Wyee Point	New South Wales	2	257	799	1039
Yallourn North	Victoria	1	UCL not defined. Featured as part of Moe UCL	1,123	1,305



### **Beaconsfield Upper (Victoria) PhARIA Category 1 (2013/14)**

Located 2km (straight line distance) east of the Melbourne UCL boundary, population growth in this region over time has seen the inclusion of smaller UCLs within the Melbourne UCL boundary. Since 1991, although the UCL boundary for Beaconsfield Upper has increased in area, the UCL population has doubled from 825 in 1991 to 2,161 in 2011. There were no pharmacy in this location in 2007 as well as 2014, but there are a large number of pharmacies nearby, with an average road distance of 4.74km to the nearest five pharmacies from the 1990 pharmacy location. As illustrated in Figure 18, there appears good access to pharmacies from this UCL. Beaconsfield Upper is positioned within the PhARIA 30km spatial buffer of Melbourne, with a PhARIA Category 1 classification for 2013/14.

Figure 18: Beaconsfield Upper UCL (Vic)



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

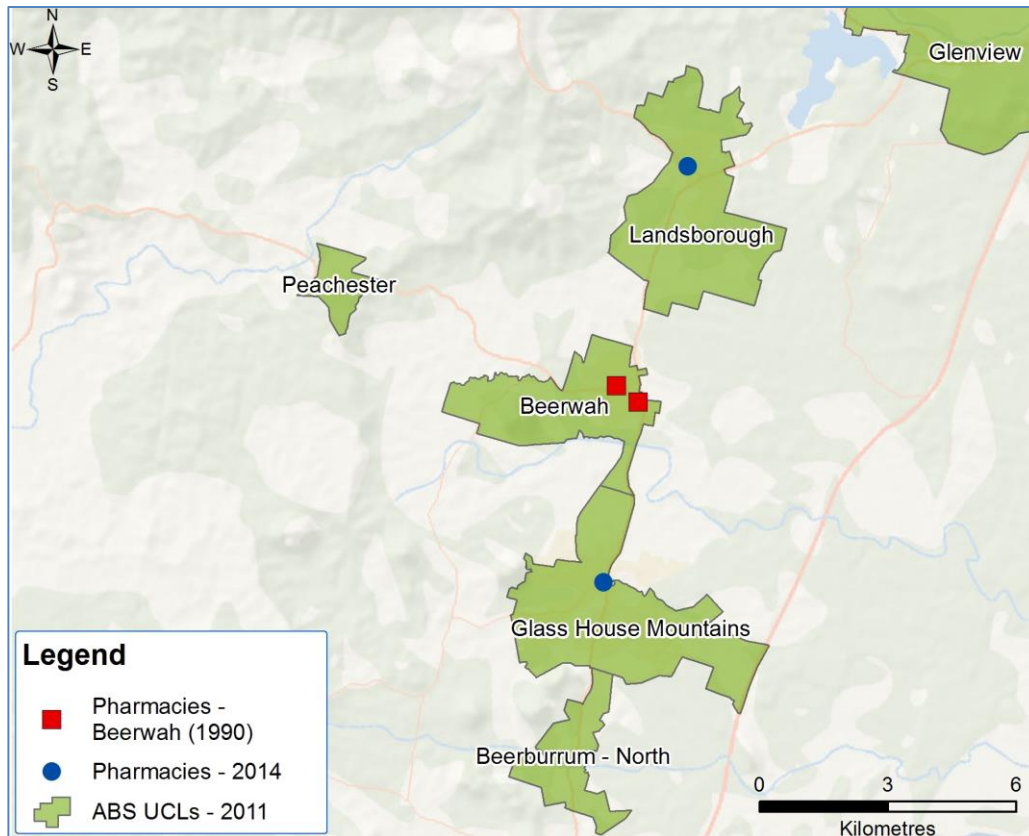
### **Beerwah (Queensland) PhARIA Category 1 (2013/14)**

Located 14km north of Brisbane and 12km south-west from the Sunshine Coast (straight line distances), Beerwah is positioned between Landsborough and Glass House Mountains UCLs, as indicated in Figure 19.

Beerwah had a 1991 enumerated population of 1,092 which increased to 1,617 in 2006 and 4,362 in 2011. However, the UCL area also increased for each census period, particularly from 2006 to 2011 which makes comparisons difficult, but may also be reflective of residential development resulting in population growth within this area. Similar increases have been experienced in the surrounding UCLs of Landsborough and Glass House Mountain. In 1990 there were two pharmacies located within Beerwah, but no pharmacies in 2007 and 2014. However, both Landsborough and Glass House Mountain retained their pharmacies across all three snapshot periods.

The distance from the 1990 pharmacies to the nearest 2014 pharmacies is 5km to Landsborough in the north and 4.5km to Glass House Mountain in the south (straight line distances), suggesting relatively good geographical access in two opposing directions. This location is a PhARIA Category 1 (2013/14), positioned within the Brisbane/Gold Coast/Tweeds Head 30km spatial buffer.

Figure 19: Beerwah UCL (Qld)



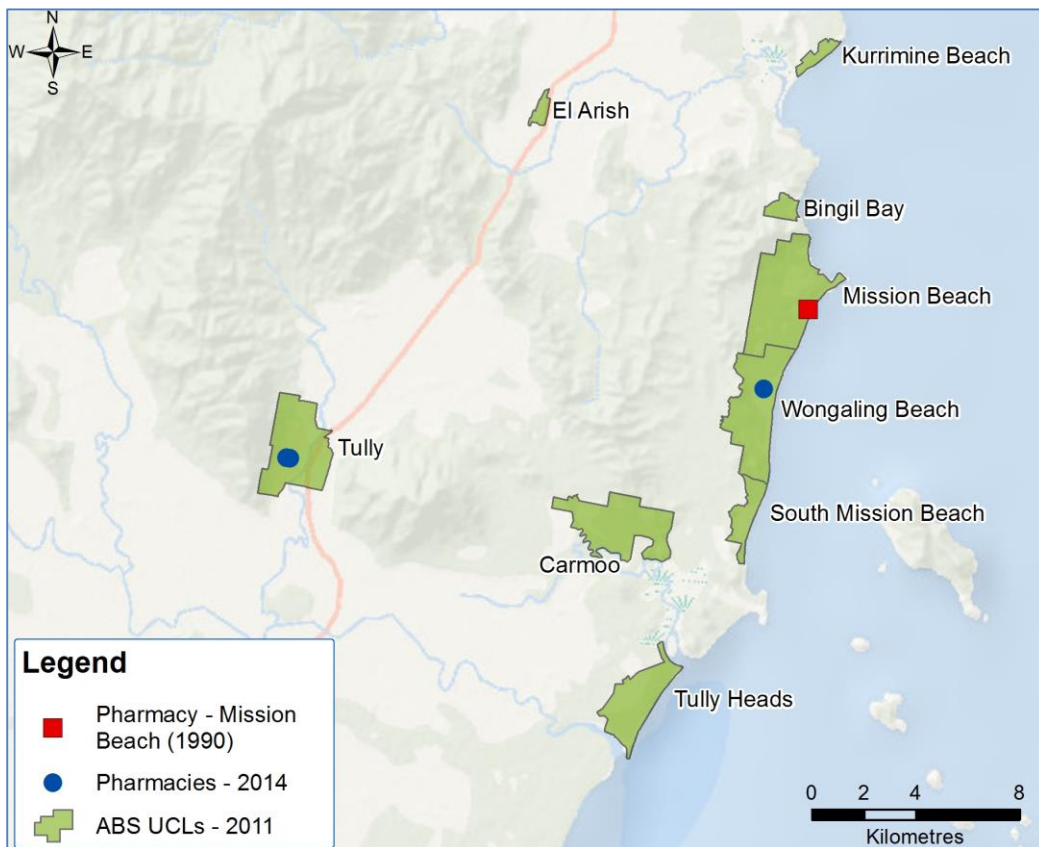
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Mission Beach (Queensland) PhARIA Category 4 (2013/14)**

Mission Beach is located along the eastern coast of Queensland, with Cairns to the north (121km) and Townsville to the south (214km) based on straight line distances. The 2011 Mission Beach UCL borders Wongaling Beach (adjoining the Mission Beach UCL, directly south) with Tully (the next largest populated UCL in proximity to Mission Beach) located 15km south-west (straight line distance). The Mission Beach UCL population was 815 in 1991, 879 in 2006 and 1,292 in 2011. Taking into consideration the increase in UCL area over this time (most noticeably in 2011), the population in this location appears to have remained relatively stable since 1991.

In 1990, there were three pharmacies located in this region, two in Tully and one at Mission Beach. In 2007, a new pharmacy was located in the larger UCL of Wongaling Beach which may have been the result of a relocation of the Mission Beach pharmacy. Pharmacy counts in Tully and Wongaling Beach remained consistent from 2007 to 2014 (two and one respectively). Taking into consideration the relatively stable population and pharmacy count in this region from 1990 to 2014, geographical access to pharmaceutical services remain mostly unchanged. Mission Beach is a PhARIA Category 4 (2013/14). Figure 20 show the location of Mission Beach and surrounding UCLs.

Figure 20: Mission Beach UCL (Qld)



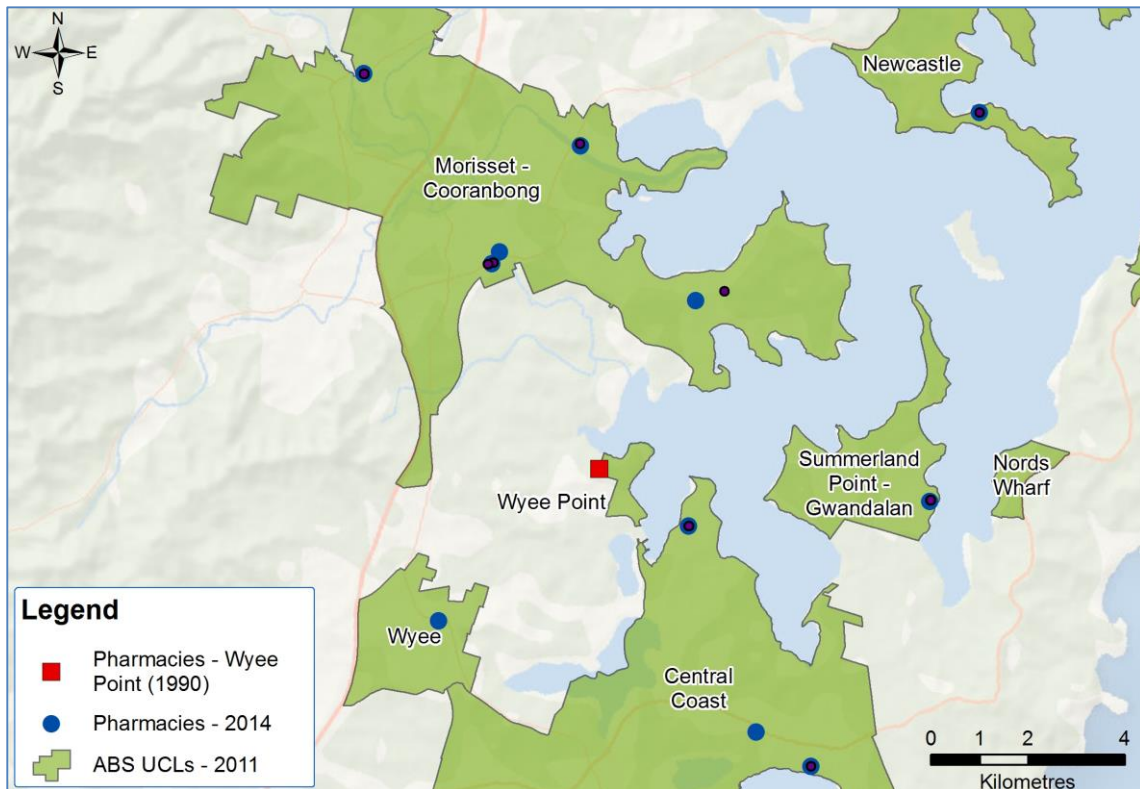
Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

### **Wyee Point (New South Wales) PhARIA Category 1 (2013/14)**

Less than 300 metres north from the Central Coast (based on the nearest UCL boundaries) and 3.5km south of Morisset-Cooranbong UCL (straight line distances), the 1991 UCL population for Wyee Point was 257. In 2006 and 2011, the population increased to 799 and 1,039 respectively, in line with the increasing UCL boundary. More noticeably was the population change and expanding boundary of the Central Coast UCL, increasing by 97,071 persons from 1991 to 2011. Coinciding with this population increase, the pharmacy count within the Central Coast increased from 65 in 1990 to 81 in 2014.

In 2014, the nearest pharmacies from the 1990 location were positioned 2km to the Central Coast and 4.5km to nearby Wyee and Morisset-Cooranbong UCLs (straight line distances). Wyee Point is a PhARIA Category 1, positioned within the Newcastle 30km spatial buffer. A map of Wyee Point and the surrounding UCLs feature in Figure 21.

Figure 21: Wyee Point UCL (NSW)



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

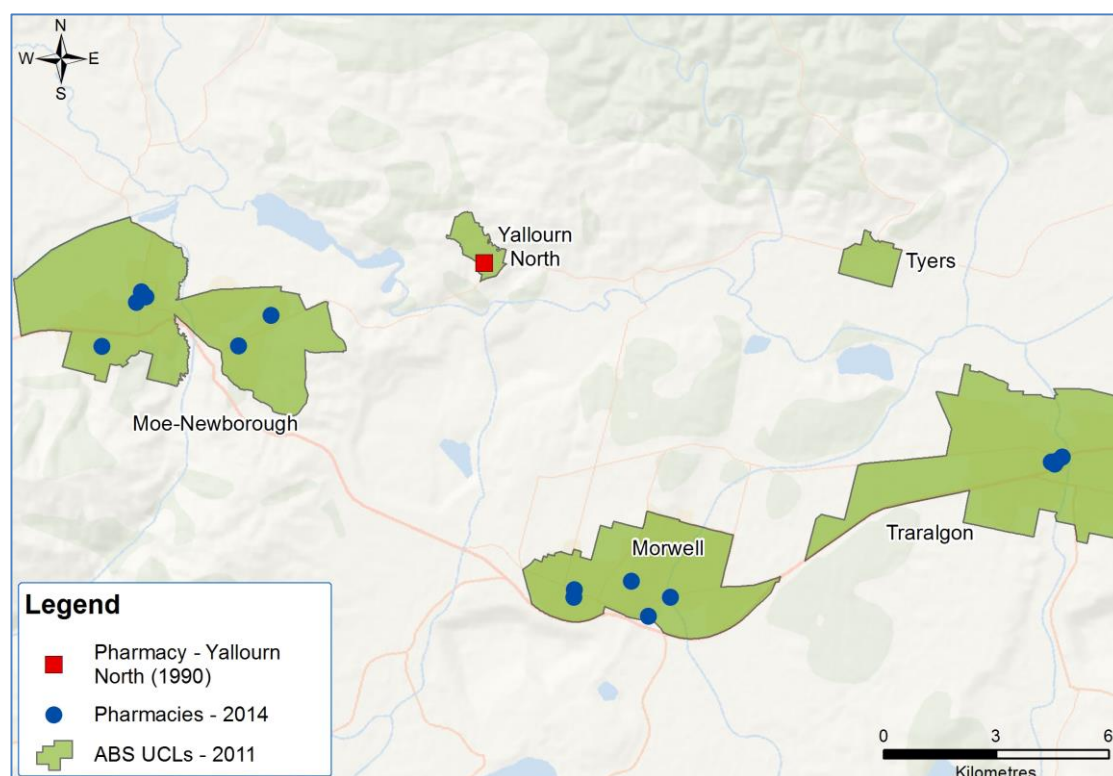
### **Yallourn North (Victoria) PhARIA Category 2 (2013/14)**

Yallourn North is surrounded by the UCLs of: Moe-Newborough (4km south-west); Tyers (9km east); Morwell (7.5km south-east); and Traralgon (10.5 km south-east), based on straight line distances. The combined population of these UCLs initially decreased from 53,325 in 1991 to 51,192 in 2006, before increasing slightly to 54,008 in 2011, suggesting a relatively stable population over time. The Yallourn North UCL in 1991 formed part of Moe-Newborough (previously called Moe-Yallourn), which makes population comparisons difficult between the 1990 and 2007 snapshot periods.

The number of pharmacies in this region has remained relatively stable over the snapshot periods, with 17 in 1991, 14 in 2007, and 15 in 2011. Specific to Yallourn North, there has been no pharmacy in this UCL since 1990, with all 15 pharmacies in 2014 located within a 16.5 km radius from the 1990 pharmacy location. The nearest pharmacies to Yallourn North are located 6km and 7km (straight line distance) in Moe-Newborough.

Yallourn North is in PhARIA Category 2 while the UCLs of Tyers and Morwell are PhARIA Category 1 (2013/14). Morwell and Tyers fall within the Traralgon 10km spatial buffer while Yallourn is 2km north-west from this spatial buffer. A map of Yallourn North and the surrounding UCLs feature in Figure 22.

Figure 22: Yallourn North UCL (Vic)



Data Sources: ABS UCL Boundaries, 2011; Department of Health Pharmacy Locations, 2015; ESRI et al., Oceans Base Map, 2014

Based on the analysis undertaken for this research task, it is possible that small UCL populations are a prominent factor impacting the loss of pharmacies from 1990 to 2014 for the 25 UCLs identified in Table 18. Observations derived from the five UCLs explored in more detail above suggest UCLs which had good access to nearby pharmacies accounted for the loss of a pharmacy within the UCL since 1990, with the exception of Mission Beach where it appears likely the 1990 pharmacy had relocated to a nearby UCL.

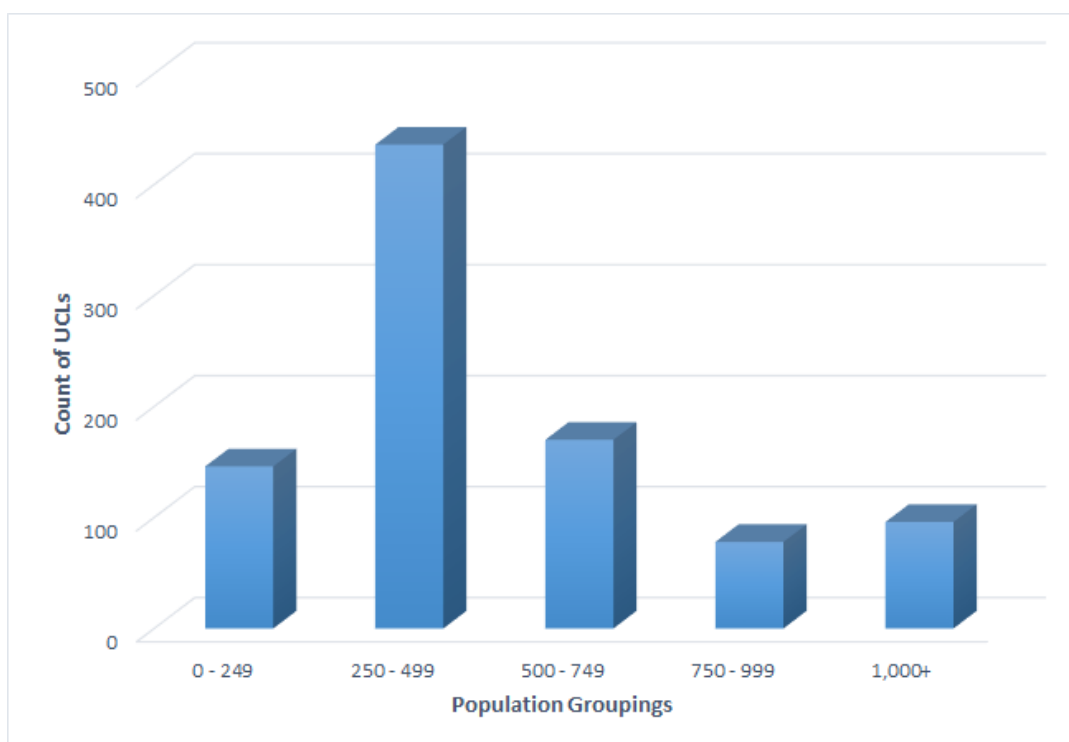
### Research Task 10: Analyse and report on non-urban area access to pharmacies, highlighting areas with a single pharmacy in 2014

This research task considered non-urban area access to pharmacies based on the geocoded pharmacy locations for the snapshot period 30 June 2014. UCLs (excluding Remainder of State/Territory, Migratory, Offshore, Shipping, and No Usual Address) were used to identify non-urban areas in accordance with the rationale outlined in Research Task 3. Access to a pharmacy was defined in terms of the presence of a pharmacy within a non-urban UCL boundary, with a spatial join undertaken to determine the number of pharmacies (as at 30 June 2014) located within each non-urban UCL.

Further to the rationale discussed in Research Task 3, it was deemed important to prevent instances where a UCL boundary may exclude a pharmacy due to its location slightly beyond a given UCL boundary (for example, on the opposite side of a major road used to define the UCL boundary). Two worksheets have been included in Appendix 5 to highlight the names and postcodes of pharmacies located less than 2km (n=21) from the nearest UCL as well as any 2014 snapshot pharmacies located more than 2km from the nearest UCL (n=11). For the purpose of this research task, the 21 pharmacies identified less than 2km from the nearest UCL have been assigned to their nearest UCL.

For this research task, there were 1,782 non-urban UCLs identified, comprising a total enumerated population of 4,067,998 persons based on the 2011 census. Of the 1,782 non-urban UCLs, there were 856 UCLs with one or more pharmacies (48.04%) representing pharmacy access to 3,552,722 persons or 87.33% of the non-urban UCL population. Of the remaining 926 UCLs without a pharmacy, 89.63% of these UCLs had a population of less than 1,000 persons. Figure 23 indicates the proportion of UCLs with no pharmacies by population groupings, of which UCLs comprising populations of 250-499 dominate.

Figure 23: Non-urban UCLs without a 2014 pharmacy by population



Of the 856 UCLs with one or more pharmacies, 616 of these UCLs were identified as having access to a single (local) pharmacy. Table 19 offers a summary of the UCL counts by State/Territory and the percentage of UCLs identified with one or more pharmacies as well as those with a single pharmacy and no pharmacy as at 30 June 2014. Appendix 5 identifies the 1,782 non-urban UCLs with associated populations and pharmacy counts, including a separate list of all single pharmacy UCLs.

Table 19: Count of UCLs with presence/absence of pharmacies by State/Territory in 2014

State/Territory	Two or More Pharmacy UCLs	Single Pharmacy UCLs	No Pharmacy UCLs	Non-Urban UCLs
ACT	0	0	1	1
New South Wales	85	187	257	529
Northern Territory	2	4	59	65
Other Territories	0	1	3	4
Queensland	48	125	229	402
South Australia	22	74	70	166
Tasmania	11	35	51	97
Victoria	52	120	173	345
Western Australia	20	70	83	173
<b>Total</b>	<b>240</b>	<b>616</b>	<b>926</b>	<b>1,782</b>

Although these research task findings offer insight into non-urban area access to pharmacy services, further analysis is recommended to determine the extent to which small UCL populations without a pharmacy have appropriate geographic access to their nearest pharmacy.

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## 5. Conclusion

This report was intended to provide insight into the ten research questions proposed by the Department relating to the themes of geographic access, spatial clustering of pharmacies, and broader analysis with respect to pharmacy locations. Although a number of the research task outcomes suggest that the spatial clustering of pharmacies has reduced in urban areas while geographic access to pharmacies in non-urban areas has improved from 2007 to 2014, there may be other factors beyond the scope of this research report influencing these outcomes and therefore, warrant further investigation. These findings would also benefit from a more in-depth analysis of spatial clustering in addition to further consideration regarding the concept of service access, which extends beyond measures of geographic distance and proximity.

All calculations undertaken as part of this report have been provided to the Department including key datasets for further use by the Department. APMRC recommends that the accurate capture and recording of pharmacy address data be considered a priority for service planning, future research opportunities, and to further inform the dissemination of funding via government incentive programs.

A number of assumptions and analysis decision were made regarding the ten research questions considered. Below is a list of potential areas for further analysis and the assumptions applied to address the ten research tasks within this report:

- Despite Australia's increasing population over the three snapshot periods, the total number of pharmacies in 2014 was slightly less than the total number of pharmacies in 1990. Although there was an increase in pharmacy numbers from 2007 to 2014, there was a notable decline experienced from 1990 to 2007. Further analysis is recommended into the potential factors contributing to this decline;
- Further analysis of the relationship between pharmacy location and socio-economic status would benefit from the utilisation of other datasets in conjunction with other research approaches not specifically based on the physical location of pharmacies (e.g. the type and frequency of medications purchased by household incomes);
- ARIA+ population breakpoint categories were used to represent an urban boundary. Other data sources exist which could have been used for this purpose, including the ABS Greater Capital City Statistical Areas or the ABS Section of State dataset. In addition, care should be taken when analysis conducted over different time periods references geographic areas applicable to only one specific period of time (i.e. 2011 UCL boundaries and the 2013/14 PhARIA categories);
- Application of a 2km distance buffer around Cat A and B UCL boundaries representing urban areas and UCL boundaries in non-urban areas (Research Task 10) may be viewed as an overcomplicating aspect. However, it was deemed important to account for boundary edge effects when data is aggregated to administratively defined areas;
- UCLs were used to identify areas where pharmacy changes have occurred over time. Other spatial and statistical analyses exist to consider different degrees of spatial clustering that do not rely on the application of administrative or census derived boundaries; and
- PhARIA categories in this report were assigned based on the 1km PhARIA interpolated surface and the geocoded street address of each pharmacy. Although this is a slight deviation from the process used to assign PhARIA categories, it was estimated to have had minimal impact on the accuracy of PhARIA category assignments, particularly for the purposes of this report.

APMRC would like to thank the Department for the opportunity to undertake this exploratory analysis. Please direct any further enquiries to [jarrod.lange@adelaide.edu.au](mailto:jarrod.lange@adelaide.edu.au)



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