Rous County Council Bulk Water Supply

Demand Forecast: 2020 - 2060

Final Report

October 2020

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JOB# 20-014: ROUS COUNTY COUNCIL DEMAND FORECAST 2020 - 2060

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0	Draft for RCC Review	R. Campbell	M. Howland	M. Howland	6 April 2020
1	Updated with RCC comments	R. Campbell		R. Campbell	16 April 2020
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3	Updated with DPIE comments	R. Campbell	M. Howland	M. Howland	26 October 2020

EXECUTIVE SUMMARY

Rous County Council (RCC) is undertaking strategic planning to ensure future water supply security for the Rous regional bulk supply area. The purpose of this report is to provide a demand forecast for the bulk supply area from the present to 2060 that incorporates a range of information including:

- Water consumption.
- Regional growth predictions.
- Demand management/water efficiency.
- Advice from RCC and its constituent councils.

This report provides data and calculations for:

- The existing number of connected properties.
- The current average and dry year water consumption for each connection type.
- The predicted future growth for each connection type.
- The predicted future consumption trends for each connection type.
- The future (2020 to 2060) dry year and average demand forecast.

Datasets are provided for each constituent council area, the RCC retail supply area and the RCC bulk supply area as a whole. Assumptions used in this report have been developed from data provided by RCC and the constituent councils, NSW Department of Planning, Industry and Environment (DPIE) and other publicly available information. This report provides a review and update of the long-term water supply demand forecast prepared in 2013.

The Rous regional bulk supply currently services 41,868 connected residential properties and 5,114 connected non-residential properties (total 46,982 connections). By 2060, the Rous regional bulk supply is predicted to serve 57,561 connected residential properties (based on estimated lot yields) and 9,361 connected non-residential properties (total 66,922 connections). The breakdown of connections in each five-year period is shown on Figure 1.

The Rous regional bulk supply currently produces 11,300 ML/a (five-year average). The predicted average demand per connection has been estimated for each connection type in each supply area. Dry year demand per connection has also been estimated based on climate correction of bulk supply demand. Future demand predictions have been developed from the growth predicted in the region (two growth scenarios for Ballina Shire and one growth scenario for other supply areas as provided by the constituent councils) and predicted water loss reduction (nil savings – using current water losses and savings predicted by the council water loss management plans) as follows:

- Scenario 1A: Revised forecast dry year demand (estimated Ballina lot yield, current water losses).
- Scenario 1B: Revised forecast dry year demand (upper estimated Ballina lot yield, current water losses).
- Scenario 2A: Revised forecast dry year demand (estimated Ballina lot yield, reduced water losses).
- Scenario 2B: Revised forecast dry year demand (upper estimated Ballina lot yield, reduced water losses).

The dry year demand for water in 2060 is predicted to be between 15,900 ML/a and 16,700 ML/a, an increase of approximately 5,000 ML/a over current demand.

Figure 2 shows the predicted future demand profile, not including any allowances for climate variation or additional demand management initiatives for Scenario 1A (estimated Ballina lot yield and current water losses). The four demand scenarios are compared to the 2013 forecast demand in Figure 3.

RCC's future water supply planning will also consider the potential connection of the constituent council local water supply areas (Wardell, Mullumbimby, Casino and Nimbin) to the Rous regional supply.

The annual demand in each five-year period for each scenario (current supply area) and the local supply areas are provided in Table 1.

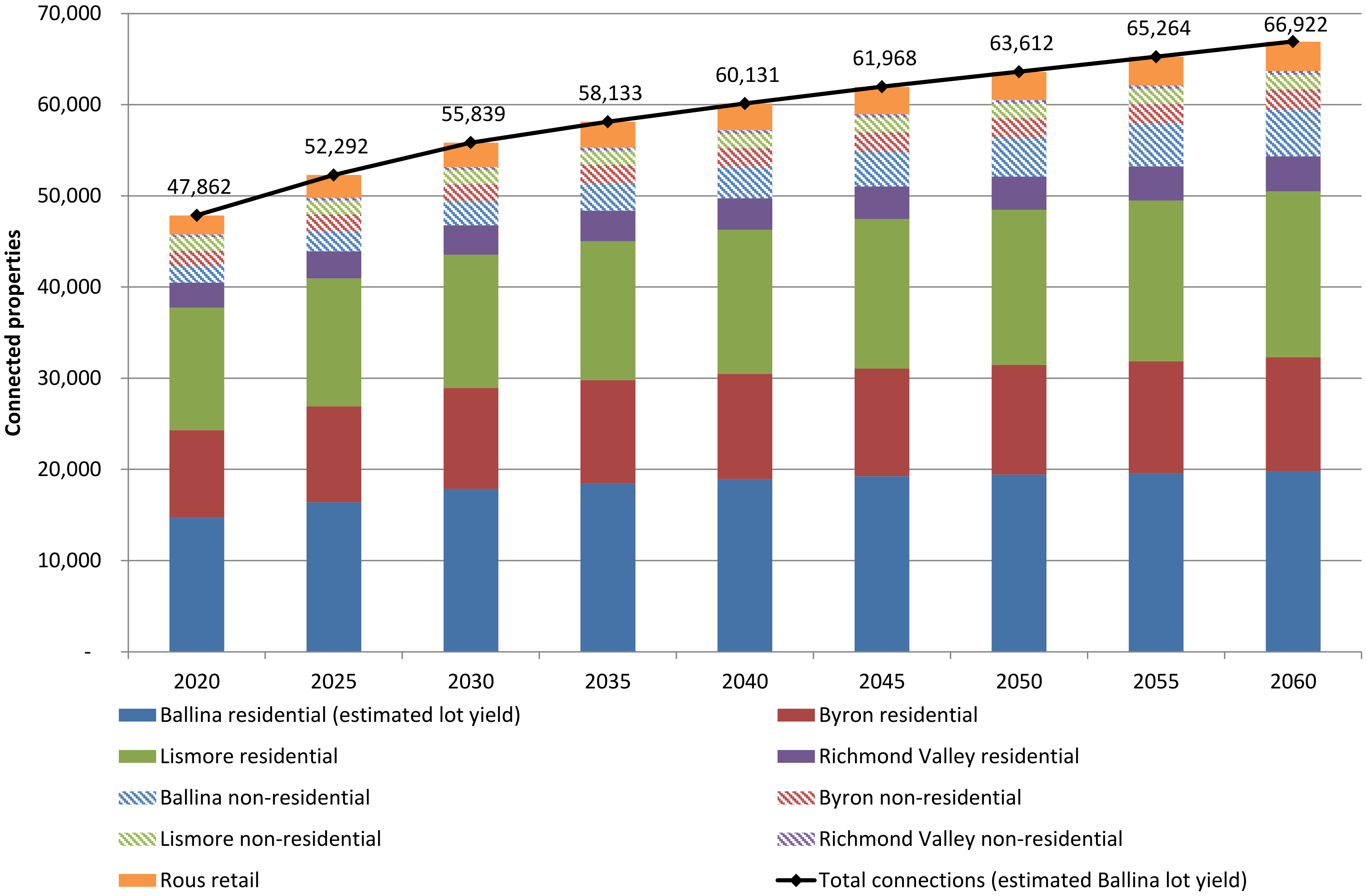

Figure 1: Forecast connected properties – Rous bulk supply area

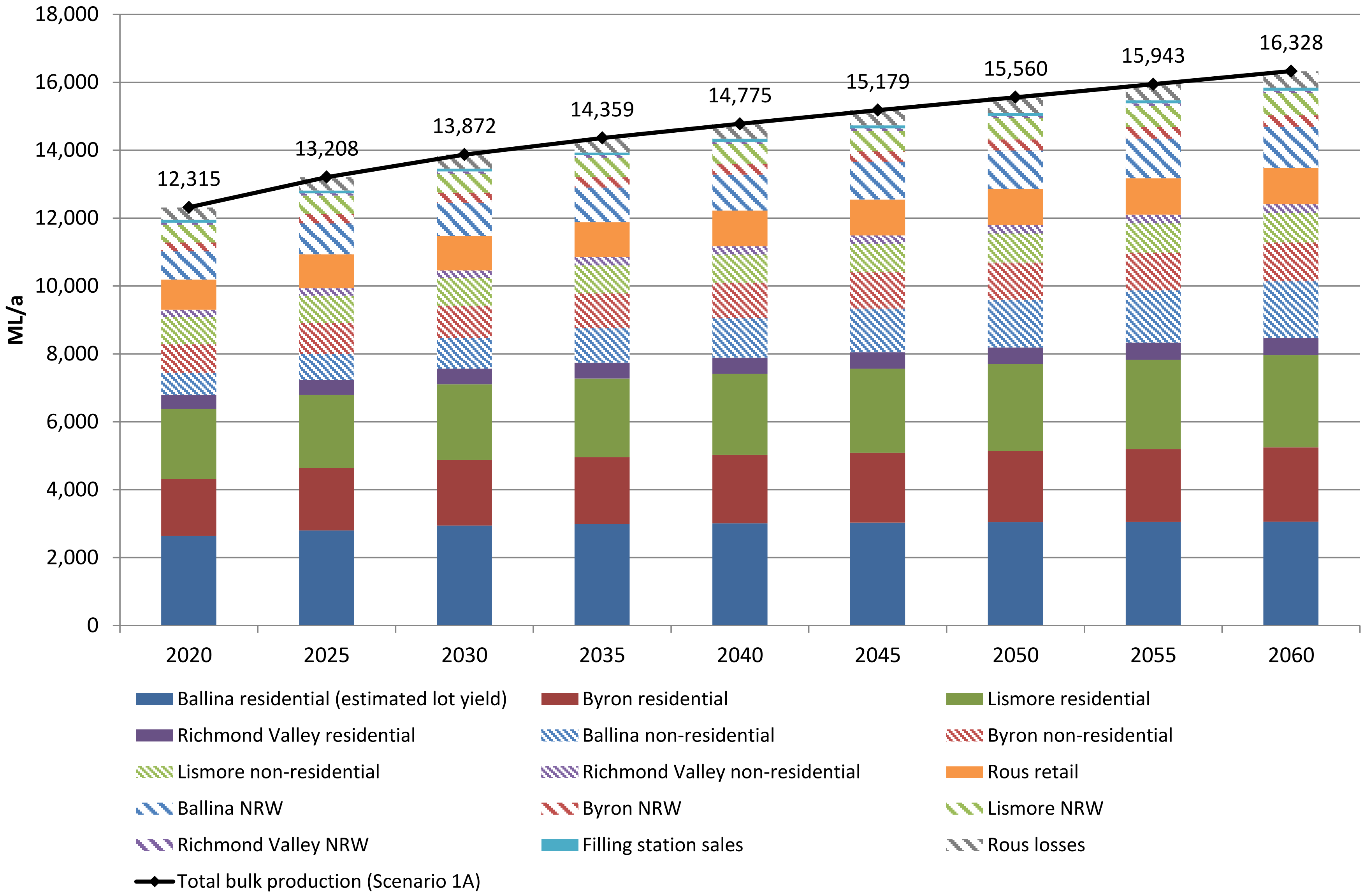

Figure 2: Forecast dry year demand (bulk production): Scenario 1A (estimated Ballina lot yield and current water losses) – Rous bulk supply area

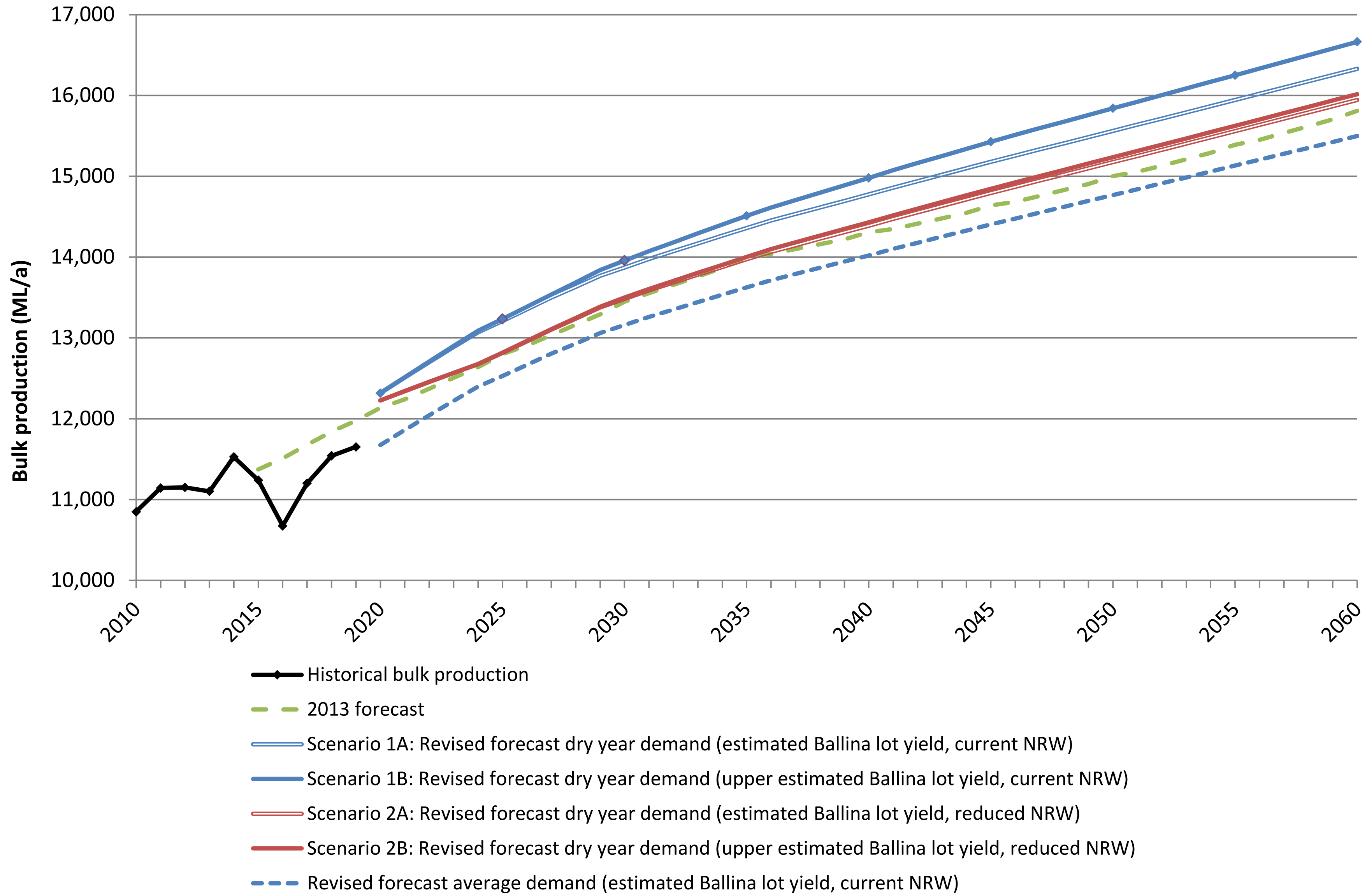

Figure 3: Forecast demand (bulk production) scenarios and comparison with the 2013 forecast – Rous bulk supply area

Table 1: Dry year demand forecast scenarios – Rous bulk supply area (ML/a)

Scenario	2020	2025	2030	2035	2040	2045	2050	2055	2060
Existing bulk supply area									
Scenario 1A: Revised forecast dry year demand (estimated Ballina lot yield, current water losses)	12,315	13,208	13,872	14,359	14,775	15,179	15,560	15,943	16,328
Scenario 1B: Revised forecast dry year demand (upper estimated Ballina lot yield, current water losses)	12,319	13,233	13,956	14,510	14,979	15,426	15,840	16,250	16,664
Scenario 2A: Revised forecast dry year demand (estimated Ballina lot yield, reduced water losses)	12,225	12,814	13,483	13,972	14,388	14,793	15,175	15,557	15,942
Scenario 2B: Revised forecast dry year demand (upper estimated Ballina lot yield, reduced water losses)	12,226	12,817	13,498	14,002	14,430	14,845	15,235	15,624	16,015
Local supplies									
Wardell	175	188	200	213	225	238	250	263	275
Mullumbimby	462	500	547	588	638	685	733	785	841
Casino	2,342	2,344	2,348	2,354	2,361	2,371	2,382	2,395	2,410
Nimbin	69	71	74	76	78	81	83	86	88

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FIGURES

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1. INTRODUCTION

Rous County Council (RCC) previously developed a long-term water supply demand forecast in 2013 (Hydrosphere Consulting, 2013a) as part of the development of its Future Water Strategy (FWS). RCC is reviewing and updating the FWS (Rous Future Water Project 2060) to ensure future water supply security for the bulk supply areas. As part of this strategic planning, a review of the likely future demand for water is required.

This report presents revised data for the bulk water supply areas as follows:

- Existing number of connections for each connection type in each supply area.
- Current average water consumption for each connection type.
- Current water demand profile.
- Predicted future growth for each connection type in each supply area.
- Predicted future consumption trends for each connection type.
- Future (2020 to 2060) bulk supply demand forecast.

Assumptions used in this report have been developed from data provided by RCC and the constituent councils, NSW Department of Planning, Industry and Environment (DPIE) and other publicly available information.

The assumptions used in this report are based on the current knowledge of water supply connections and demand and predicted growth. It is acknowledged that there is significant uncertainty that will result from long-term predictions and ongoing monitoring and modification of the forecast will be required.

2. BULK AND RETAIL WATER SUPPLY SERVICE AREAS

RCC provides bulk water to four local water utilities (LWUs) on the far north coast of NSW, servicing the urban areas of the following constituent council local government areas (LGA):

- Ballina Shire Council (BaSC), excluding Wardell and surrounds.
- Byron Shire Council (BySC), excluding Mullumbimby.
- Lismore City Council (LCC), excluding Nimbin.
- Richmond Valley Council (RVC), excluding Casino and all land west of Coraki.

RCC also provides water supply services to rural and urban connections direct from the bulk supply trunk main system (retail customers).

The RCC bulk and retail water supply transfer network is shown on Figure 4.

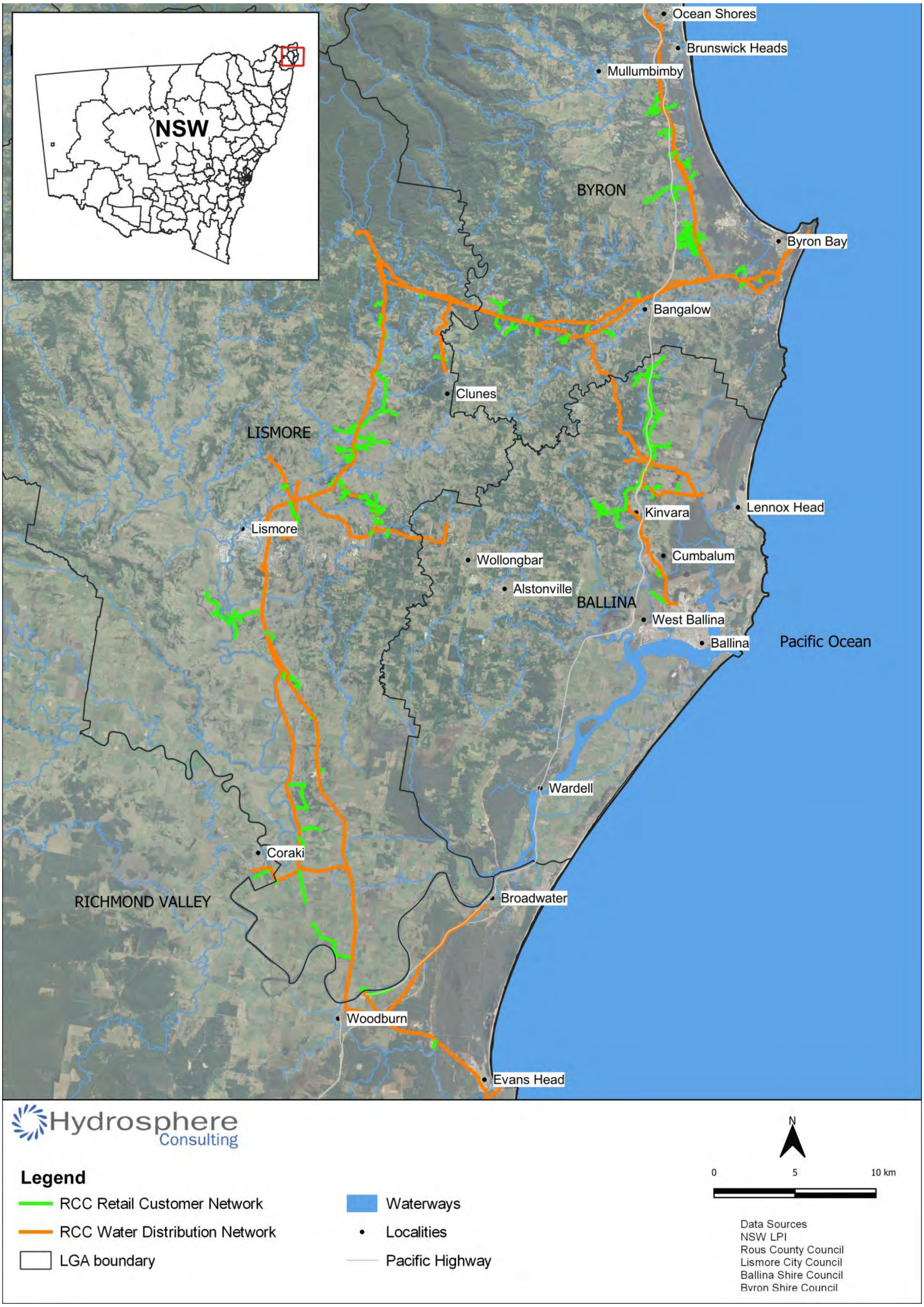

Figure 4: RCC bulk and retail water supply network

3. 2013 DEMAND FORECAST

The 2013 demand forecast for the RCC water supply area (Hydrosphere Consulting, 2013a) incorporated a range of information available at that time including:

- Water consumption.
- Regional growth predictions.
- Demand management/water efficiency.
- Advice from RCC and the constituent councils.

The 2013 demand forecast provided the data and calculations for:

- Number of connections between 2007 and 2010.
- Average water consumption between 2007 and 2010 for each connection type.
- Water demand profile between 2007 and 2010.
- Predicted future growth for each connection type (to 2060).
- Predicted future consumption trends for each connection type.
- 2010 to 2060 demand forecast.

Data was provided for each constituent council area, the RCC retail supply area and the RCC bulk supply area as a whole.

The data available on the existing number of connections and the predicted connection growth were used to estimate the future number of connections for each connection type. This relied on assumptions used for each council data set including:

- The rate of infill.
- The availability, demand and timing of greenfield development (new release areas).
- The density of future development (e.g. single or multi-residential).
- The rate of conversion of inefficient houses to efficient (BASIX compliant) houses through renovations and uptake of efficient appliances.
- The extension of recycled water supplies to new release areas.
- The rate of non-residential development.

The predicted demand per connection was also estimated for each connection type in each supply area. The 2013 demand forecast assumed that the average per connection demand for each connection type will remain static throughout the 50-year period and this was the basis of the long-term forecast of consumption.

RCC also prepared a forecast of the peak day demand at each of its sell point meters between 2012 and 2060 (Hydrosphere Consulting, 2013b). The agreed methodology for this demand forecast included a review of peak day production data to confirm that peaking factors provided in the 2013 Peak Day Demand Forecast are still appropriate as well as provision of recent data on average day demand and peak day demand.

4. METHODOLOGY

The analysis of existing and future water supply connections and demand has been undertaken in a similar way to the 2013 forecast. Where new datasets are available, the assumptions have been reviewed and updated.

The demand forecast addresses the requirements of the NSW Government's *Integrated Water Cycle Management (IWCM) Strategy Check List*, February 2019 (NSW Government, 2019) where relevant and where datasets are available (refer Appendix 1).

4.1 Data Sources

The components of the RCC bulk water supply system are shown on Figure 5.

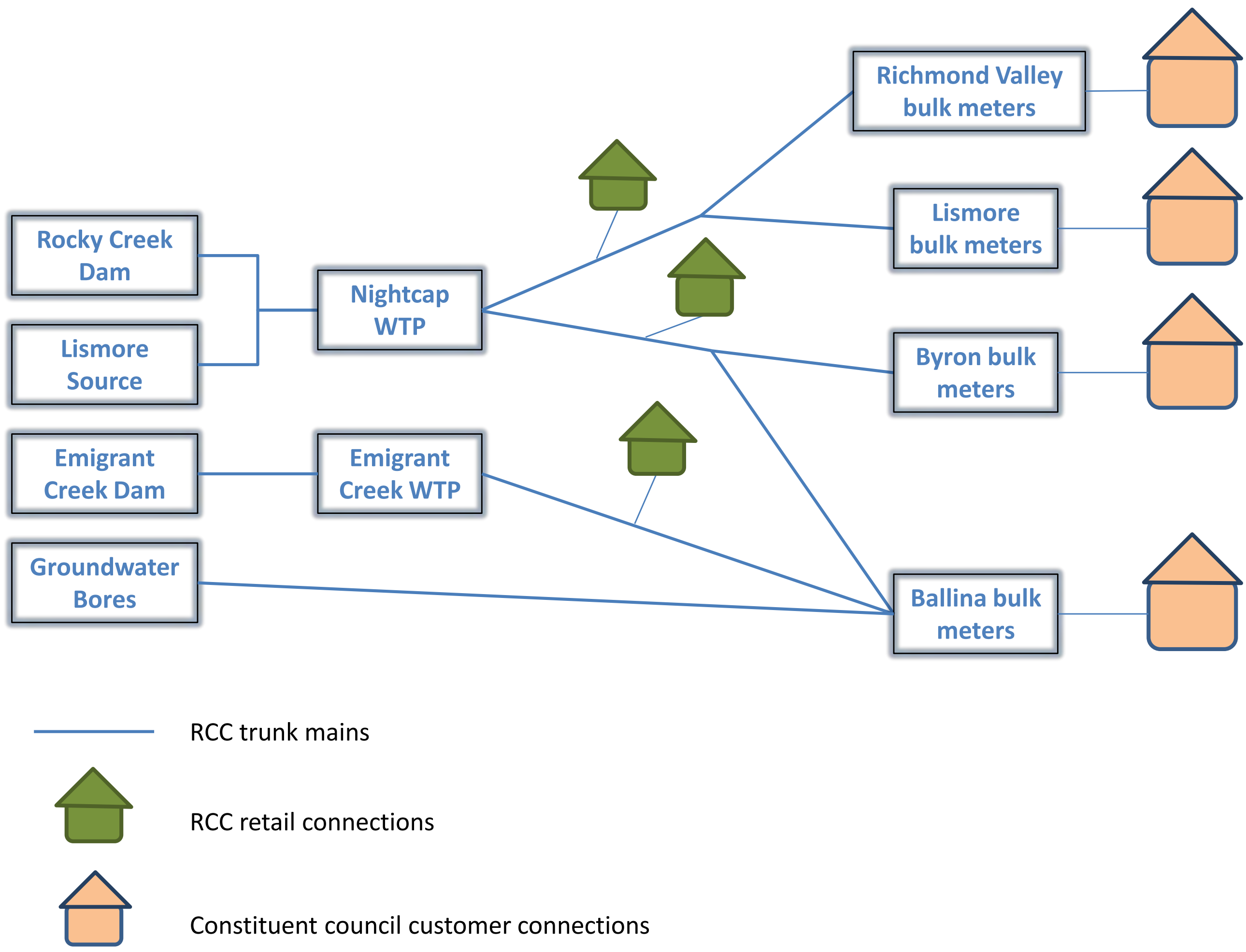

Figure 5: Bulk supply sources and distribution to the constituent councils and retail customers

4.1.1 Existing Customers and Demand

The data sources used to analyse the existing demand included:

- Customer and meter reading data from the four constituent councils and RCC retail customers. The data from the constituent councils varies based on the capability and functions of the council customer management databases. Existing connections have been classified as residential and non-residential connected properties (as provided by the constituent councils) with non-residential connections further characterised if available. There are differences in the definition and recording of connection types as well as modifications to the data collection and categorisation over time which limits the comparison of data between councils and between some years. The raw data (generally quarterly or annual meter reading data) from each council has been analysed to present the number of connected properties and consumption for each connection type (as available).

- RCC bulk production and bulk supply data for each council supply area. These data have been used to estimate the water losses in each council area and the Rous bulk supply. Non-revenue water (NRW) for the councils has been estimated as the difference between the supply metered at RCC's bulk meters and the supply metered at the council customer meters. Because this volume is derived this way, the NRW estimate may also consist of house meter errors, leakage from council assets, bulk meter errors, differences in time periods (meter reading, etc.), unbilled water (including water used by councils for maintenance) and unauthorised consumption.

In this study, data on consumption and connections are used to derive a per connection consumption rate for each customer category. This is used to forecast future demand from new connections with an allowance for water losses used to forecast the bulk supply demand.

With consideration of the data limitations, the available data have been used to estimate the number of connected properties for the following connection types between 2010/11 and 2018/19:

- Dual reticulated residential (single and multi-residential) – Ballina Shire.
- BASIX residential (single and multi-residential) – refer Section 4.1.3.
- Non-BASIX residential (single and multi-residential).
- Non-residential (further classification varies between councils).
- Rous retail connections.

The base year (last year of historic data provided) is 2018/19 (2019). The first year of the forecast is 2019/20 (2020). Data is presented by water year (which correspond to financial year) throughout this report.

The data from the 2013 demand forecast are also presented for each council.

4.1.2 Future Customers and Demand

The data sources for estimating future customers and demand include:

- Council development projections – lot yield, size, type, supply area (where available).
- Predicted consumption for each connection type from existing consumption data (Section 4.1.1).
- Demand management actions and predicted efficacy.

4.1.3 BASIX Data

BASIX is the NSW Government's online sustainability tool that has mandated water and energy savings for residential development in regional NSW since July 2005. BASIX certificate information has been provided by DPIE for 2011/12 to 2017/18. The certificates database provides information on building location and estimated water consumption. The certificate data indicate if the property is in a reticulated water scheme, the water source for toilets, household, garden etc. (rainwater tank or reticulated alternative supply) and rainwater tank volume.

The BASIX certificates have been analysed to determine the number of certificates in each water supply area. The total number of certificates for each year in each area is shown in Table 2 and Table 3. This includes BASIX certificates that specified that the connection was using the town water supply or a dual reticulated connection.

Table 2: Number of single residential BASIX connections

Bulk supply area	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2011-2018
Ballina-Alstonville/ Wollongbar	27	32	46	80	71	42	44	342
Ballina- Knockrow	27	28	56	61	78	60	56	366
Byron Shire	109	130	158	196	214	203	213	1,223
Lismore	49	68	66	45	62	89	66	445
Rous retail	24	18	29	34	30	46	27	208
Richmond Valley	10	12	10	21	18	29	32	132
Total RCC bulk supply areas	246	288	365	437	473	469	438	2,716
Ballina dual reticulated	21	50	55	95	121	144	131	617

Table 3: Number of multi-residential BASIX connections

Bulk supply area	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2011-2018
Ballina-Alstonville/ Wollongbar	3	2	3	2	2	4	1	17
Ballina- Knockrow	3	11	5	12	15	24	23	93
Byron Shire	7	10	21	33	43	40	61	215
Lismore	3	6	3	11	8	10	5	46
Rous retail	1	0	1	2	2	15	12	33
Richmond Valley	1	2	1	3	1	3	3	14
Total RCC bulk supply areas	18	31	34	63	71	96	105	418

A BASIX compliant property is considered to represent a “water efficient” connection due to the installation of water saving measures such as efficient appliances and alternative water sources (rainwater tanks). The number of new BASIX houses has been assumed to be equivalent to the total number of new connections in the supply area. The number of renovated BASIX houses has been assumed to be the remainder of the BASIX certificates in each year. This may be an over-estimate as there may be some BASIX certificates that are not converted to BASIX connections.

Similarly, a non-BASIX property is assumed to be non-efficient and a higher average consumption has been applied to account for the variation in household characteristics and water uses.

The estimated water consumption (potable) is given for each certificate. The BASIX certificate data was also used to estimate the per connection consumption for BASIX compliant connections using the estimated water consumption reported on each certificate. The estimated water consumption for BASIX compliant buildings is the average water consumption on the BASIX certificates in each water supply area at the time of their development application (Table 4). The data presented from the BASIX certificates is for properties with a rainwater tank. Dual reticulated consumption is discussed in Section 5.6. The average of all years was used as there were insufficient data for individual years to enable year-by-year analysis. It is considered that climate-related variability between years is unlikely to affect the robustness of this analysis.

Table 4: Estimated water consumption – BASIX (kL/connection/a)

Supply Area	Single-residential BASIX	Multi-residential BASIX
BaSC-Alstonville	144	109
BaSC-Knockrow	129	107
Byron Shire	111	102
Lismore	140	103
Rous retail	111	98
Richmond Valley	112	102
Total RCC bulk supply areas	122	103

In addition to the new development, it has been assumed that some existing connections will be converted from non-BASIX to BASIX connections as they are renovated or through take-up of efficient appliances. The rate of conversion is assumed to be 0.5% p.a. prior to 2015, 1.0% p.a. until 2040 and 0.5% p.a. between 2040 and 2060.

4.1.4 Climate Corrected Demand

Daily water demand patterns are highly variable and are likely to be influenced by a broad range of factors. The council data provides an estimate of the consumption per connection type. For each council area, this varies over the available time period which may be due to the influences of short-term climate variations or other non-climate variables. Analysis of some demand influences is provided for each Council in this report. Despite variability in the data there is an intuitive connection between climate and water demand which has been considered in the development of the demand forecast.

The demand of non-residential connections may be less influenced by climate variables than residential connections. The demand patterns of some of the larger non-residential connections in the bulk supply area (e.g. Broadwater Sugar Mill) are likely to be influenced by production rates rather than climate. Conversely, water usage for non-residential connections such as sporting grounds and nurseries are more likely to be influenced by climate. No data on the consumption patterns of individual non-residential connections were available for analysis for this report.

The water losses are variable between councils and between each year of data. The reasons for these variations are not yet known, however it should be noted that as this estimate is derived from the difference between bulk and customer supply meters, metering errors are also incorporated into this statistic, as well as actual losses and real unmetered water.

The 2013 demand forecast included a review of the influence of climatic variables to determine if there was a quantifiable linkage to bulk production and whether these climatic variables during the 2006/07 – 2009/10 period were representative of a 'normal' period. This is further discussed in Appendix 2.

Using the current NSW Security of Supply Methodology, water security is achieved if the secure yield of a water supply is at least equal to the unrestricted dry year annual demand (NSW Office of Water, 2013).

Analysis has been undertaken to identify key climate-influencing factors such rainfall, temperature and evaporation and evaluate changes in demand due to periods of dry/hot climate. This has been used to estimate the unrestricted dry year annual demand. Further details are provided in Appendix 2.

4.1.5 Demand Management Actions

Demand management initiatives have been successful in the region at reducing water demand. The 2018 Regional Demand Management Plan (RDMP, Hydrosphere, 2018) provides details on demand management strategies to be adopted over the next four years (2019 - 2022) within the Ballina, Byron, Lismore and Richmond Valley Council areas. The initiatives in the RDMP target all potable water supply customers in the region.

Table 5 outlines demand management actions from the RDMP, the current status of implementation and the expected reduction in demand that will result.

Table 5: Demand management actions and tasks

Action	Target reduction in demand (based on key performance indicators in RDMP)	Predicted reduction in demand (based on current implementation status and predicted effectiveness)
Monitoring, Evaluation and Reporting: Timely, accurate and consistent reporting to assist with ongoing RDMP development and evaluation. Consumption information reported to customers.	Nil predicted.	Nil predicted.
Water Loss Management: Quantify quarterly losses. Detect and repair leaks. Reduce losses to sustainable levels.	Refer Table 6 below.	LCC prepared a water loss management plan (WLMP) in 2015 and an updated timeline in 2019 which indicated the potential to achieve a reduction in losses of 108 ML/a with implementation of actions completed by 2021. However, based on recent data, this is unlikely to be achieved by this date. The other constituent councils prepared WLMPs in 2020 which indicate the potential to achieve a reduction in losses of: BySC: 66 ML/a by 2024. BaSC: 65 ML/a by 2023. RVC: 100 ML/a including Casino (date not specified but assumed to be by 2024). This has been reduced to 20 ML/a for the bulk supply area. RCC: not estimated, assumed to be 120 ML/a. Total estimated reduction in NRW: 459 ML/a (significantly lower than the targets in the RDMP, Table 6).
Sustainable Water Partner Program: This program offers assistance to non-residential high water users to reduce consumption.	5 ML/a from year 2 (2019/20 onwards)	Nil predicted (based on limited completion of tasks that will result in water savings).

Action	Target reduction in demand (based on key performance indicators in RDMP)	Predicted reduction in demand (based on current implementation status and predicted effectiveness)
Smart Metering: Investigate the implementation of new technology for identifying leaks and monitoring consumption.	KPI to be developed. RCC and the constituent councils have commenced investigations into smart metering but no water loss reduction has been assumed.	Nil predicted (based on limited completion of tasks that will result in water savings).
Recycled Water: Develop opportunities to replace potable water with treated sewage effluent and encourage the use of recycled water.	Reduction in metered potable water supply for participating customers: BaSC – 25% BySC – 10%	Included in forecast connections and consumption.
Rainwater Tank Rebates: Encourage customers to supplement potable water supply with rainwater by offering a rebate for rainwater tanks.	65 rebates provided per year with 25% reduction in metered potable supply for those properties.	Nil predicted (based on limited completion of tasks that will result in water savings). Conversion from inefficient to efficient houses is included in the forecast connections and consumption.
Community Engagement and Education: Promote water efficiency.	Refer Table 6 below.	Included in demand per connection for BASIX (efficient) households.

Table 6: RDMP targets

Indicator	2018	2022 Target	2026 Target
NRW (%)	17.0%	12.0%	10.0%
NRW (ML/a)	2,430	1,620	1,320
Reduction in NRW	-	810	1,110
Residential consumption per connection (kL/a)	180	165	160
Total demand per connection (kL/a)	280	260	250
Residential demand per person (L/d)	195	175	170

As most of the demand management actions have not yet been implemented, only the water loss management actions will be considered in this demand forecast. Given the progress in implementation of water loss management actions and water loss reduction predicted in the WLMPs, the RDMP water loss management targets are not considered to be achievable with current commitments. Therefore, two scenarios have been developed for water savings due to demand management:

1. No water loss management – using current average losses for each Council.
2. Predicted WLMP targets as in Table 5.

The estimated water loss reduction is based on the constituent council WLMPs which identify feasible opportunities for savings. It has been assumed that the WLMP actions will be put in place and the savings will be realised. This can be monitored in future reviews of the demand forecast. While other demand management actions may be implemented in future, these have not been adopted in the RDMP and will not be considered in the demand forecast.

5. BALLINA SHIRE BULK SUPPLY AREA

5.1 Bulk Water Supply Area

The bulk water supply network within Ballina Shire is shown on Figure 6.

5.2 Historical Connected Properties and Consumption

BaSC has supplied raw data on number of meters and metered consumption throughout the Shire between 2011 and 2019. This includes properties with dual meters, of which some were connected to the recycled water supply and some were supplied with potable water (while recycled water supplies are being developed). Analysis of these data compared to data on metered consumption reported to DPIE as part of annual performance reporting (adjusted for Wardell) shows that the new consumption values are significantly higher between 2017 and 2019. When compared to bulk sales, the level of NRW is (average) 5% p.a. between 2017 and 2019 which is considered too low (when compared to losses reported in the 2013 demand forecast) and therefore inaccurate.

The datasets are compared to the connected properties and metered consumption data reported to DPIE as part of annual performance reporting (adjusted for Wardell) in Figure 7 and Figure 8.

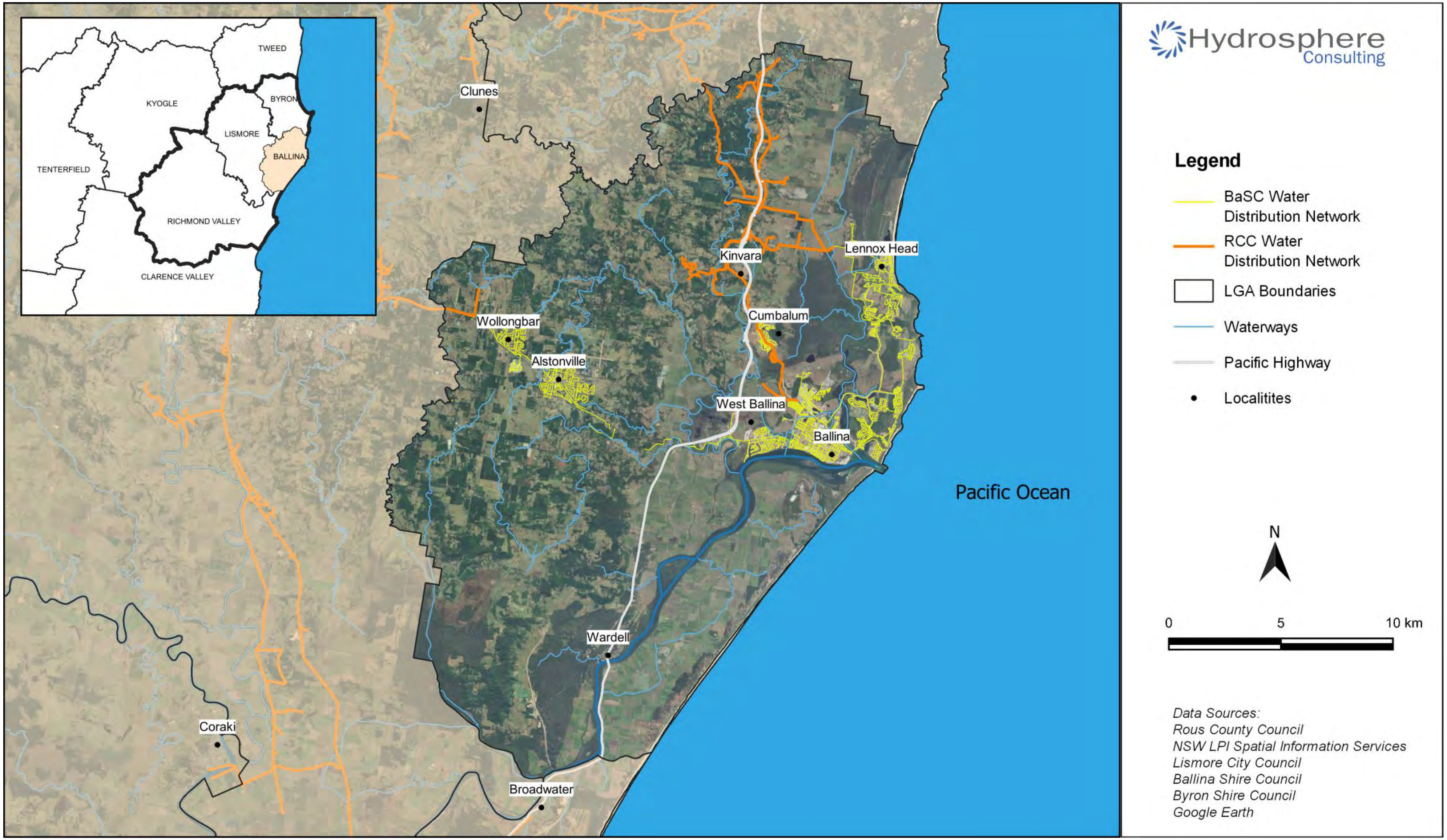

Figure 6: Bulk water supply network - Ballina Shire

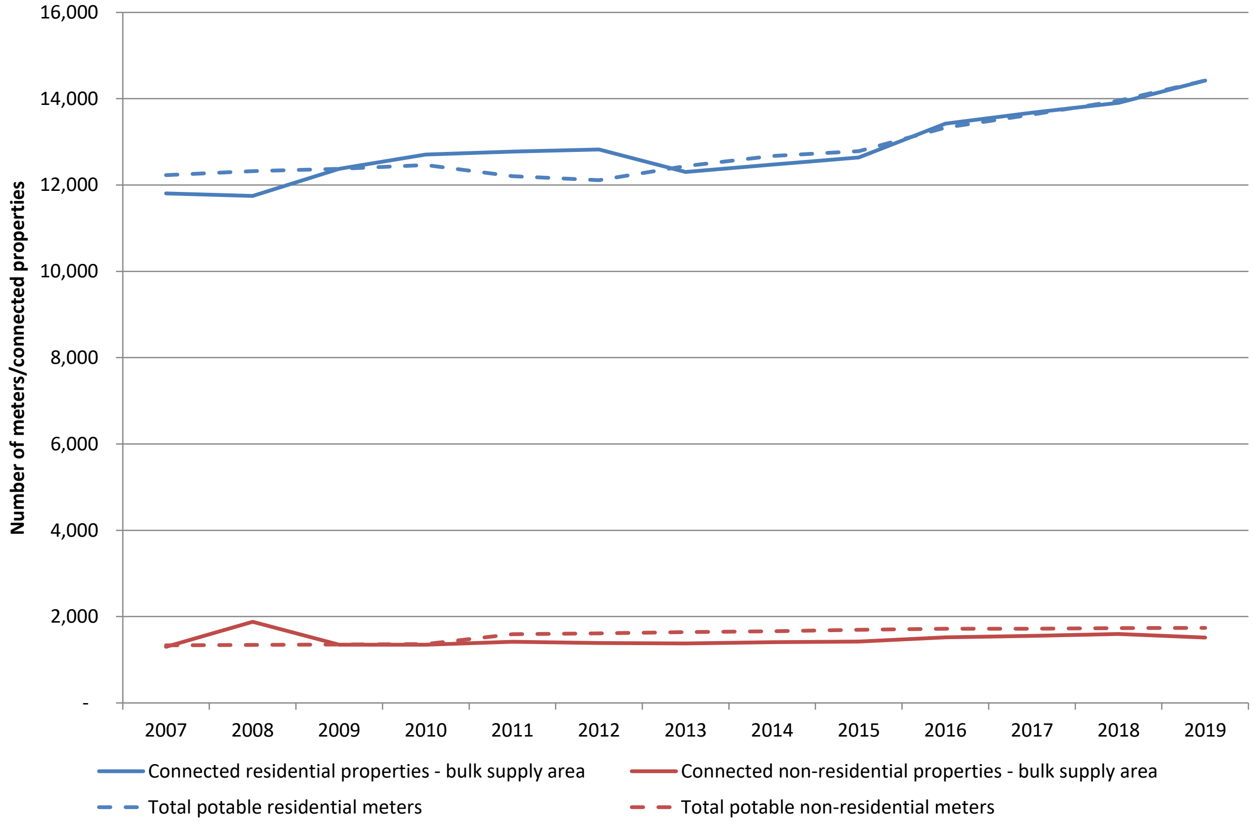

Figure 7: Comparison of data on meters and connected properties - Ballina Shire

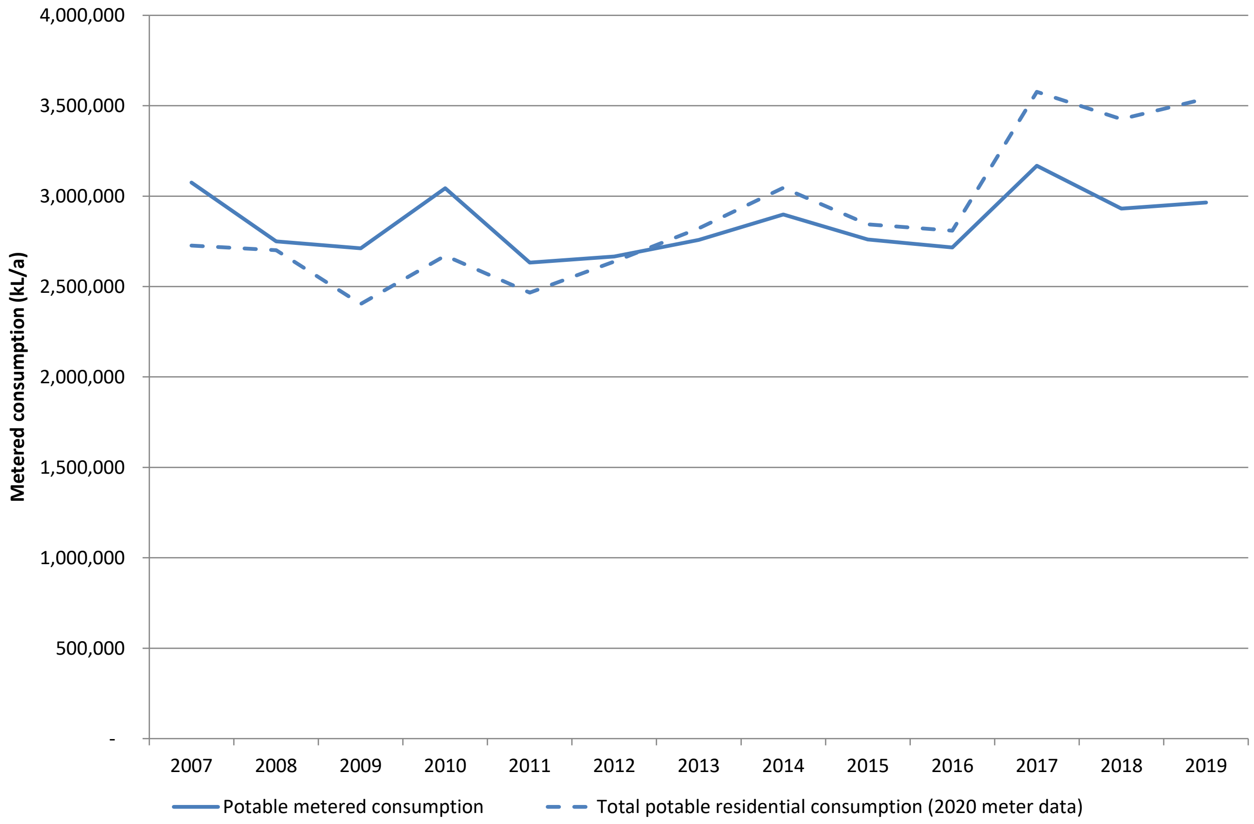

Figure 8: Comparison of data on metered consumption - Ballina Shire

The meter data has been used to derive the number of potable connected properties as shown on Figure 9.

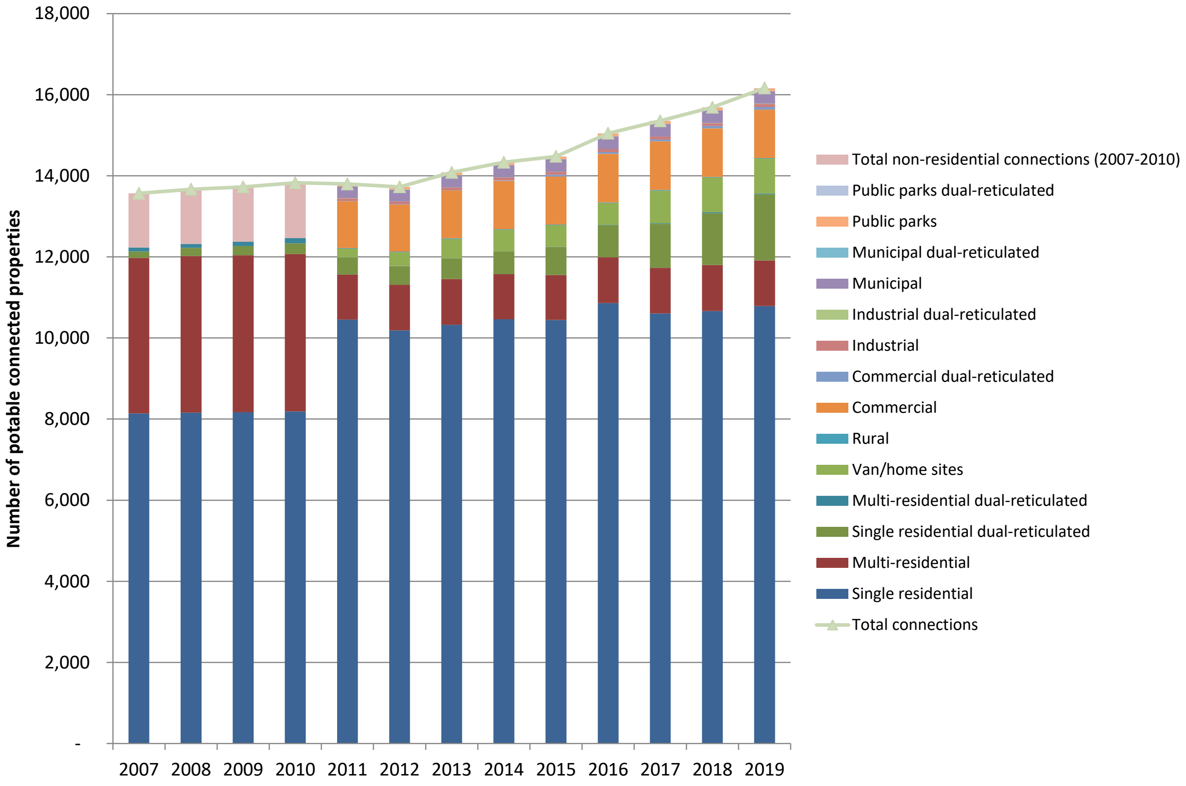

Figure 9: Historical connected properties – Ballina Shire

The new data on consumption values are higher (and therefore are considered to be inaccurate). BSC has acknowledged the data discrepancies and has since provided reasons for the discrepancies. This issue is expected to be resolved in the next review of the demand forecast. The consumption data from the annual reporting to DPIE is used in this study (Figure 10).

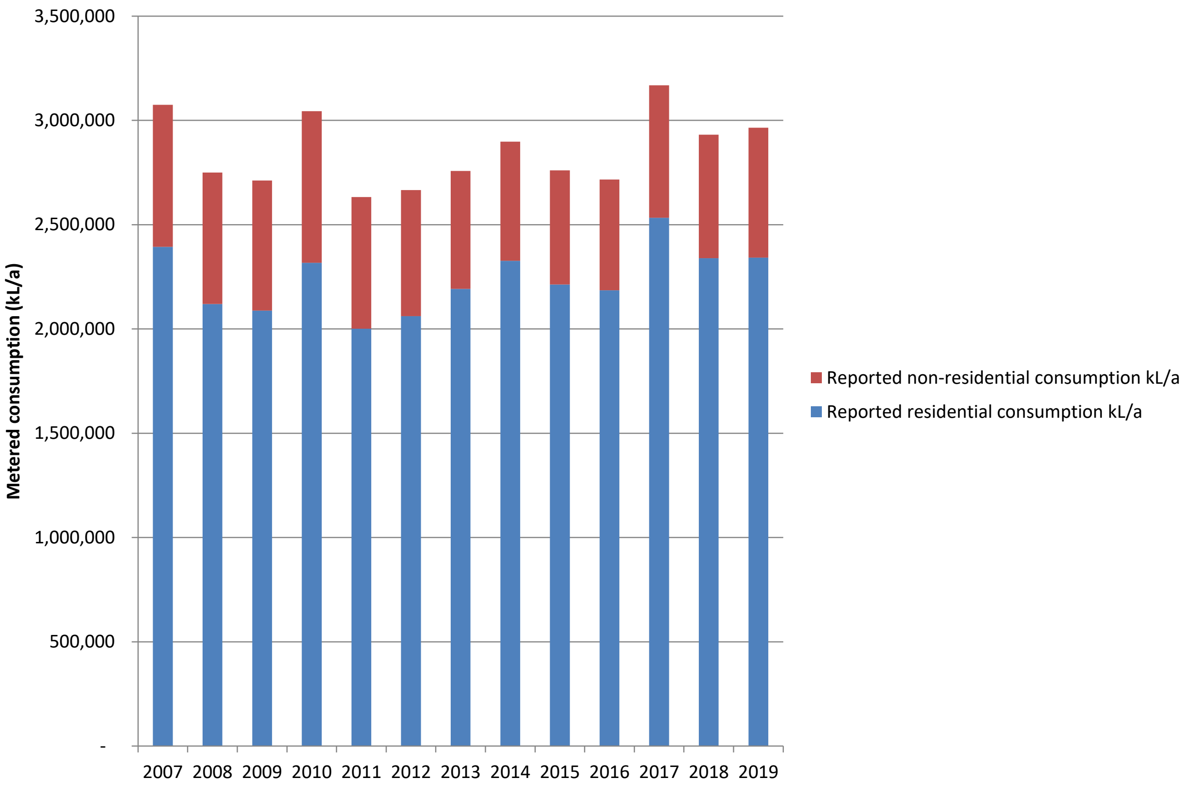

Figure 10: Historical metered consumption – Ballina Shire

The breakdown of residential properties including BASIX and non-BASIX properties is given on Figure 11.

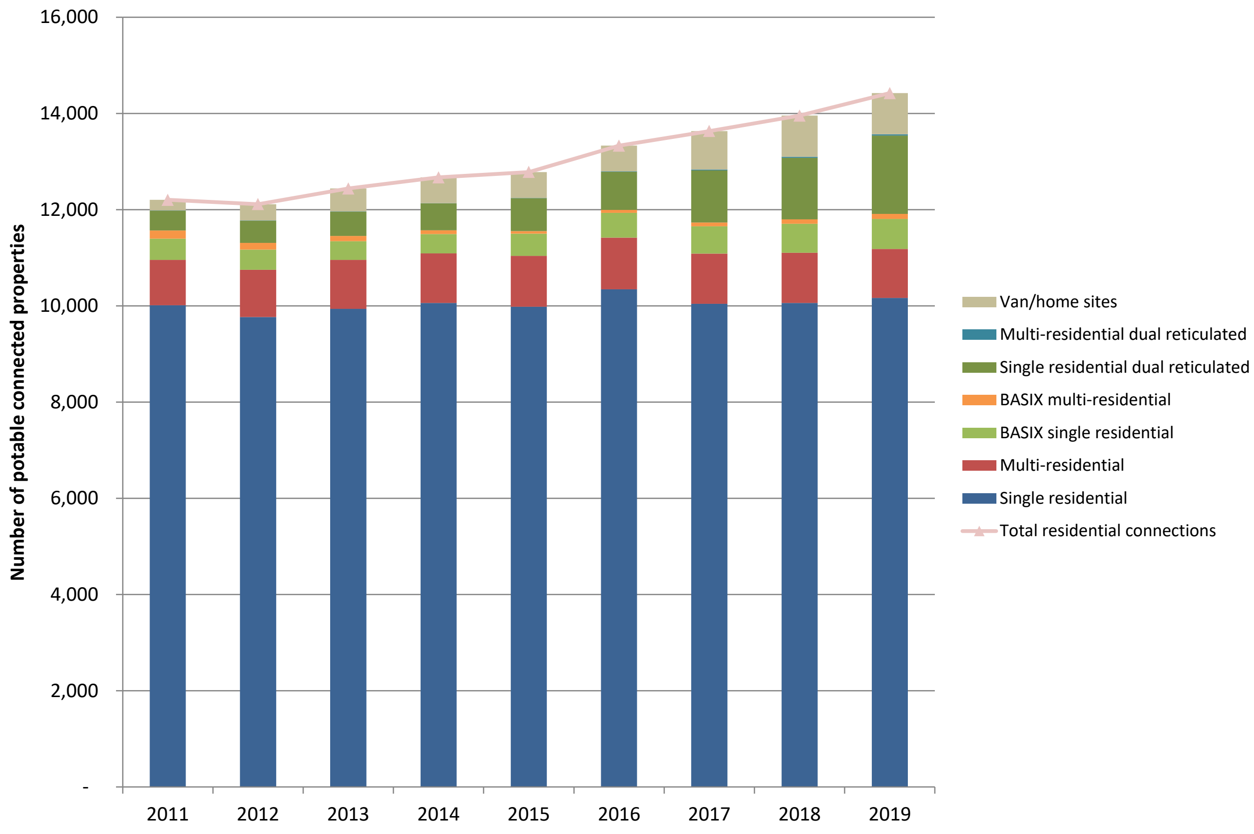

Figure 11: Historical connected residential properties (including BASIX) - Ballina Shire

There are a few dual-reticulated areas within the Shire that are still supplied with potable water through the recycled water meter. However, BaSC has advised that all dual reticulated areas will be supplied with recycled water within the next 18 months. For the purposes of this study, all recycled water meters are assumed to be supplied with recycled water. This is not considered to substantially influence the demand forecast but this assumption will be monitored.

5.3 Factors Influencing Metered Consumption

The impact of the following factors on metered customer demand has been assessed:

- Number of connected properties (refer Figure 12). Residential consumption has generally increased between 2011 and 2019 along with the number of residential connections but a similar relationship is not observed for non-residential consumption.

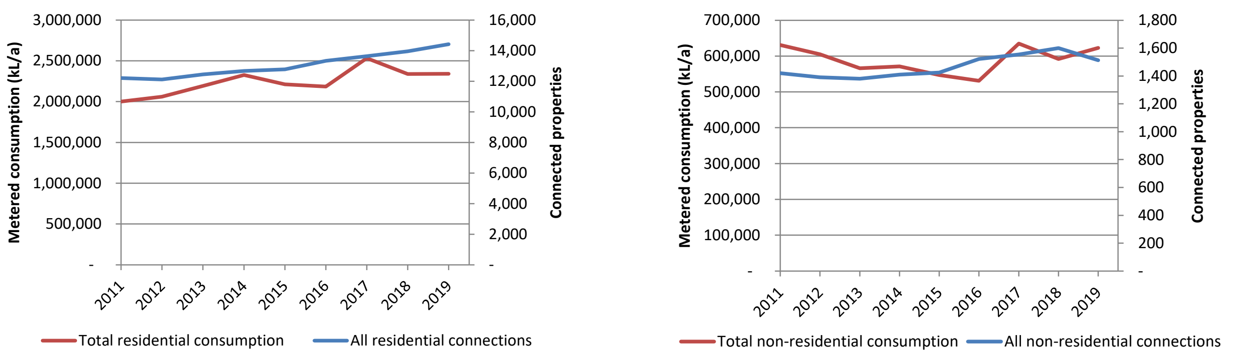

Figure 12: Comparison between connected properties and metered demand - Ballina Shire

- Climate (average maximum temperature and annual rainfall at Ballina, refer Figure 13). Residential consumption appears to increase with low rainfall in some years and increase with high temperatures but a similar relationship is not observed for non-residential consumption. Climate correction is discussed in Section 5.6 and Appendix 2.

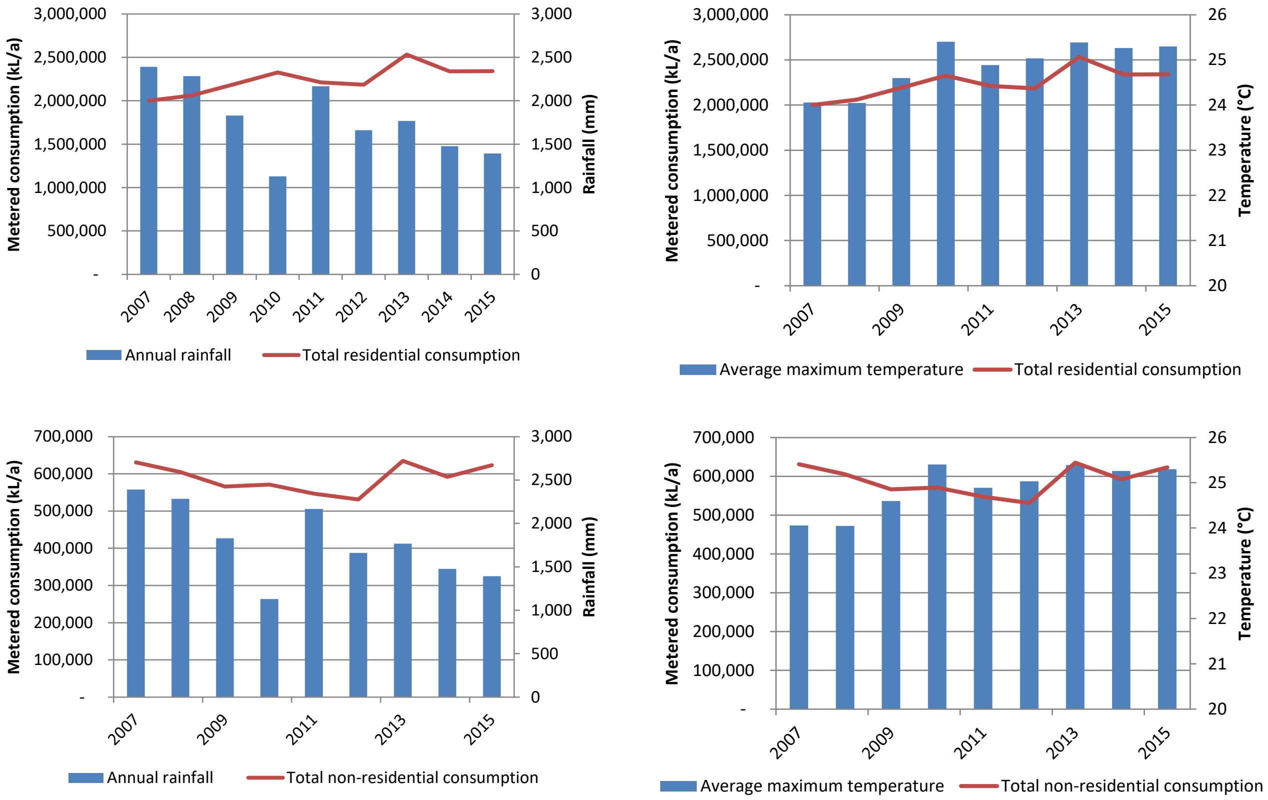

Figure 13: Comparison between climate and metered demand - Ballina Shire

- Water pricing (usage charge, refer Figure 14). Despite the increasing price of water since 2011, the residential consumption per connection has remained relatively stable. However, non-residential consumption has decreased with the increasing price of water.

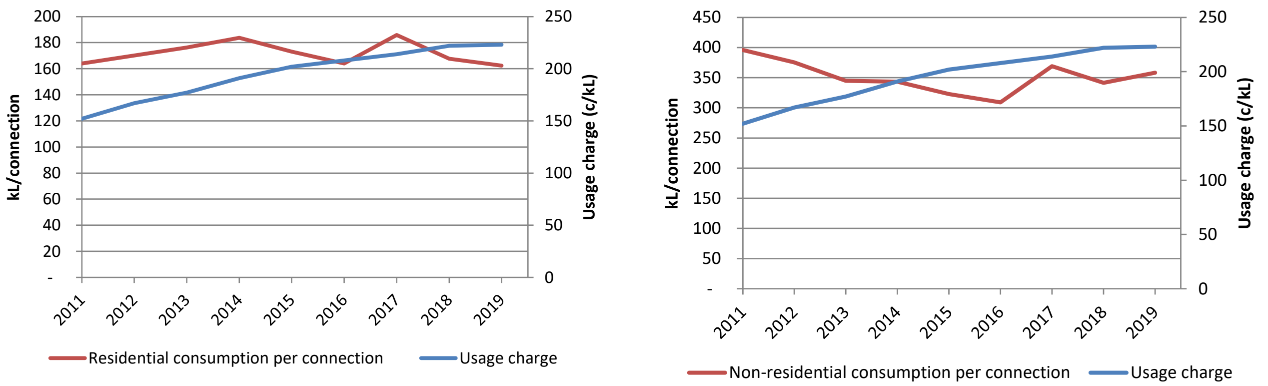

Figure 14: Comparison between usage charge and metered demand - Ballina Shire

Drought restrictions are discussed in Section 5.4.

5.4 Bulk Supply from RCC

RCC has bulk supply meters at Knockrow and Alstonville/Wollongbar for Ballina Shire bulk sales.

5.4.1 Knockrow

Daily bulk water supply to Knockrow and restrictions imposed are shown in the following figure between June 2001 and March 2019. Until December 2017, RCC collected bulk metered supply data on a daily basis (Figure 15). Since then, RCC has been developing a water database and data has been extracted from SCADA for the summer periods only.

Restrictions were imposed across the regional supply area during the 2002/03 drought (up to level 5) and level 1 restrictions were imposed in the second half of 2007. Restrictions were successful in reducing demand in 2002/03.

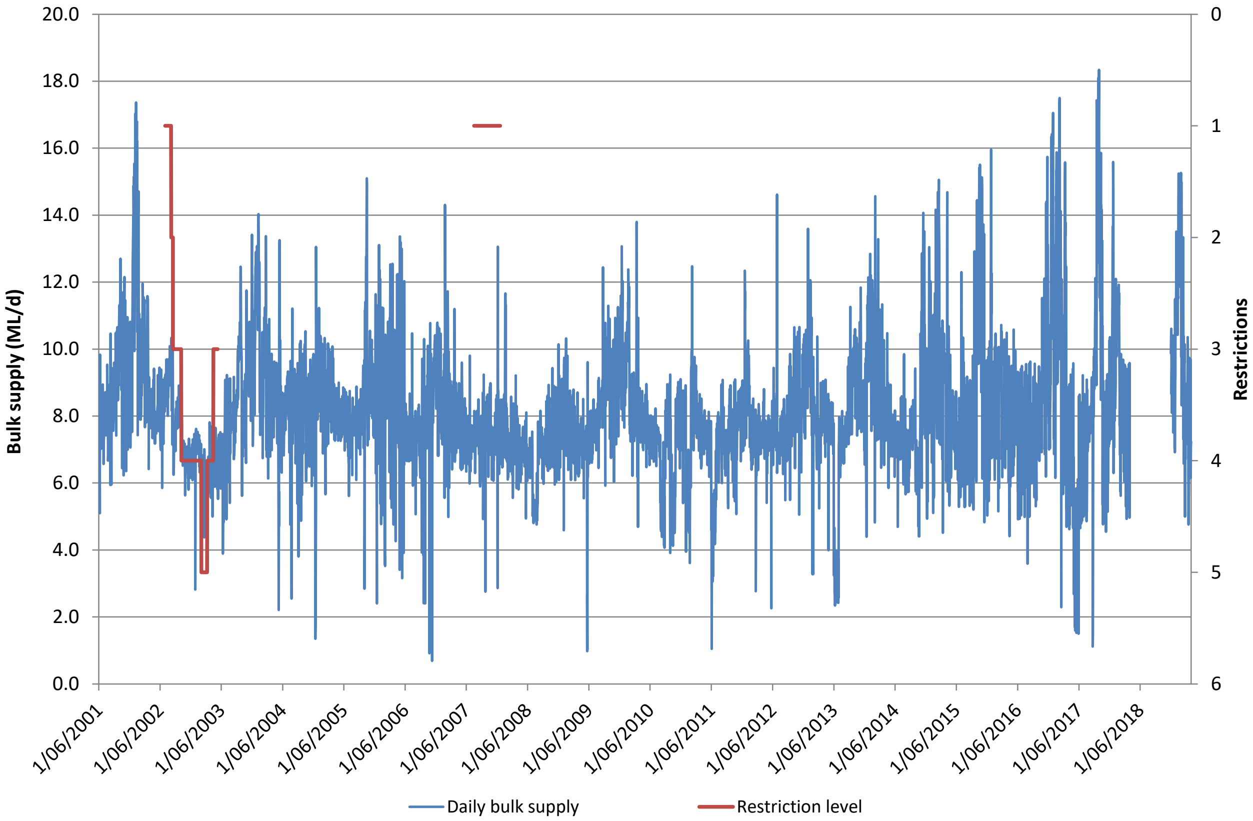

Figure 15: Daily supply to Ballina Shire (Knockrow): 1/6/2001 – 31/3/2019

The daily bulk meter data for Knockrow since 2001/02 were used to assess the average day demand (ADD) and peak day demand (PDD) for each year. ADD, summer PDD and PDD:ADD ratio are shown in Table 7 for each year.

Table 7: Summer period peak and annual average demand – Ballina (Knockrow)

Summer period	PDD (summer)	ADD	PDD:ADD
2001/02	17.4	9.3	1.9
2002/03	7.6	7.2	1.1
2003/04	14.0	9.0	1.6
2004/05	13.1	8.3	1.6

Summer period	PDD (summer)	ADD	PDD:ADD
2005/06	13.1	8.4	1.6
2006/07	14.3	8.0	1.8
2007/08	13.1	7.3	1.8
2008/09	10.3	7.3	1.4
2009/10	13.1	8.6	1.5
2010/11	12.5	7.0	1.8
2011/12	12.3	7.6	1.6
2012/13	13.6	7.8	1.7
2013/14	14.6	8.6	1.7
2014/15	15.1	8.2	1.8
2015/16	16.0	8.5	1.9
2016/17	17.5	8.4	2.1
2017/18 (1)	14.5	*8.4*	*1.7*
2018/19 (1)	15.3	*8.4*	*1.8*
Average	-	8.9	-
Maximum	17.5	-	2.1

Note 1: Daily datasets are only available for the summer period of 2018 and 2019. The average of the previous 4 years ADD has been used here.

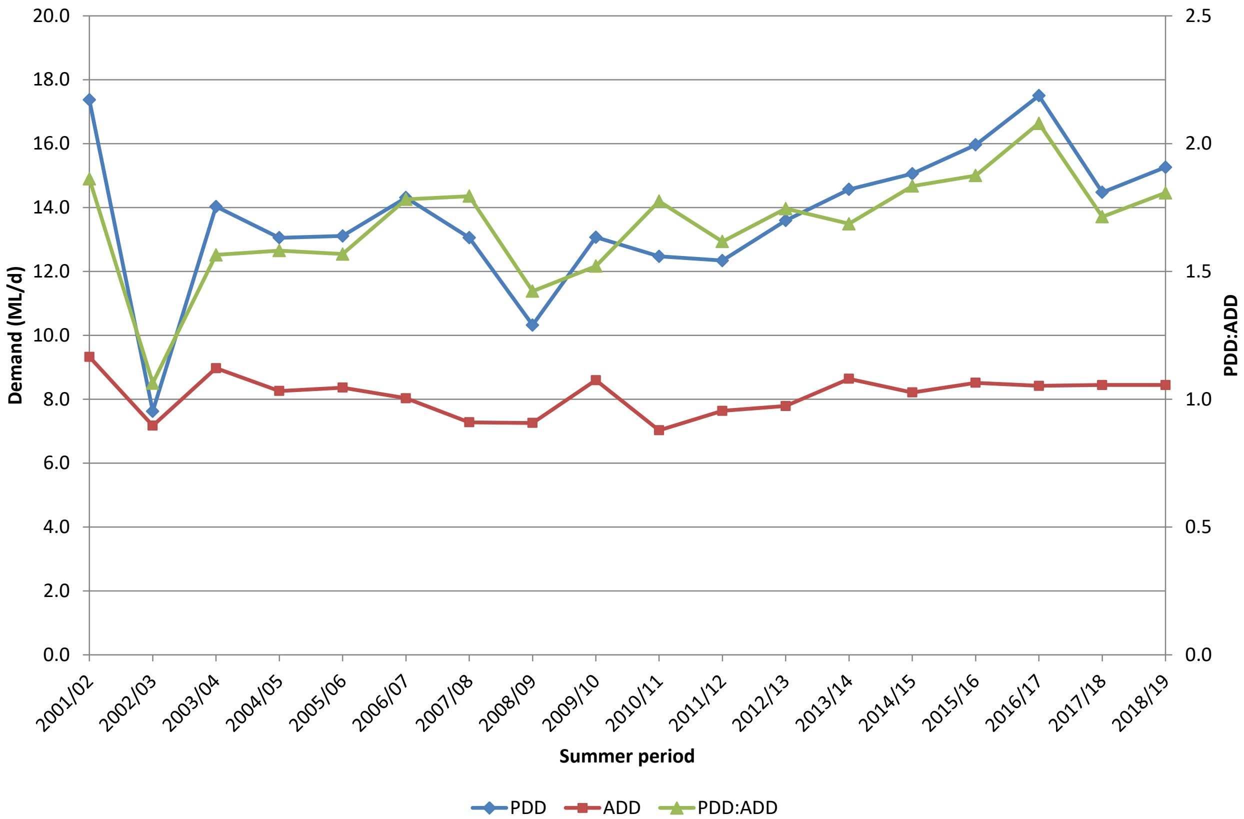

Figure 16: Summer period peak and average demand – Ballina (Knockrow)

Prior to the extended dry period which commenced in 2017/18, the highest demand and PDD:ADD ratio was experienced in 2001/02 (17.4 ML/d, 1.9) in the lead up to the 2002/03 drought and restrictions imposed. The maximum PDD and PDD:ADD ratio since 2001/02 was experienced in 2016/17 (17.5 ML/d, 2.1). Daily demand and rainfall for 2001/02 and 2016/17 (recorded at Ballina Airport AWS) are shown in the following figures.

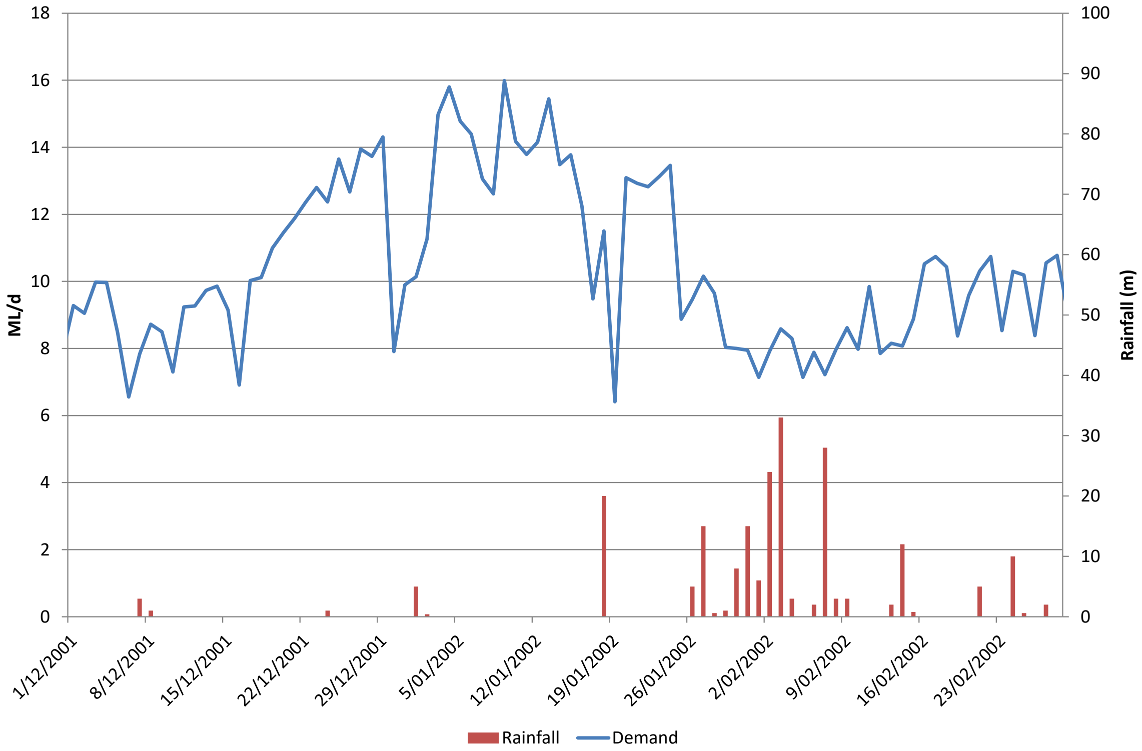

Figure 17: Daily demand and rainfall – Ballina (Knockrow) 2001/02

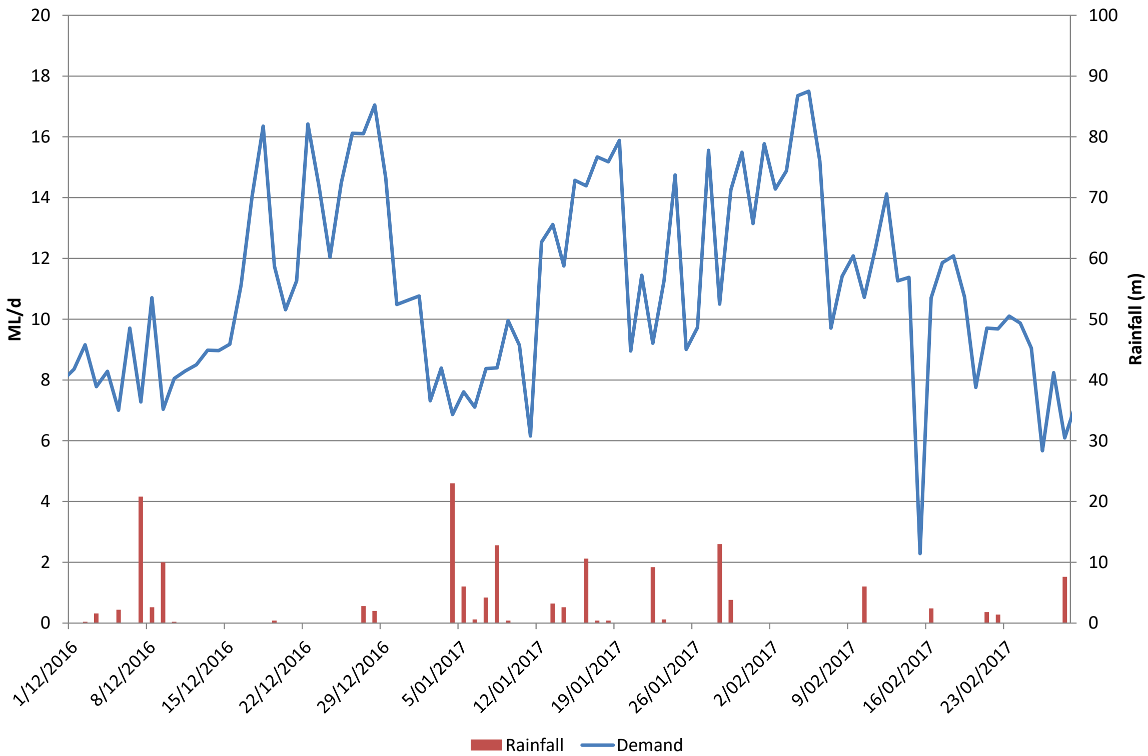

Figure 18: Daily demand and rainfall – Ballina (Knockrow) 2016/17

Figure 19 shows the persistence of the peak demand in 2001/02 and 2016/17 in comparison to the average and 95th percentile demand since 2002. The peak periods in 2001/02 and 2016/17 persisted for over 2 weeks (then returned to average demand).

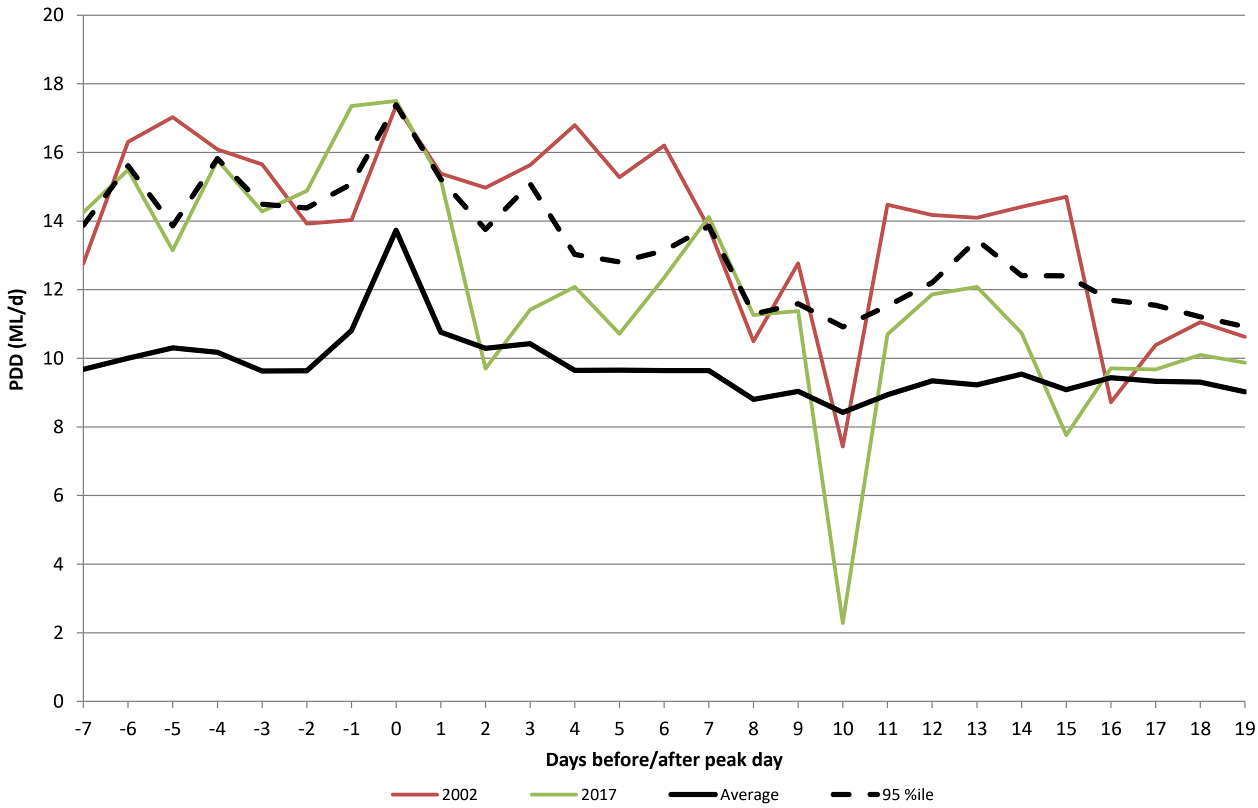

Figure 19: Peak demand pattern – Ballina (Knockrow)

The highest recorded summer PDD (17.5 ML/d) was recorded on 5 February 2017 with 27 mm rainfall in the previous 2 weeks (2.1 times the 2016/17 average demand). The highest PDD in 2001/02 (17.4 ML/d) was recorded on 9 January 2002 with 5 mm rainfall in the previous 2 weeks (1.9 times the 2001/02 average demand). A peak day to average day ratio of 2.1 is considered appropriate for the future peak demand forecast for the Knockrow service area.

5.4.2 Alstonville/Wollongbar

Daily bulk water supply to Alstonville/Wollongbar areas and restrictions imposed between June 2001 and March 2019 are shown in the following figure.

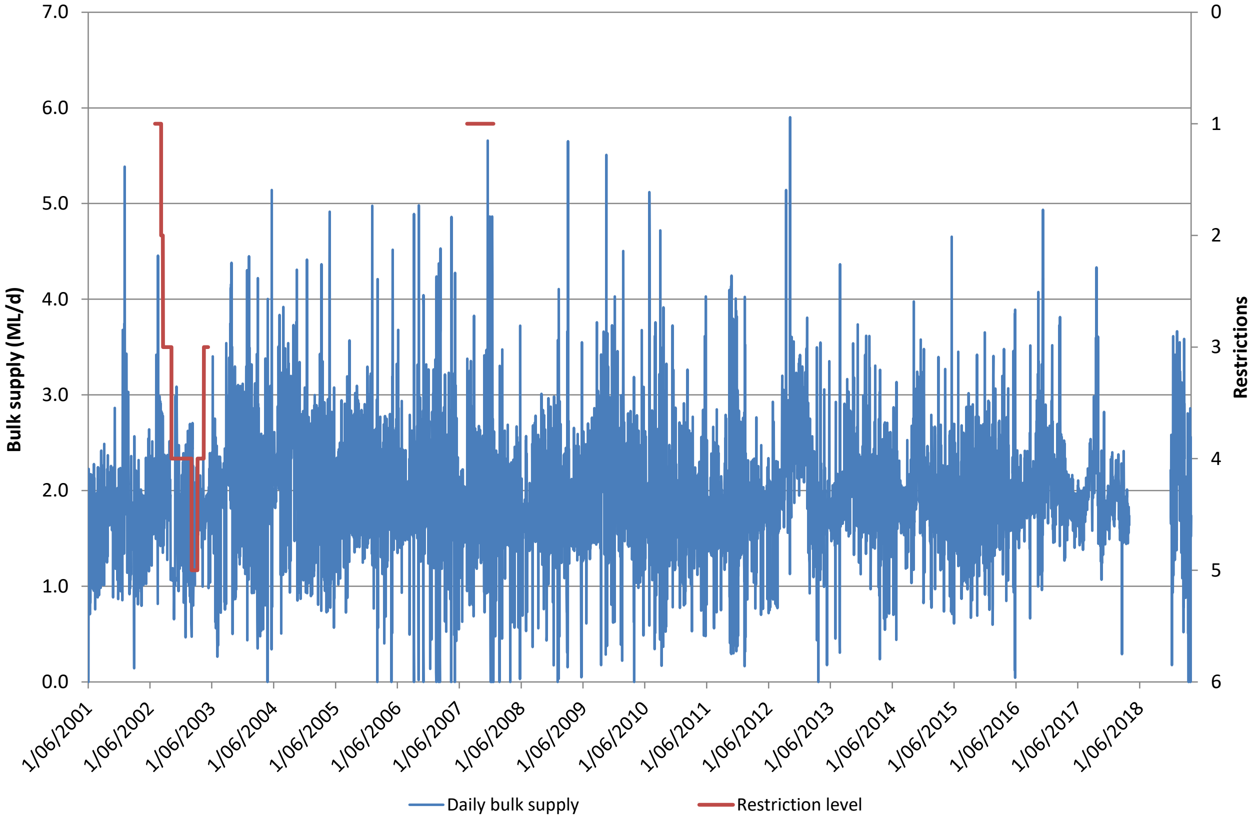

Figure 20: Daily supply to Ballina Shire (Alstonville): 1/6/2001 – 31/3/2019

The daily bulk meter data for Alstonville/Wollongbar since 2001/02 was used to assess the ADD and PDD for each year. Many of the peak demands occur following a period of low or nil bulk supply (for operational reasons) and are not considered to represent peak day demands. Peak demand values are shown in Table 8.

Table 8: Summer period peak and average demand – Ballina (Alstonville/Wollongbar)

Summer period	Summer PDD	ADD	PDD:ADD
2001/02	5.4	1.7	3.1
2002/03	2.7	1.8	1.5
2003/04	4.5	2.2	2.0
2004/05	4.4	2.2	2.0
2005/06	5.0	2.1	2.4
2006/07	4.5	2.0	2.3
2007/08	4.9	1.8	2.7
2008/09	4.1	1.8	2.3
2009/10	4.5	2.1	2.2
2010/11	3.3	1.8	1.8
2011/12	4.0	1.8	2.2
2012/13	3.8	2.1	1.8

Summer period	Summer PDD	ADD	PDD:ADD
2013/14	3.6	2.0	1.8
2014/15	3.5	1.9	1.8
2015/16	3.4	1.9	1.8
2016/17	3.8	2.1	1.8
2017/18 (1)	2.4	2.0	1.2
2018/19 (1)	3.7	2.0	1.8
Average	-	2.0	
Maximum	5.4	-	3.1

Note 1: Daily datasets are only available for the summer period of 2018 and 2019. The average of the previous 4 years ADD has been used here.

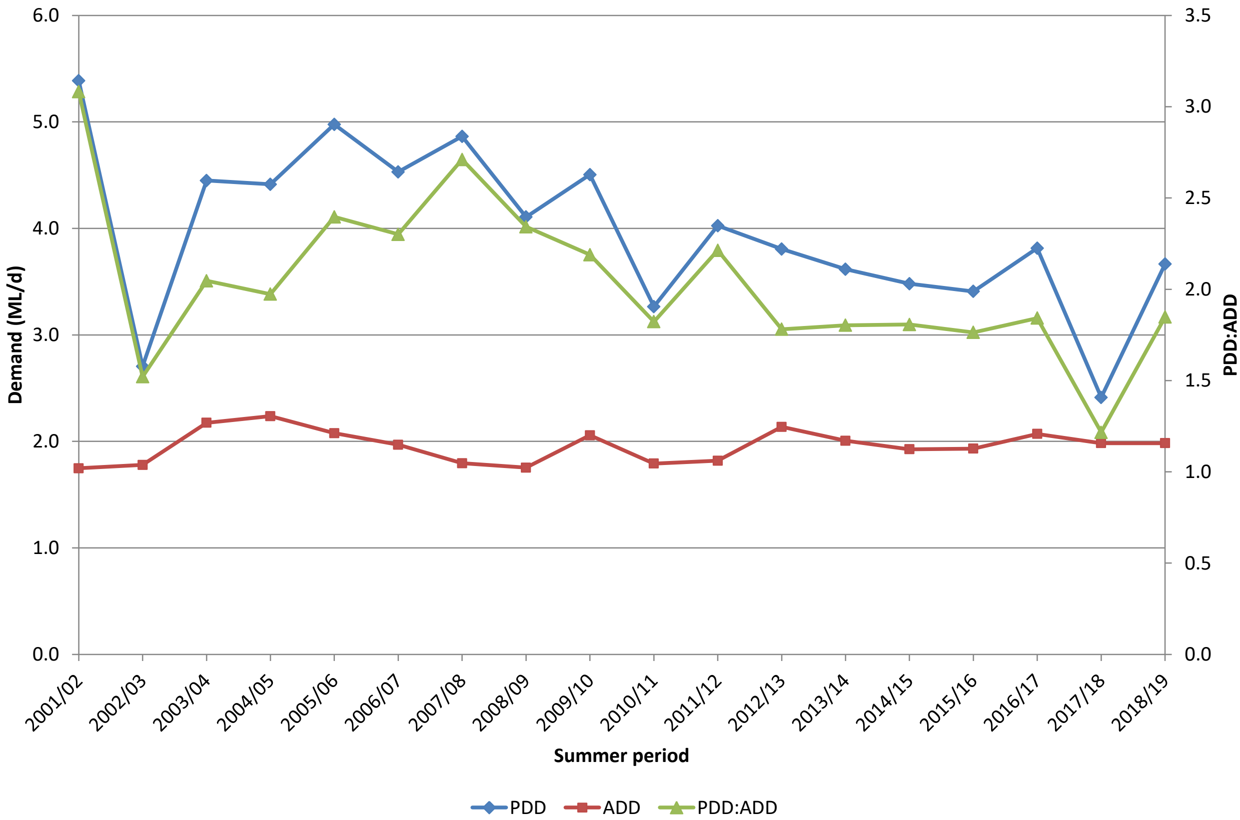

Figure 21: Summer period peak and average demand – Ballina (Alstonville/Wollongbar)

The highest demand was experienced in 2001/02 (5.4 ML/d) with a PDD:ADD ratio of 3.1. Daily demand and rainfall for 2001/02 (recorded at McLeans Ridges BOM station) is shown in the following figure.

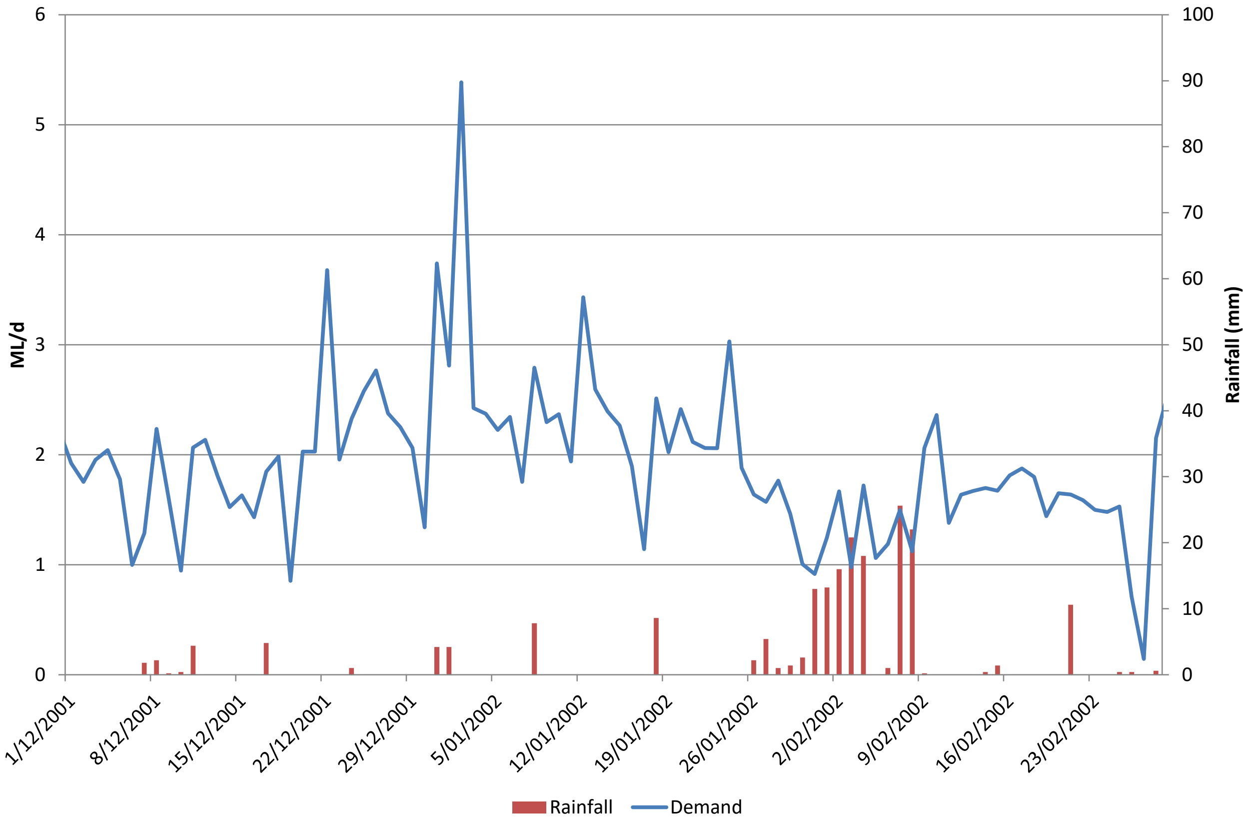

Figure 22: Daily demand and rainfall – Ballina (Alstonville/Wollongbar) 2001/02

The highest recorded summer PDD (5.4 ML/d) was recorded on 2 January 2002 with 9 mm rainfall in the previous 2 weeks (3.1 times the 2001/02 average demand). A peak day to average day ratio of 3.1 is considered appropriate for the future peak demand forecast for the Alstonville/Wollongbar service area.

5.5 Non-Revenue Water

Metered consumption, bulk water supplied and NRW for Ballina Shire are shown on Figure 23. The data suggest that the average NRW over the last 5 years was 736,897 kL/a or 20.3% of bulk supply. Between 2007 and 2010, NRW ranged from 16.6% p.a. to 20.8% p.a. (as reported in the 2013 demand forecast). The 2013 demand forecast assumed NRW would be 17% p.a. between 2020 and 2060. This assumed that BaSC's water loss management program would be successful in achieving savings of 240 ML/a (7% p.a.).

BaSC has advised that the data reported to DPIE does not include bulk sales from filling stations or drinking water used to top up the recycled water reservoirs. In addition, there may be some errors in the reported consumption. With consideration of these differences, BaSC has calculated the average NRW over the last 5 years as 18.4 % or 664,527 ML/a (72 ML/a less than used in this report). The difference in the NRW is not considered significant and the DPIE data has been used as a conservative approach.

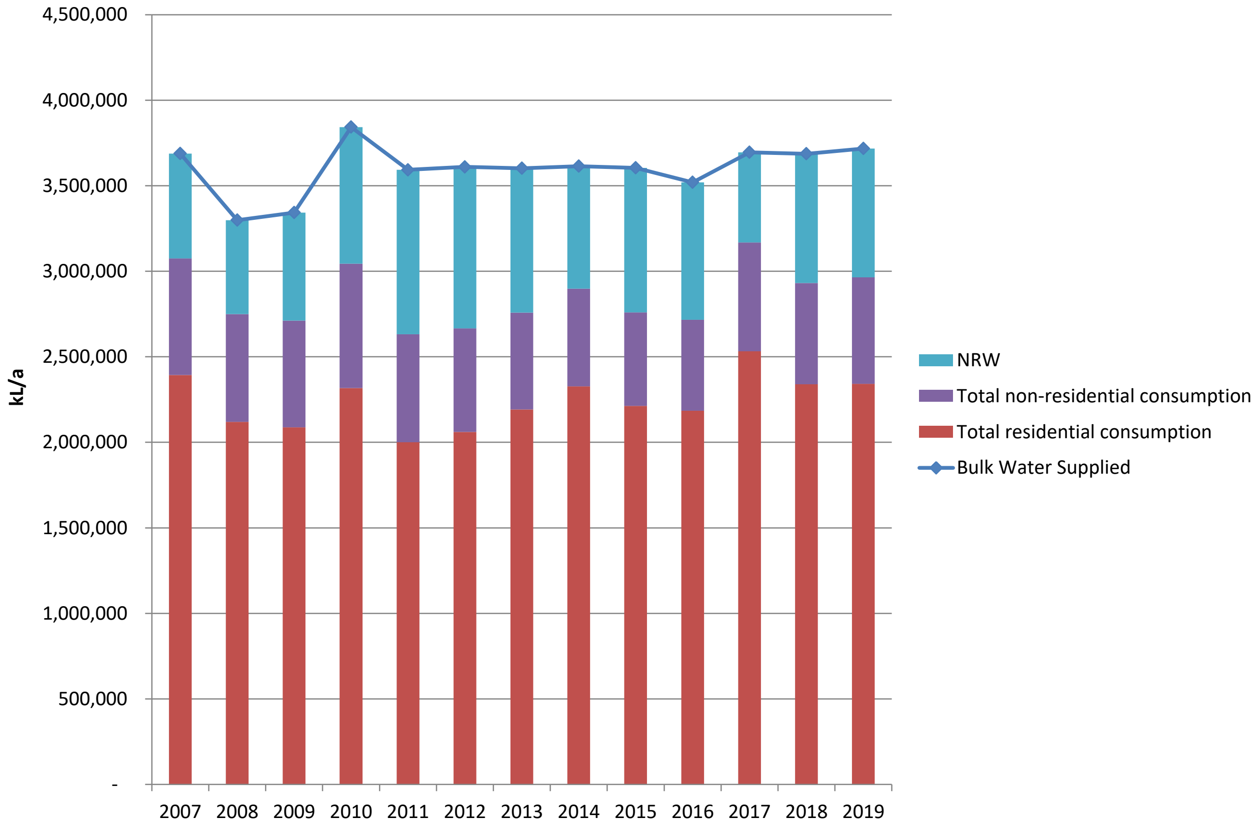

Figure 23: Bulk supply, metered consumption and NRW – Ballina Shire

5.6 Average and Dry Year Demand

The climate correction analysis undertaken for Ballina Shire bulk supply area suggests that the dry year demand is 5.9% higher than the average demand (Appendix 2). The historical metered consumption per connection for each customer type and the average, maximum and dry year consumption per connection are shown in Table 9. This table also shows the average consumption per connection used in the 2013 demand forecast. The revised consumption rates are slightly higher than the 2013 rates used.

Data provided by BSC for metered consumption of dual reticulated properties (recycled meter) was not considered reliable. The certificate data for dual reticulated properties also seemed unreliable (large variation with average 134 kL/a in Ballina Shire compared to the houses with rainwater tanks (135 kL/a). The average predicted consumption of a dual reticulated property in Ballina Shire as a percentage of a non-BASIX property (79%) was applied to reduce the consumption of dual-reticulated properties (to 108 kL/a). This is also the methodology adopted in 2013. The average of all years was used as there were insufficient data for individual years to enable year-by-year analysis. It is considered that climate-related variability between years is unlikely to affect the robustness of this analysis.

Table 9: Consumption per connection – Ballina Shire (kL/a)

Connection type	2015	2016	2017	2018	2019	5 year average	5 year maximum	Dry year	2013 forecast (average)
Single residential	189	177	210	185	185	189	210	200	200
Multi-residential	112	110	118	114	114	114	118	120	132
BASIX single residential	135	135	135	135	135	135	135	142	138
BASIX multi-residential	108	108	108	108	108	108	108	114	132
Single residential dual reticulated	103	103	103	103	103	103	103	109	179
Multi-residential dual reticulated	83	83	83	83	83	83	83	88	179
Van/home sites	132	143	130	161	96	133	161	140	not used
Total residential	*173*	*164*	*186*	*168*	*162*	*171*	*186*	*181*	*176*
Rural	651	672	658	783	927	738	927	782	not used
Commercial	303	294	352	332	332	322	352	342	
Commercial dual-reticulated	21	26	43	34	90	43	90	45	
Industrial	263	306	281	371	680	380	680	403	
Industrial dual-reticulated	107	133	106	72	63	96	133	102	
Municipal	480	429	428	331	420	417	480	442	
Municipal dual-reticulated	105	108	152	51	29	89	152	94	
Public parks	162	175	681	722	352	419	722	443	
Public parks dual-reticulated	64	17	15	18	66	36	66	38	
Total non-residential	*323*	*309*	*369*	*342*	*358*	*340*	*369*	*360*	*331*

5.7 Predicted Growth

BaSC has provided growth assumptions used in the development of its local growth management strategy as number of new residential lots in each development area expected to be developed between 2020 and 2046. Residential growth is provided as the estimated lot yield as well as an upper estimate of lot yield. There are no data available on growth beyond 2046. Between 2046 and 2060, residential growth is assumed to continue at the same longer-term rate (0.3% p.a. for estimated lot yield and 0.6% p.a. for upper estimated lot yield).

BaSC has also provided the area of non-residential land expected to be developed between 2020 and 2036. The total area of employment land in 2016/17 is reported as 115 ha (Department of Planning and Environment, 2019). The land earmarked for non-residential development in the local growth management strategy is 193.7 ha, resulting in a potential 168% increase in employment land (and assumed increase in non-residential connections at the same rate). This land is assumed to be developed between 2020 and 2036 with the same non-residential mix as at present. Beyond this time, additional land is expected to be released for non-residential development in line with demand. This non-residential development is assumed to continue at the same rate as the non-residential growth between 2036 and 2060.

The development areas are shown in the following figures and development estimates are summarised in Table 10. Most new development will occur in the dual reticulated water supply areas. All other residential development is assumed to be BASIX compliant (efficient) dwellings. Development is expected to include BASIX multi-residential properties (12% of total) and dual multi-residential properties (2% of total), similar to current connections.

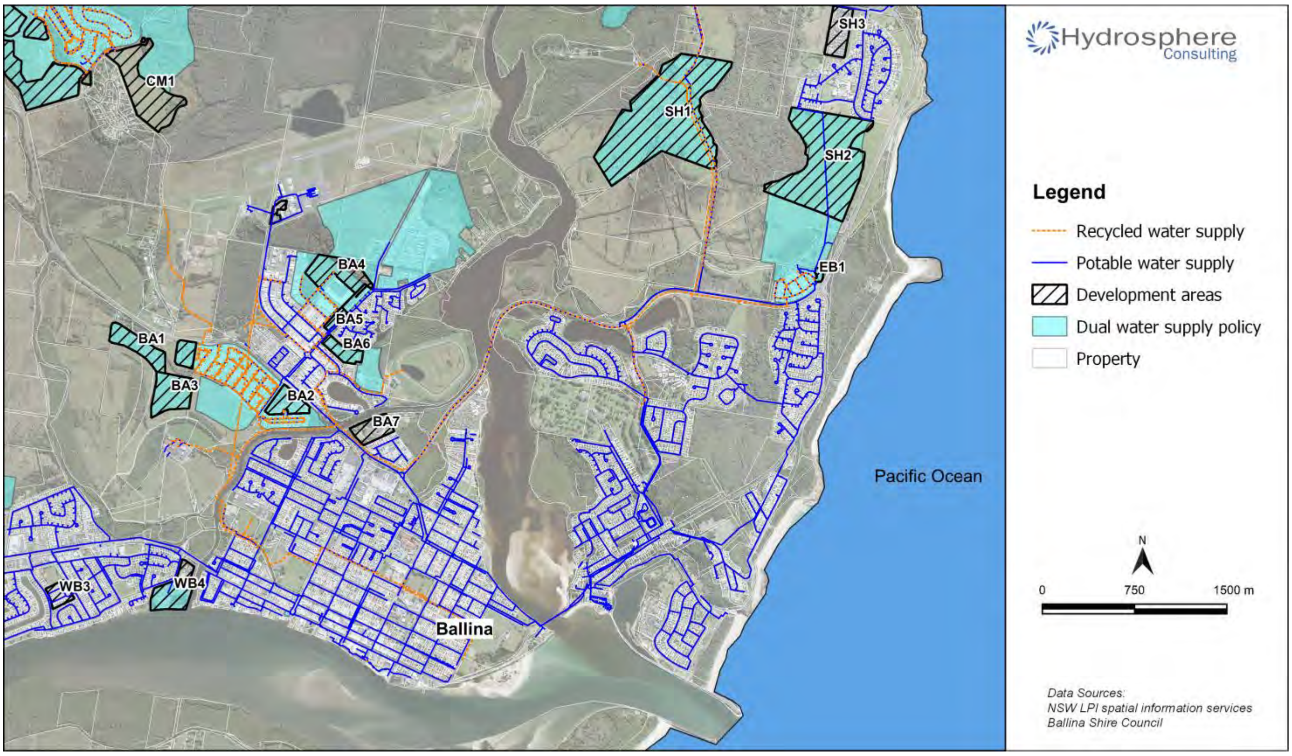

Figure 24: Development areas and dual reticulated supply – Ballina Island and Skennars Head

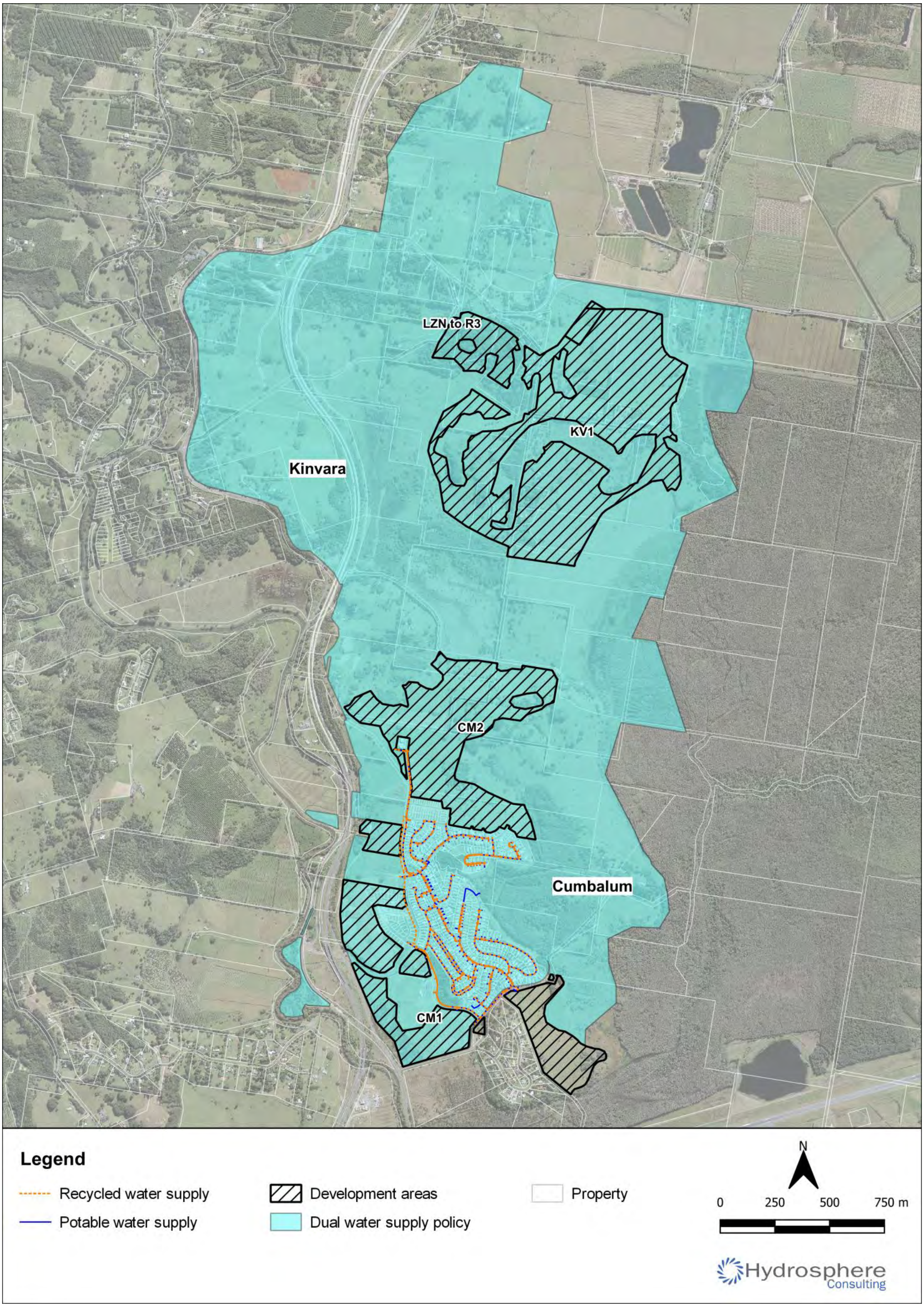

Figure 25: Development areas and dual reticulated supply – Cumbalum and Kinvara

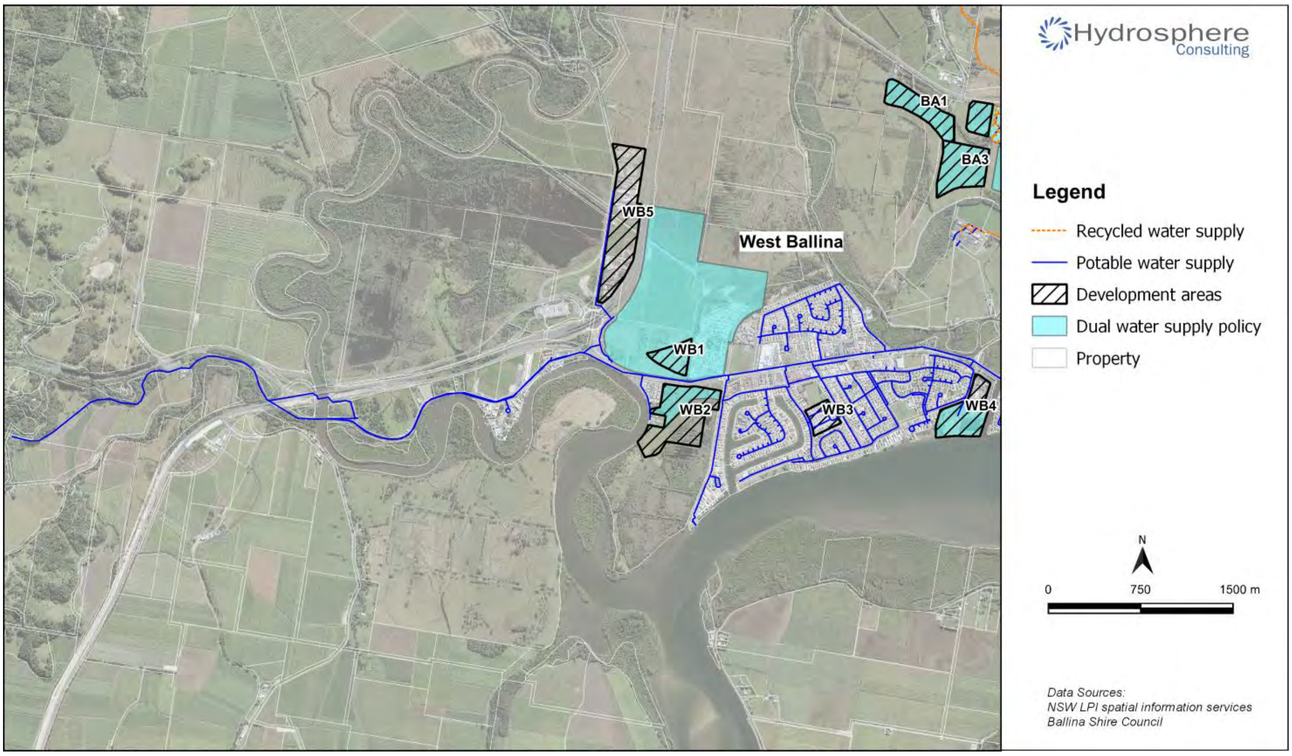

Figure 26: Development areas and dual reticulated supply – West Ballina

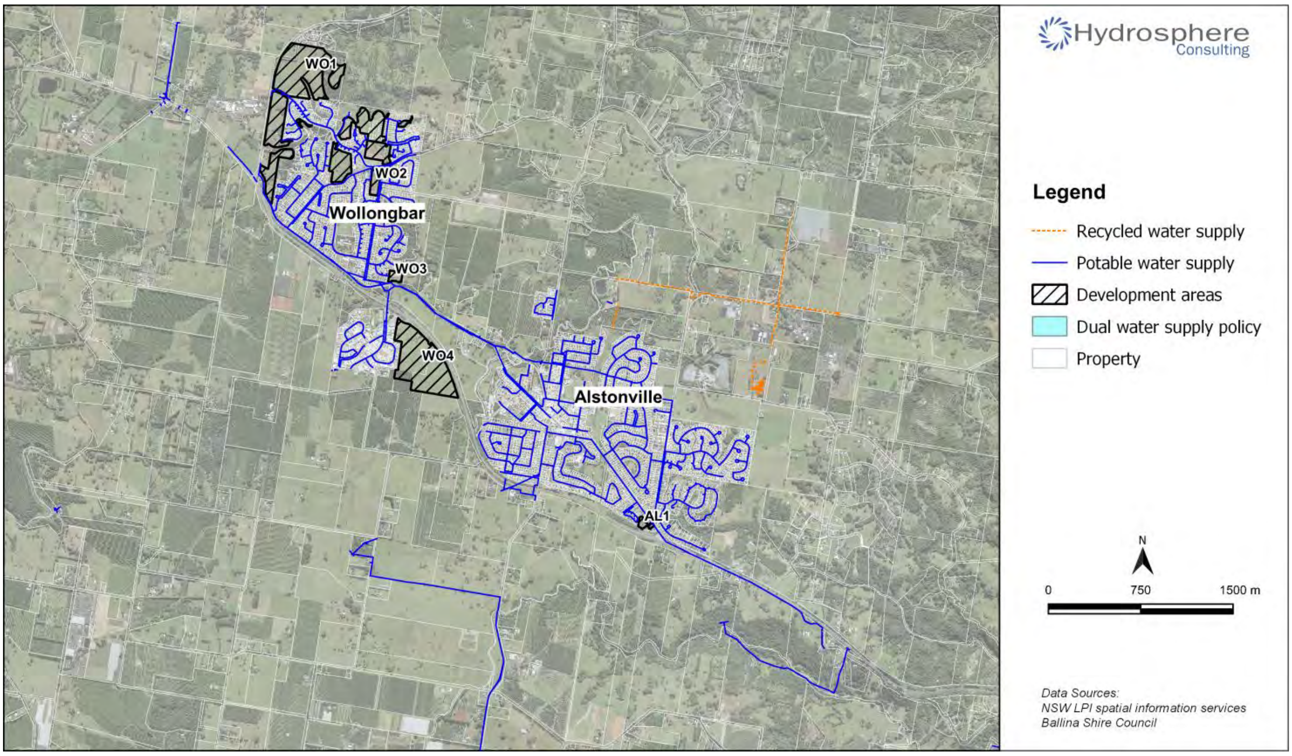

Figure 27: Development areas and dual reticulated supply – Alstonville

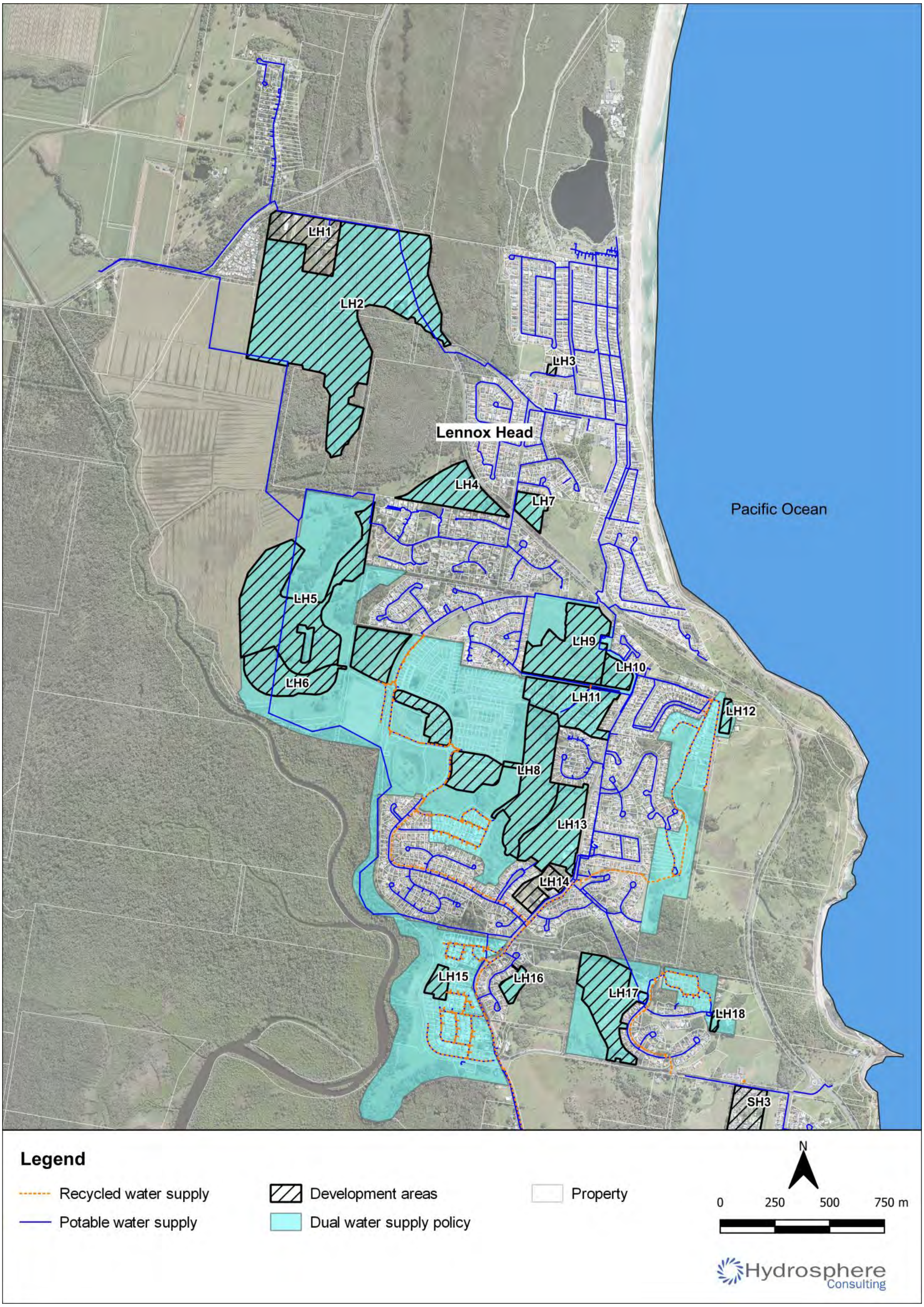

Figure 28: Development areas and dual reticulated supply – Lennox Head

Table 10: Development projections - Ballina Shire

Development type	2020 - 2030	2031 - 2040	2041 - 2050	2051 - 2060
Scenario A: estimated residential lot yield				
Potable only	734	16	-	-
Dual reticulated	2,724	1,031	482	196
Scenario B: upper estimated residential lot yield				
Potable only	958	30	-	-
Dual reticulated	3,060	1,865	930	440
Non-residential				
New potable commercial	797	725	725	725
New dual reticulated commercial	53	48	48	48
New potable industrial	1	1	1	1
New dual reticulated industrial	51	47	47	47

The forecast number of residential and non-residential connections in each ten-year period is shown in Table 11.

Table 11: Future connections – Ballina Shire

Connection Type	2020	2030	2040	2050	2060
Scenario A: estimated residential lot yield					
Single residential	10,062	9,100	8,230	7,827	7,445
Multi-residential	1,009	912	825	785	746
BASIX single residential	789	2,333	3,218	3,678	4,190
BASIX multi-residential	125	300	389	436	490
Single residential dual reticulated	1,851	4,299	5,310	5,739	5,932
Multi-residential dual reticulated	29	79	100	108	112
Van/home sites	857	857	857	857	857
Total residential	*14,721*	*17,881*	*18,928*	*19,431*	*19,772*

Connection Type	2020	2030	2040	2050	2060
Scenario B: upper estimated residential lot yield					
Single residential	10,062	9,100	8,230	7,827	7,445
Multi-residential	1,009	912	825	785	746
BASIX single residential	808	2,530	3,427	3,915	4,537
BASIX multi-residential	127	327	417	468	535
Single residential dual reticulated	1,851	4,628	6,455	7,247	7,672
Multi-residential dual reticulated	29	86	123	139	147
Van/home sites	857	857	857	857	857
Total residential	*14,743*	*18,440*	*20,335*	*21,239*	*21,940*
Non- residential					
Rural	14	14	14	14	14
Commercial	1,268	1,993	2,718	3,443	4,168
Commercial dual-reticulated	70	118	166	213	261
Industrial	77	78	80	81	82
Industrial dual-reticulated	7	53	100	147	193
Municipal	308	308	308	308	308
Municipal dual-reticulated	3	3	3	3	3
Public parks	71	71	71	71	71
Public parks dual-reticulated	4	4	4	4	4
Total non-residential connected properties	*1,822*	*2,643*	*3,463*	*4,284*	*5,105*

A comparison between the historical data, the revised forecast of connected properties and the 2013 forecast is shown in the following figure. The longer-term projection of residential properties is lower in the revised forecast due to the lower estimated lot yields. The non-residential connection forecasts are similar.

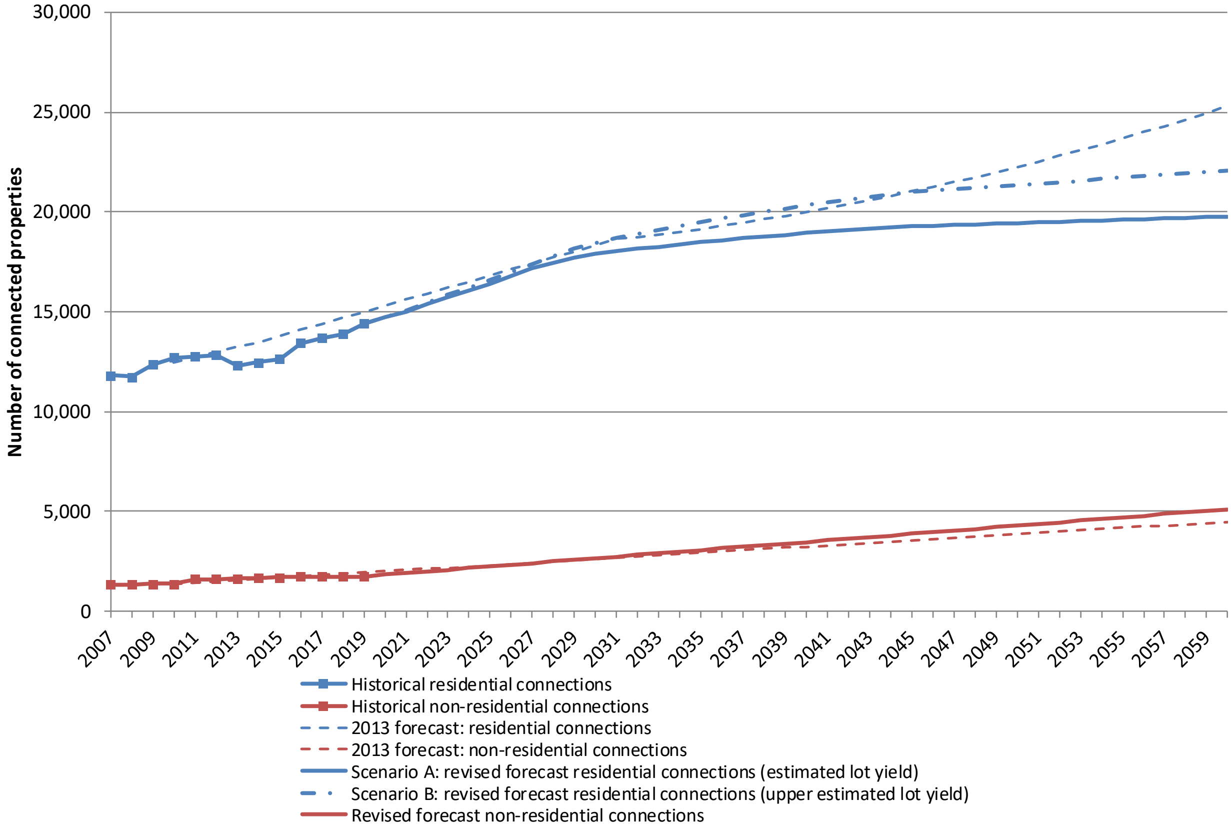

Figure 29: Forecast number of connections and comparison with 2013 demand forecast – Ballina Shire

5.8 Predicted Future Demand

5.8.1 Consumption

The forecast average and dry year customer demand is shown on Figure 30 along with the 2013 forecast. The revised forecast is similar to the 2013 forecast.

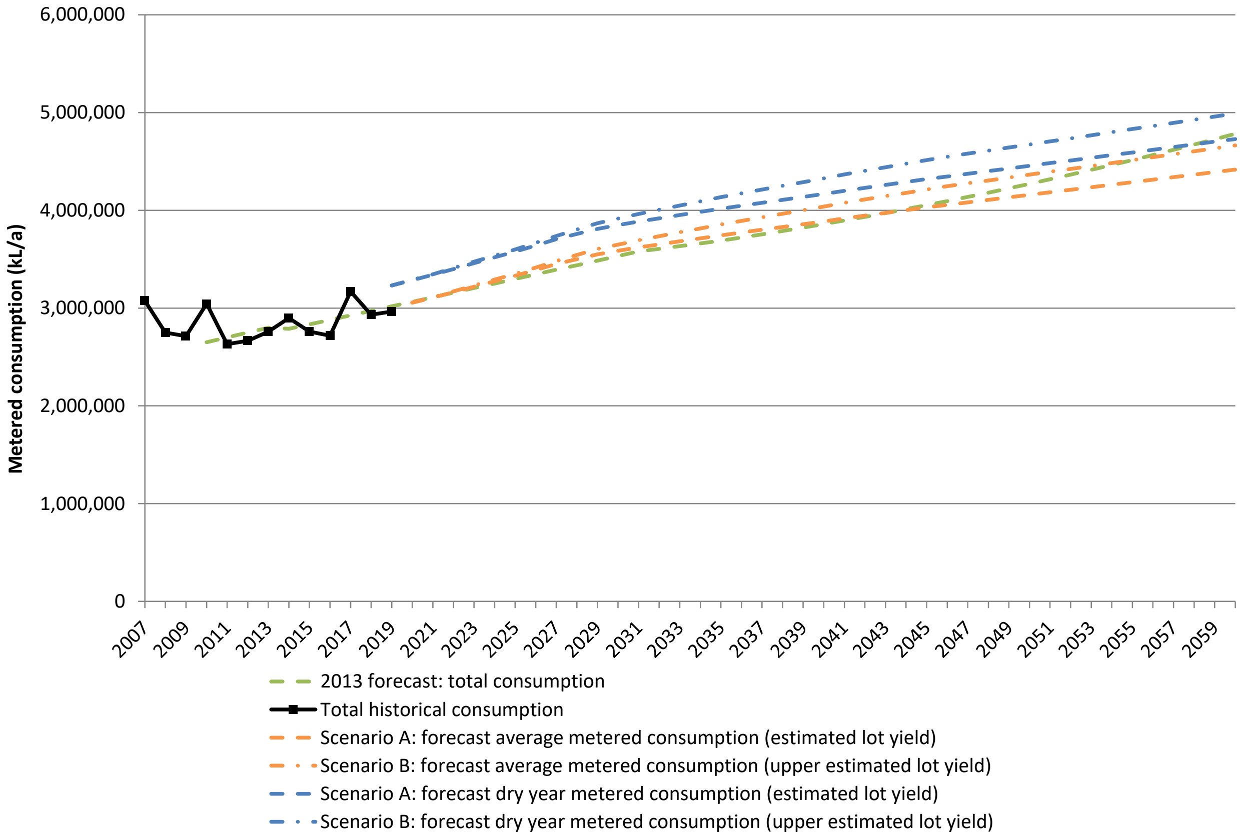

Figure 30: Revised forecast metered consumption and comparison with 2013 demand forecast – Ballina Shire

5.8.2 Water loss management measures

Two scenarios have been developed for water savings due to demand management:

1. No water loss management – using current average NRW = 20.3% of bulk supply.
2. Predicted NRW with WLMP targets – NRW savings of 65 ML/a by 2024.

The Ballina Shire demand with scenarios 1 and 2 is shown on Figure 31 and also compared to the 2013 forecast.

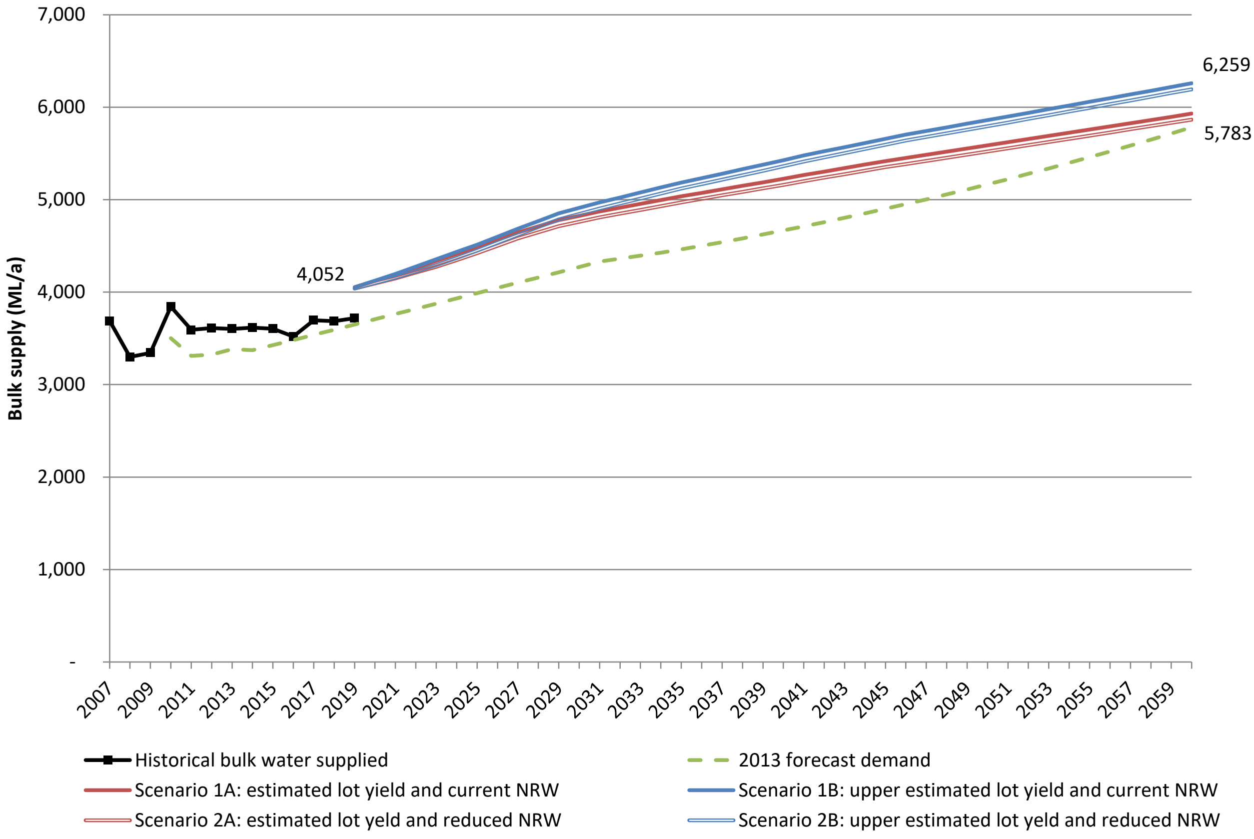

Figure 31: Dry year unrestricted demand forecast: water loss management scenario 1 and 2 and comparison with 2013 forecast – Ballina Shire

6. BYRON SHIRE BULK SUPPLY AREA

6.1 Bulk Water Supply Area

The bulk water supply network within Byron Shire is shown on Figure 32.

6.2 Historical Connected Properties and Consumption

BySC provided data on metered connections and consumption between 2010/11 and 2018/19. For the last 3 years, Council has classified the non-residential connections further into categories to match those required by the NSW performance reporting (commercial, industrial and institutional). Data for the last 3 years are available as annual totals. Prior to that, datasets are available as quarterly totals but not further categorised into non-residential types.

Annual connected property data is shown on Figure 33. The majority of non-residential connections are commercial properties. Annual metered consumption is shown on Figure 34.

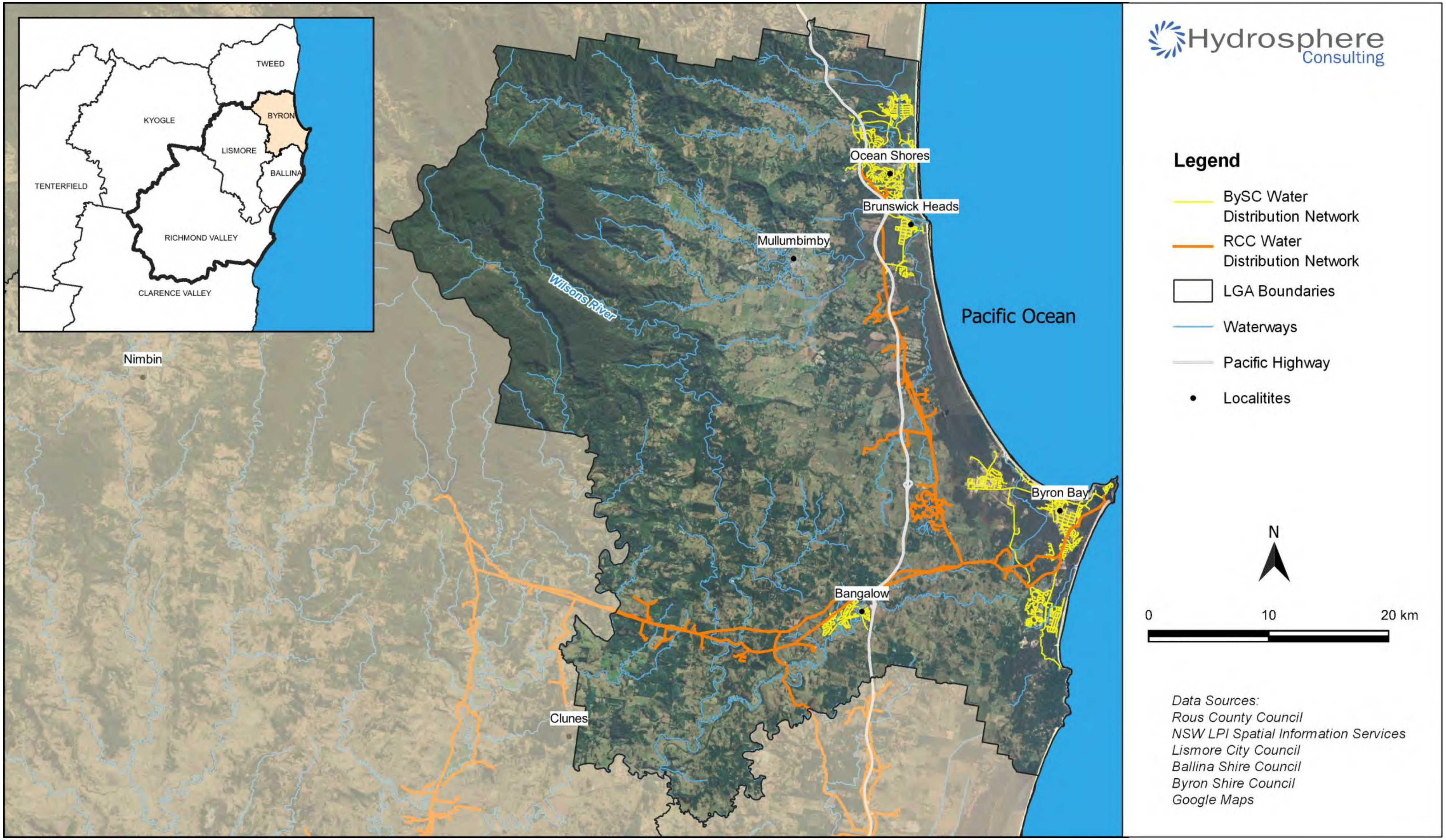

Figure 32: Bulk water supply network - Byron Shire

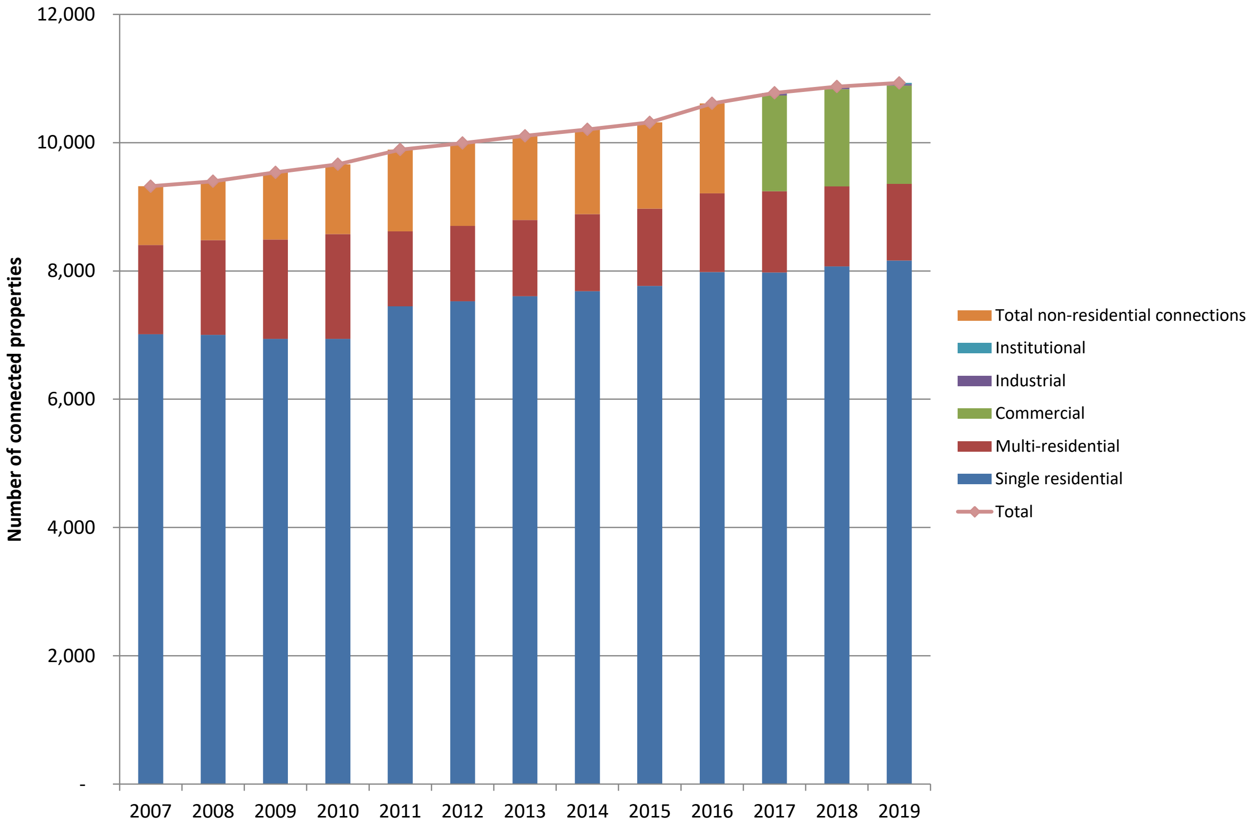

Figure 33: Historical connected properties - Byron Shire

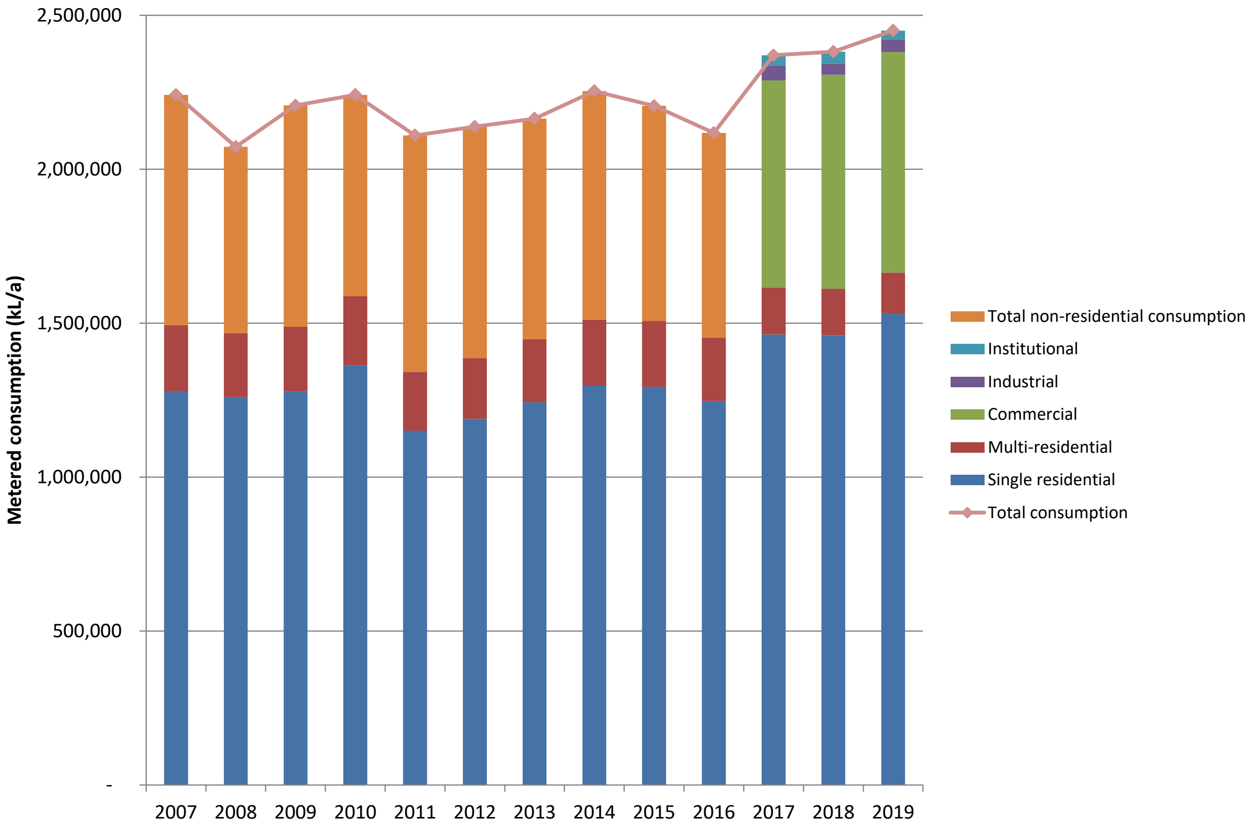

Figure 34: Historical metered consumption – Byron Shire

The breakdown of residential properties including BASIX and non-BASIX properties is given on Figure 33.

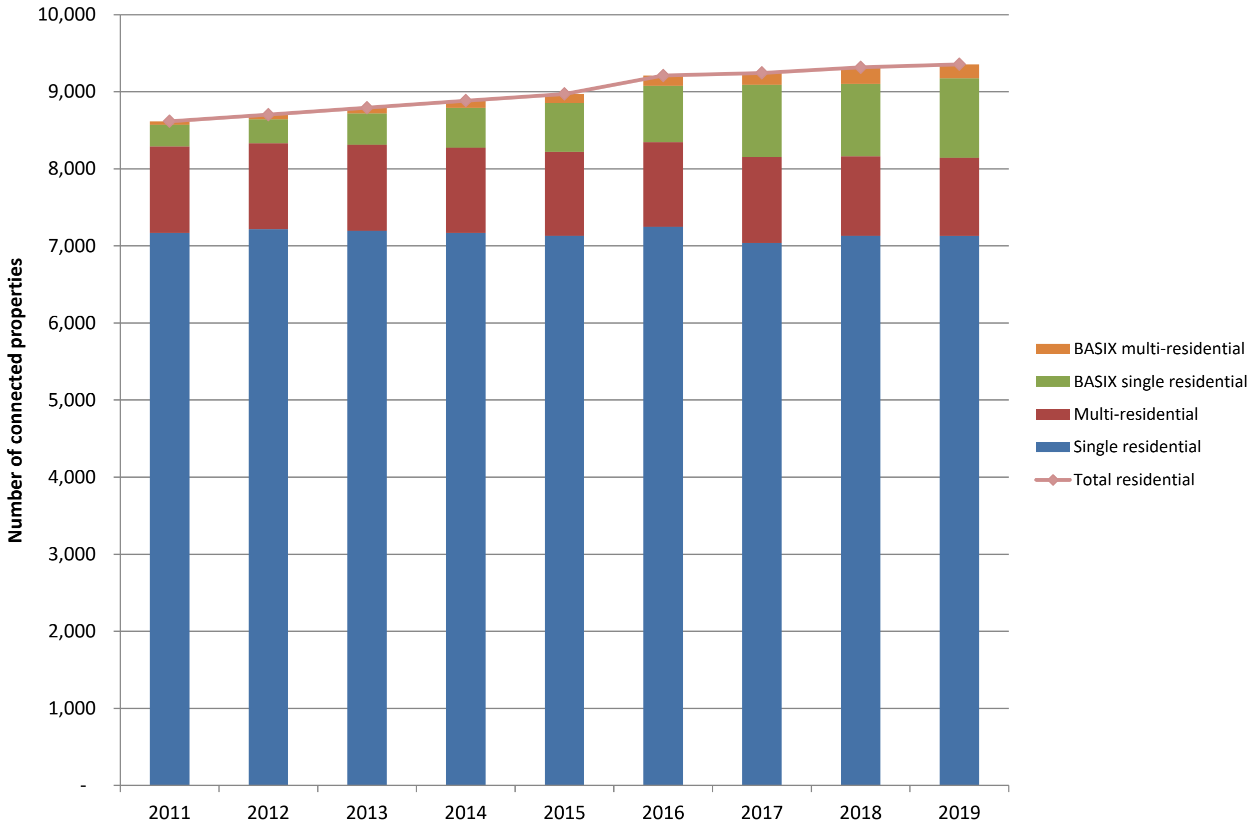

Figure 35: Historical connected residential properties (including BASIX) - Byron Shire

6.3 Factors Influencing Metered Consumption

Annual residential consumption appears to be increasing between 2007 and 2019 but a similar trend is not apparent with non-residential consumption (refer Figure 34).

The impact of the following factors on metered customer demand has been assessed:

- Number of connected properties (refer Figure 36). Residential consumption has increased between 2007 and 2019 along with the number of residential connections but a similar relationship is not observed for non-residential connections/consumption.

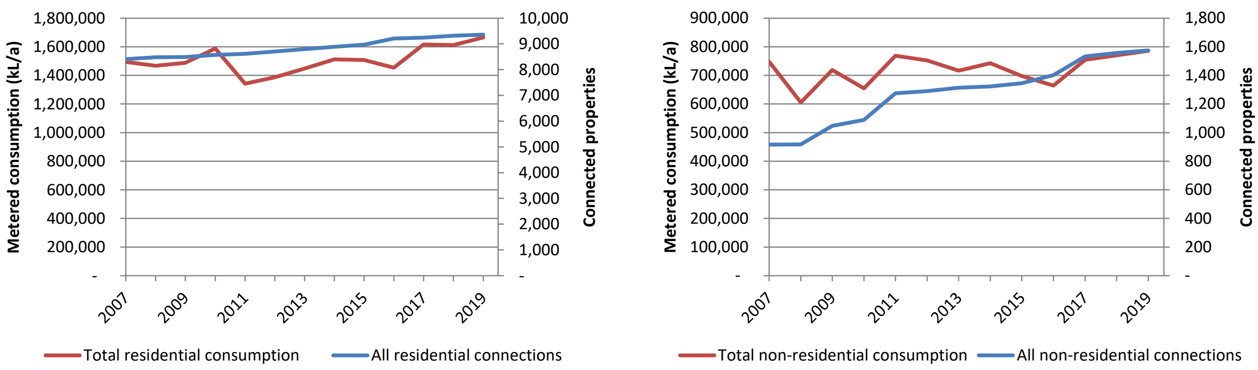

Figure 36: Comparison between connected properties and metered demand - Byron Shire

- Climate (average maximum temperature and annual rainfall at Byron Bay (refer Figure 37). Residential consumption appears to increase with low rainfall in some years and increase with high temperatures but a similar relationship is not observed for non-residential consumption. Climate correction is discussed in Section 6.6 and Appendix 2.

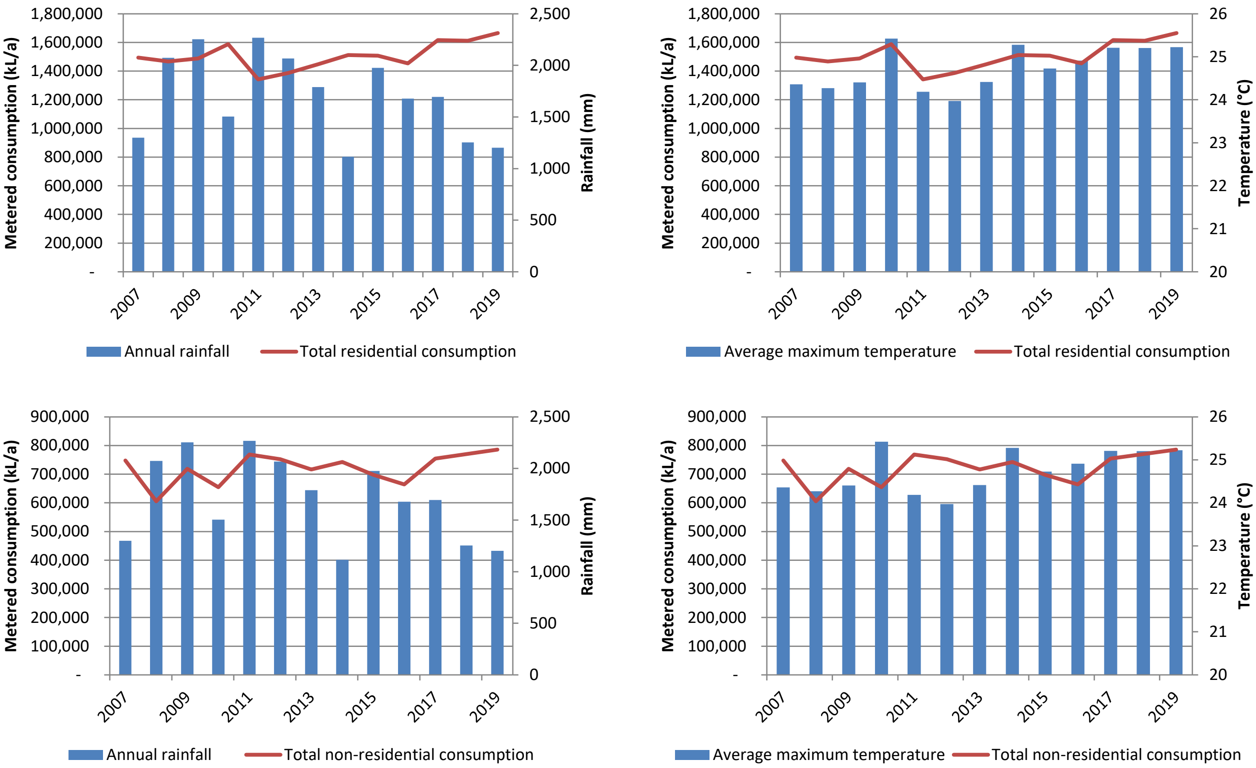

Figure 37: Comparison between climate and metered demand - Byron Shire

- Water pricing (usage charge, refer Figure 38). Despite the increasing price of water since 2007, the residential consumption per connection has remained relatively stable. However, non-residential consumption has decreased with the increasing price of water.

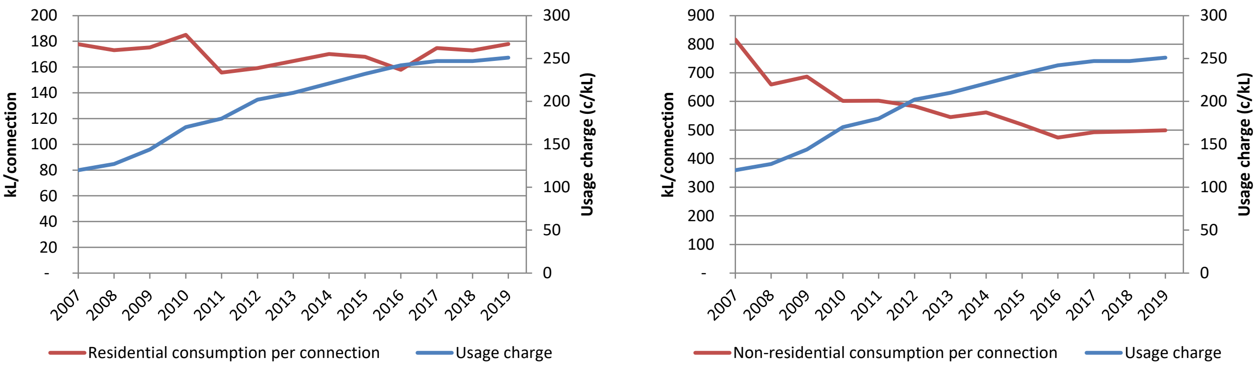

Figure 38: Comparison between usage charge and metered demand - Byron Shire

Drought restrictions are discussed in Section 6.4.

6.4 Bulk Supply from RCC

Daily bulk water supply to Byron Shire and restrictions imposed are shown on Figure 39.

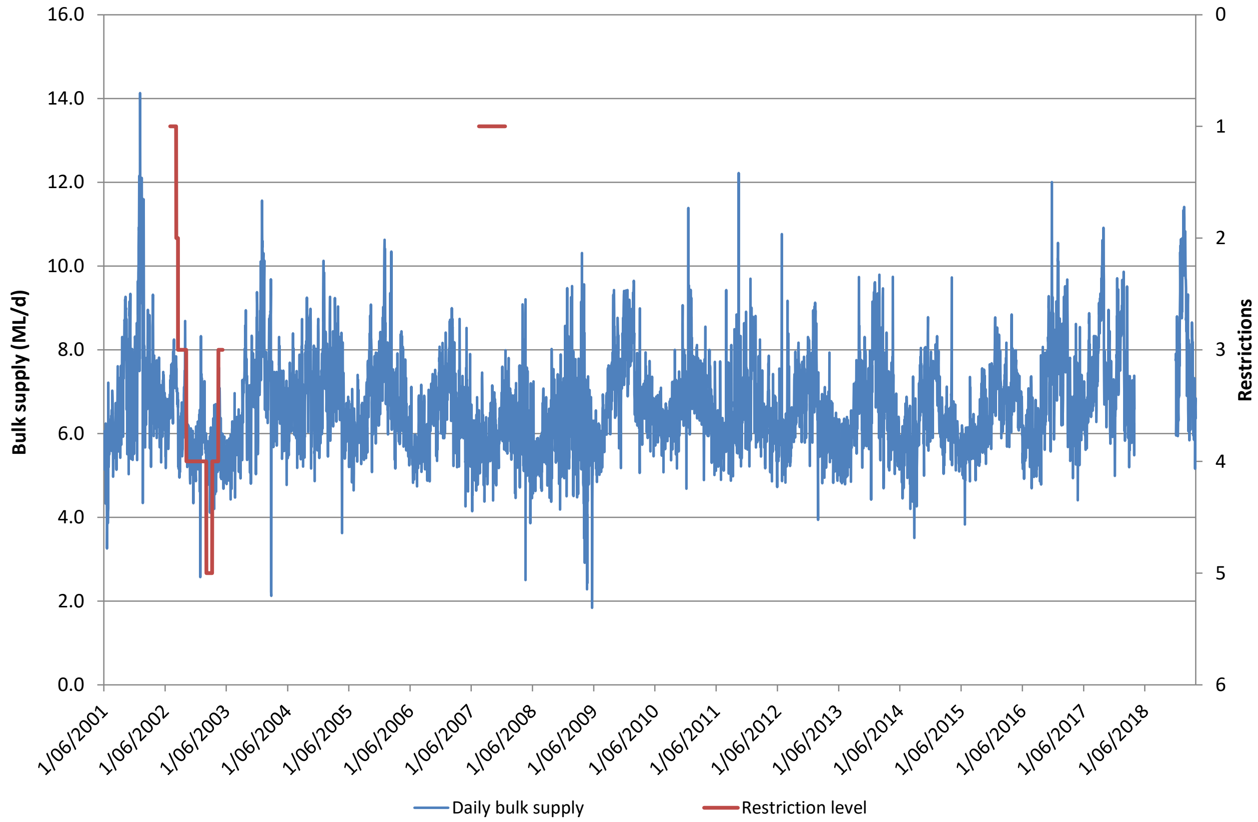

Figure 39: Daily supply to Byron Shire: 1/6/2001 – 31/3/2019

The daily bulk meter data since 2001/02 were used to assess the ADD and PDD for each year. ADD, summer PDD and PDD:ADD are shown in Table 12 and Figure 40 for each year.

Table 12: Summer period peak and average demand – Byron Shire

Summer period	PDD	ADD	PDD:ADD
2001/02	14.1	7.2	2.0
2002/03	8.3	5.9	1.4
2003/04	11.6	6.9	1.7
2004/05	10.1	7.0	1.4
2005/06	10.6	6.8	1.6
2006/07	9.0	6.4	1.4
2007/08	8.0	6.0	1.3
2008/09	9.5	6.1	1.6
2009/10	9.6	7.1	1.4
2010/11	11.4	6.7	1.7
2011/12	9.7	6.5	1.5
2012/13	9.1	6.4	1.4
2013/14	9.8	6.6	1.5
2014/15	8.3	6.3	1.3

Summer period	PDD	ADD	PDD:ADD
2015/16	8.8	6.6	1.3
2016/17	10.6	7.0	1.5
2017/18 (1)	9.9	6.6	1.5
2018/19 (1)	11.4	6.6	1.7
Average	-	6.6	-
Maximum	14.1	-	2.0

Note 1: Daily datasets are only available for the summer period of 2018 and 2019. The average of the previous 4 years ADD has been used here.

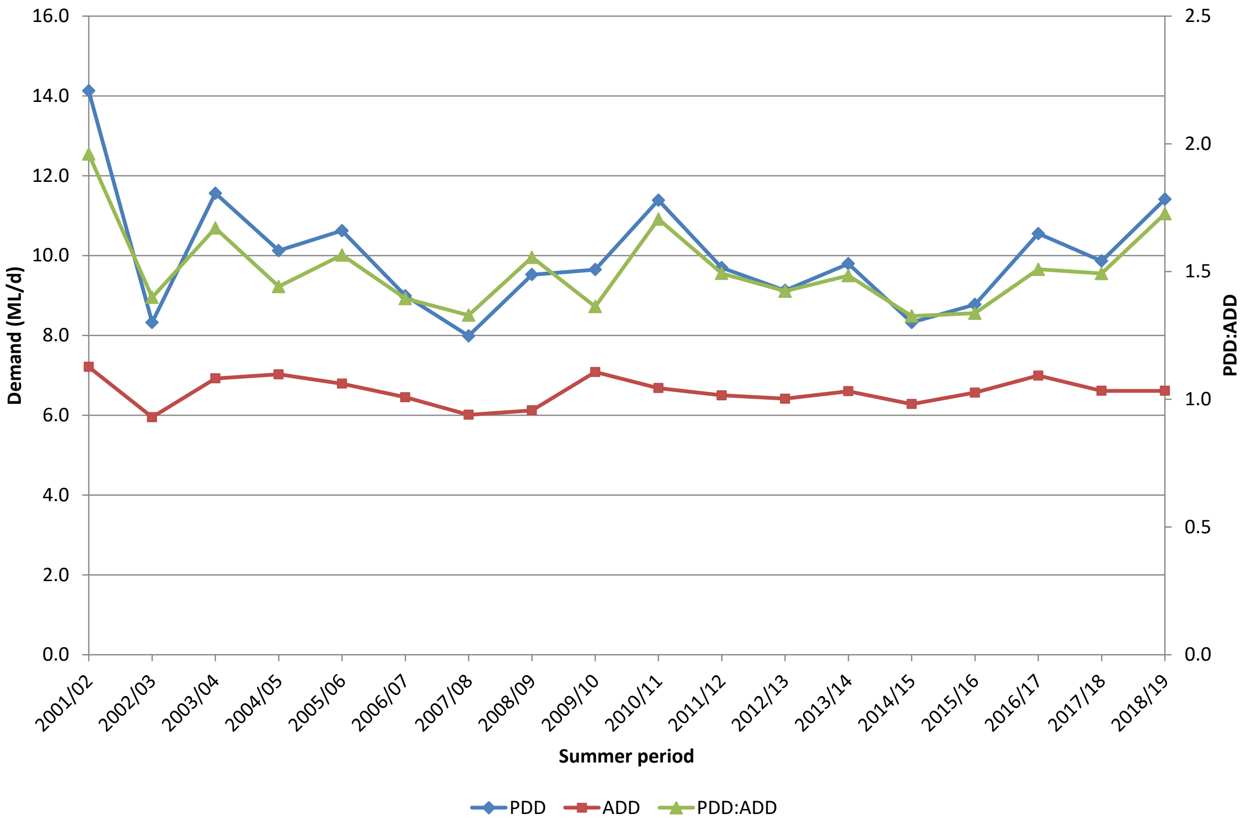

Figure 40: Summer period peak and average demand – Byron Shire

The highest demand was experienced in 2001/02 (14.0 ML/d) with a PDD:ADD ratio of 2.0. Daily demand and rainfall for 2001/02 (recorded at Byron Bay BOM station) is shown in the following figures.

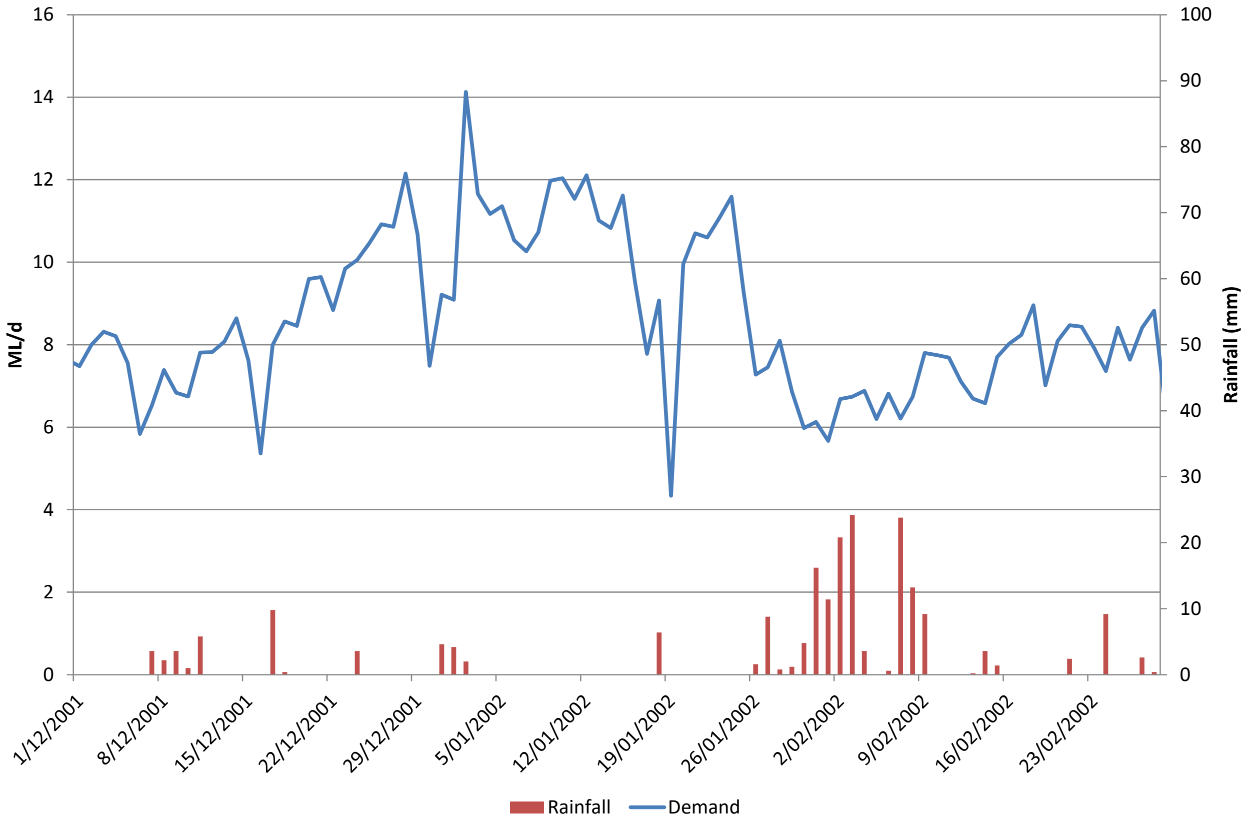

Figure 41: Daily demand and rainfall – Byron Shire: 2001/02

The highest recorded summer PDD (14.1 ML/d) was recorded on 2 January 2002 with 12 mm rainfall in the previous 2 weeks (2.0 times the 2001/02 average demand). A peak day to average day ratio of 2.0 is considered appropriate for the future peak demand forecast for the Byron Shire service area.

6.5 Non-Revenue Water

Metered consumption, bulk water supplied and NRW for Byron Shire are shown on Figure 42. Average NRW over the last 5 years was 237,820 kL/a or 9.3% of bulk supply. Between 2007 and 2010, NRW ranged from 5.3% p.a. to 14.3% p.a. (as reported in the 2013 Demand Forecast). The 2013 demand forecast assumed NRW would be 5% p.a. between 2020 and 2060 (based on the average losses between 2007 and 2010).

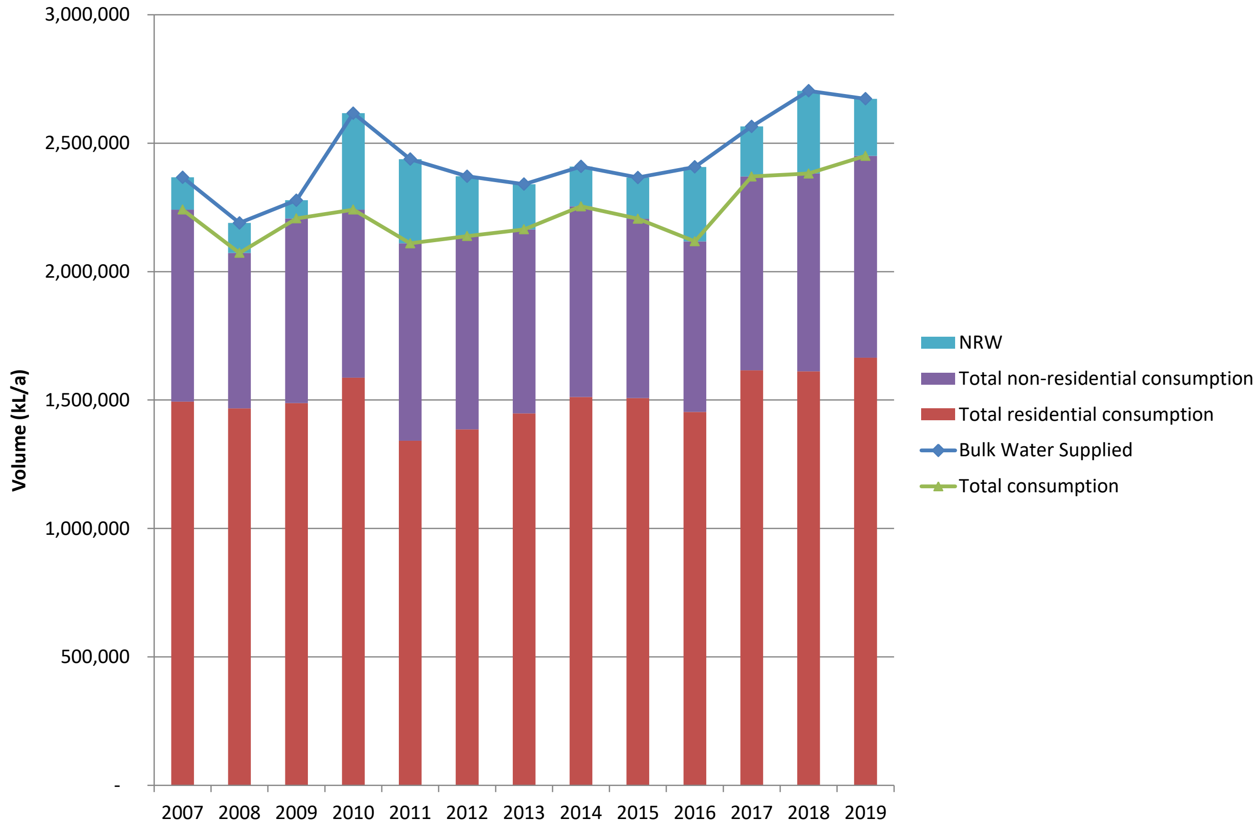

Figure 42: Bulk supply, metered consumption and NRW – Byron Shire

6.6 Average and Dry Year Demand

The climate correction analysis undertaken for Byron Shire bulk supply area suggests that the dry year demand is 3.5% higher than the average demand (Appendix 2). The historical metered consumption per connection for each customer type and the average, maximum and dry year consumption per connection are shown in Table 13. This table also shows the average consumption per connection used in the 2013 demand forecast. The revised consumption rates are slightly lower than the 2013 rates used.

Table 13: Consumption per connection – Byron Shire (kL/a)

Connection type	2015	2016	2017	2018	2019	5 year average	5 year maximum	Dry year	2013 forecast (average)
Single residential	183	172	194	190	199	188	199	192	192
Multi-residential	114	107	124	127	114	117	127	120	134
BASIX single residential	111	111	111	111	111	111	111	114	138
BASIX multi-residential	97	97	97	97	97	97	97	99	99
Total residential	168	158	175	173	178	170	178	175	177

Connection type	2015	2016	2017	2018	2019	5 year average	5 year maximum	Dry year	2013 forecast (average)
Commercial			451	459	467	459	467	470	
Industrial			2,151	1,769	1,815	1,912	2,151	1,960	not used
Institutional			1,823	1,978	1,555	1,785	1,978	1,830	
Total non-residential	519	474	492	495	499	496	519	508	687

6.7 Predicted Growth

BySC has prepared growth management strategies for urban land, rural areas and business/industrial land (BySC 2019a; 2019b; 2019c). The development areas and estimated capacity and timing of development are discussed below.

Anticipated residential development from 2020 to 2036 is summarised in Table 14 and shown on the following figures. Residential development is expected to be a mix of single and multi-residential properties that are BASIX compliant. There are no data on predicted growth beyond 2036. Beyond 2036, the number of new residential connections each year is assumed to the same as between 2032 and 2036.

Table 14: Anticipated residential development - Byron Shire

Stage	Vacant	Infill	New release area
Short-term	293	150	50
2 – 5 years	410	150	5
5 – 10 years	383	212	2
10 + years	70	203	-
Total	**1,156**	**715**	**57**

Source: Byron Shire Council (2019a)

Anticipated business and industrial development from 2020 to 2041 is summarised in Table 15. Business tenancies are assumed to generate demand equivalent to a commercial property.

Table 15: Anticipated business and industrial development - Byron Shire

Stage	Large footprint business tenancies	Smaller business tenancies	Industrial expansion
By 2022	-	59	181
By 2028	-	60	123
By 2031	1	61	-
By 2041	1	143	-
Total	**2**	**323**	**304**

Source: BySC (2019b), BySC (2019c)

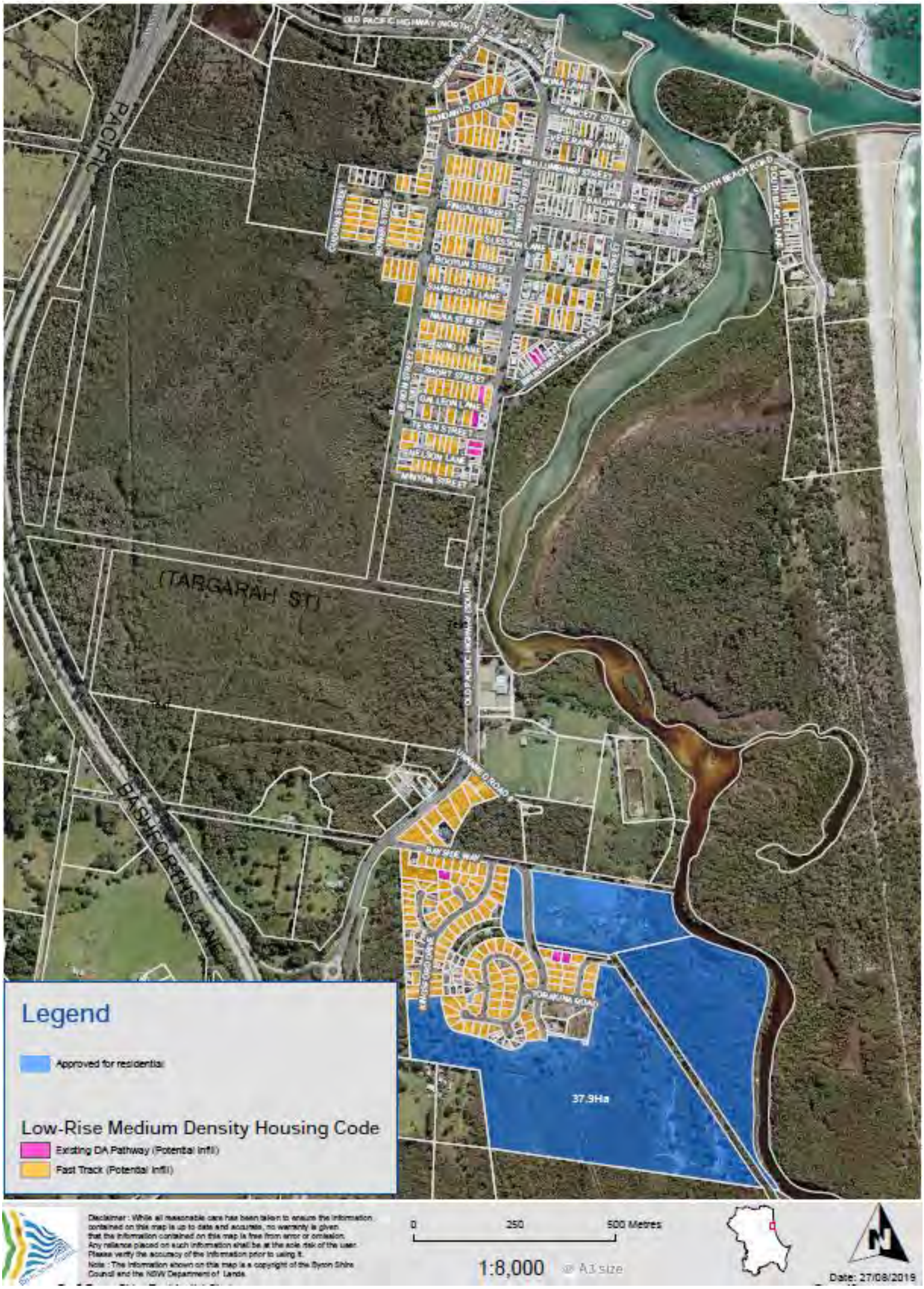

Figure 43: Potential urban housing supply – Brunswick Heads

Source: BySC (2019a)

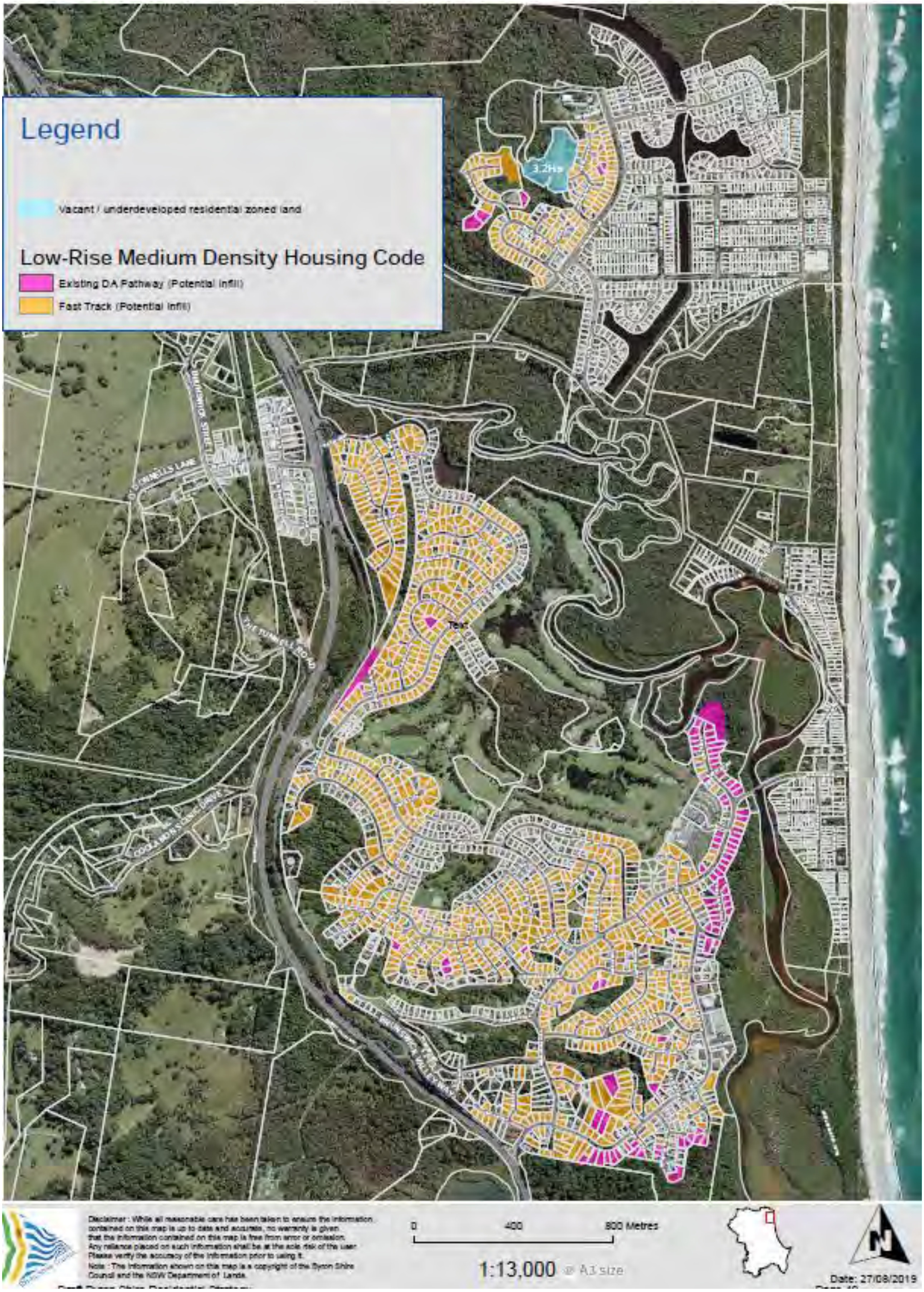

Figure 44: Potential urban housing supply – Ocean Shores and New Brighton

Source: BySC (2019a)

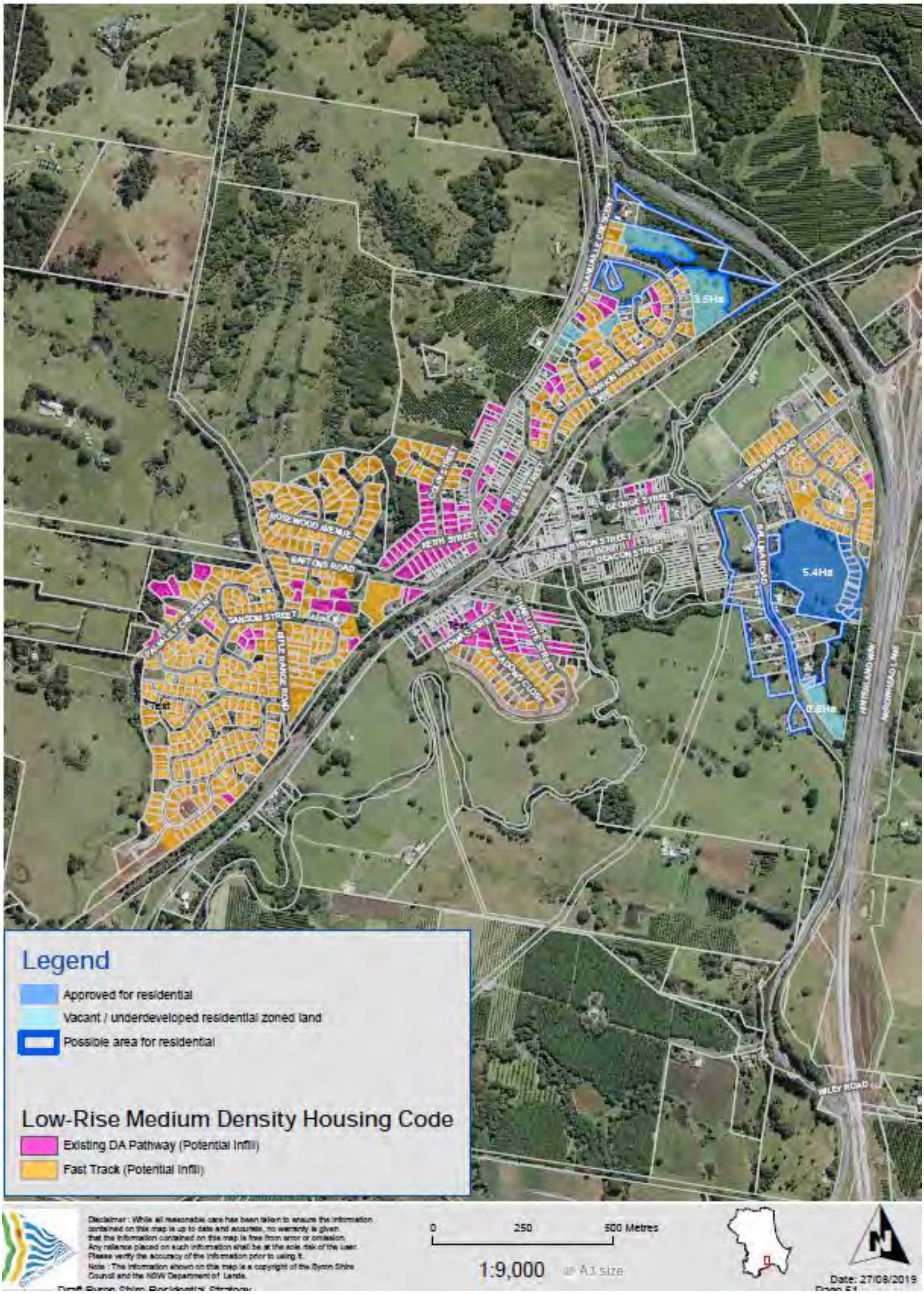

Figure 45: Potential urban housing supply – Bangalow

Source: BySC (2019a)

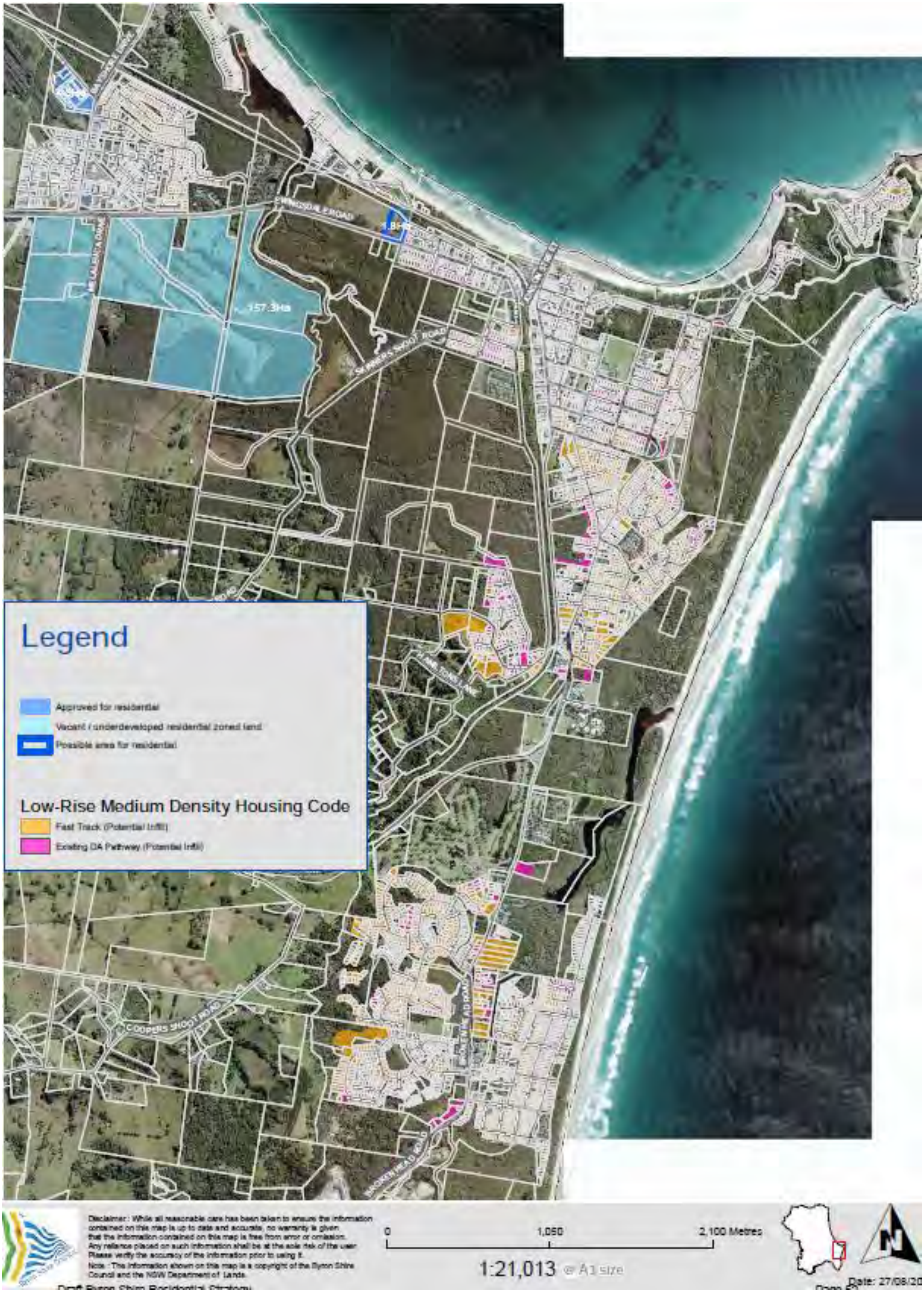

Figure 46: Potential urban housing supply – Byron Bay and Suffolk Park

Source: BySC (2019a)

The resulting number of connections in each ten-year period is given in Table 16.

Table 16: Future connections – Byron Shire

Connection Type	2010	2020	2030	2040	2050	2060
Single residential	7,222	7,097	6,351	5,744	5,195	4,698
Multi-residential	1,111	1,082	904	818	740	669
BASIX single residential	209	669	3,284	4,311	5,280	6,197
BASIX multi-residential	32	123	519	690	823	964
Total residential connected properties	8,574	8,971	11,058	11,548	12,038	12,528
Commercial		1,554	1,697	1,895	1,976	2,056
Industrial		83	143	143	152	158
Institutional		18	18	18	19	20
Non-residential connected properties	1,088	1,655	1,858	2,059	2,146	2,234
All connected properties	9,662	11,258	12,916	13,607	14,184	14,762
Bulk supply area growth (total connections) % p.a.	1.3%	3.0%	0.5%	0.4%	0.4%	0.4%

A comparison between the historical data, the revised forecast of connected properties and the 2013 forecast is shown in the following figure. The longer-term projections of residential properties are similar but the revised projection of non-residential connected properties is higher due to the higher development projections.

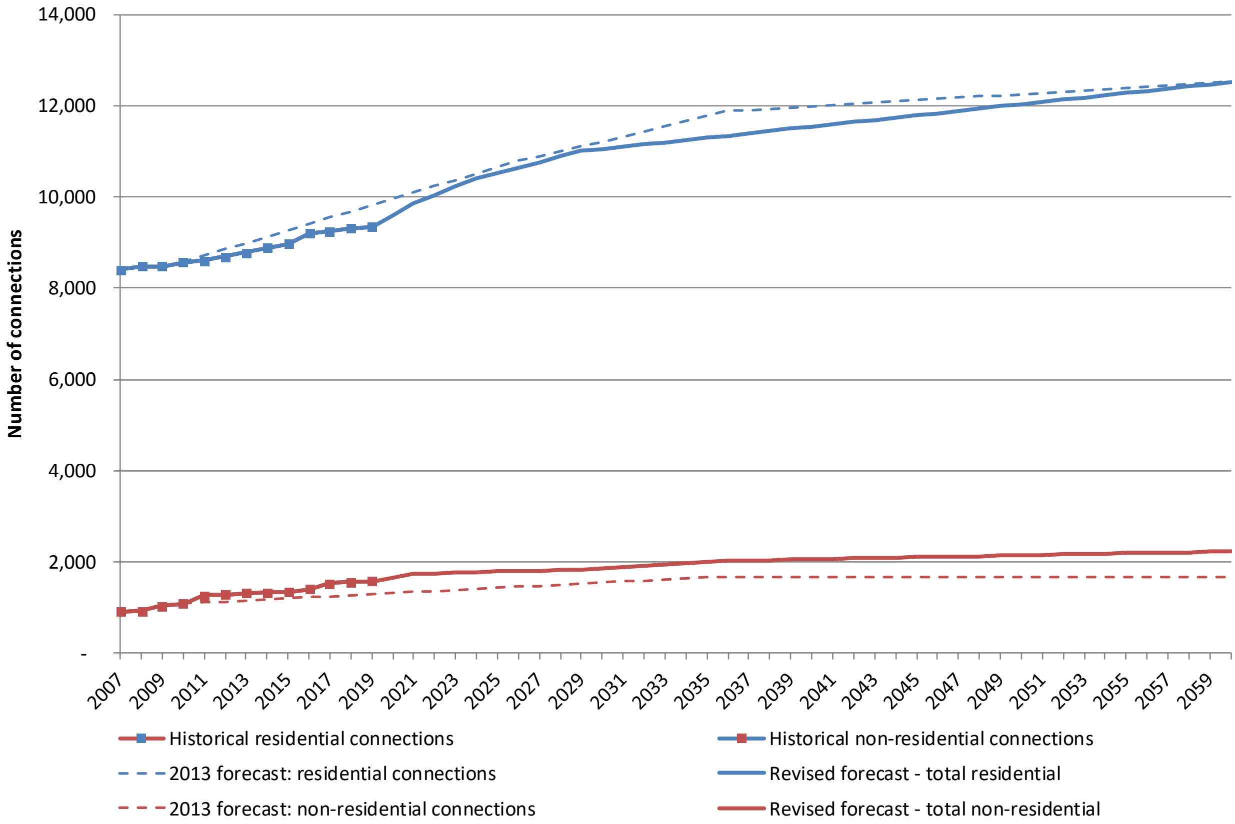

Figure 47: Forecast number of connections and comparison with 2013 demand forecast – Byron Shire

6.8 Predicted Future Demand

6.8.1 Consumption

The forecast average and dry year customer demand is shown on Figure 48 along with the 2013 forecast. The longer-term revised forecast is higher than the 2013 forecast due to the higher growth in commercial and industrial connections and the associated high consumption for the non-residential connections.

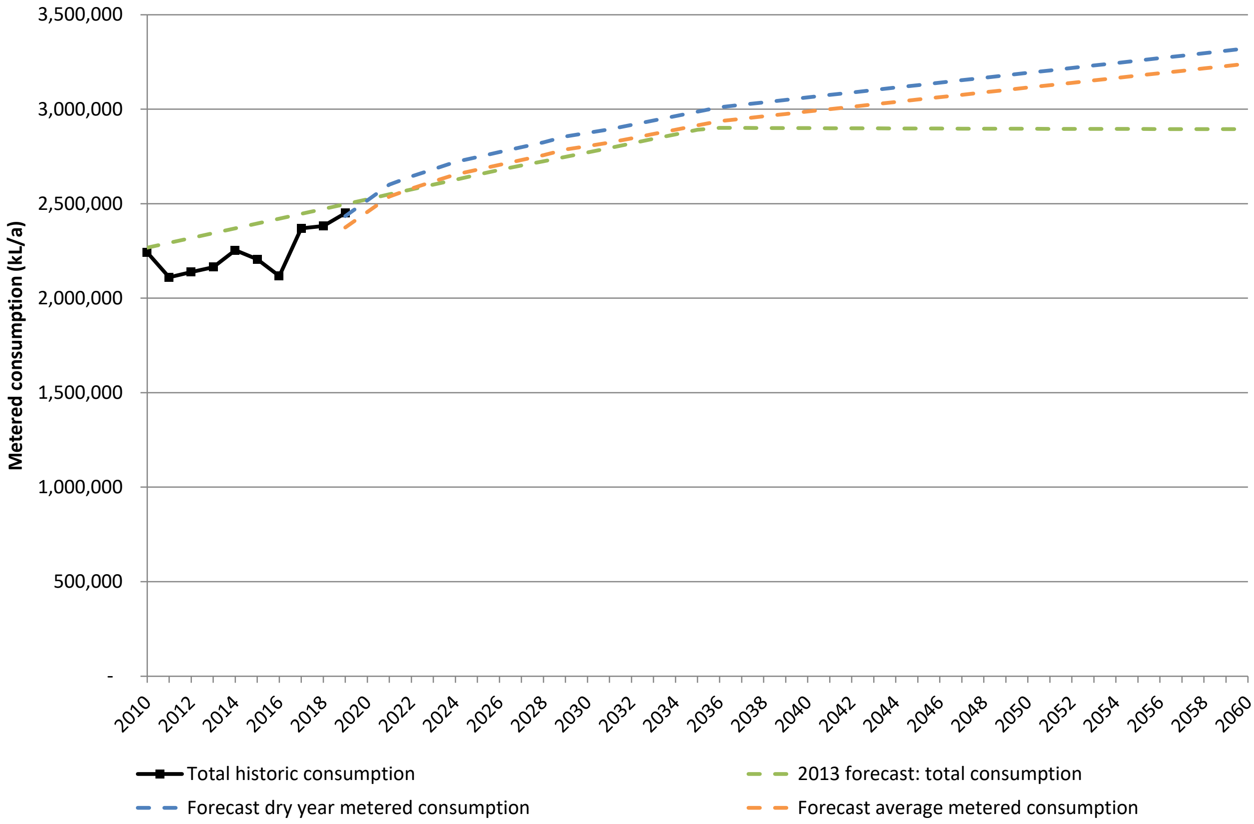

Figure 48: Revised forecast metered consumption and comparison with 2013 demand forecast – Byron Shire

6.8.2 Water loss management measures

Two scenarios have been developed for water savings due to demand management:

1. No water loss management – using current average NRW = 9.3% of bulk supply.
2. Predicted NRW with WLMP targets – NRW savings of 66 ML/a by 2024.

The Byron Shire demand with scenarios 1 and 2 is shown on Figure 49 and also compared to the 2013 forecast.

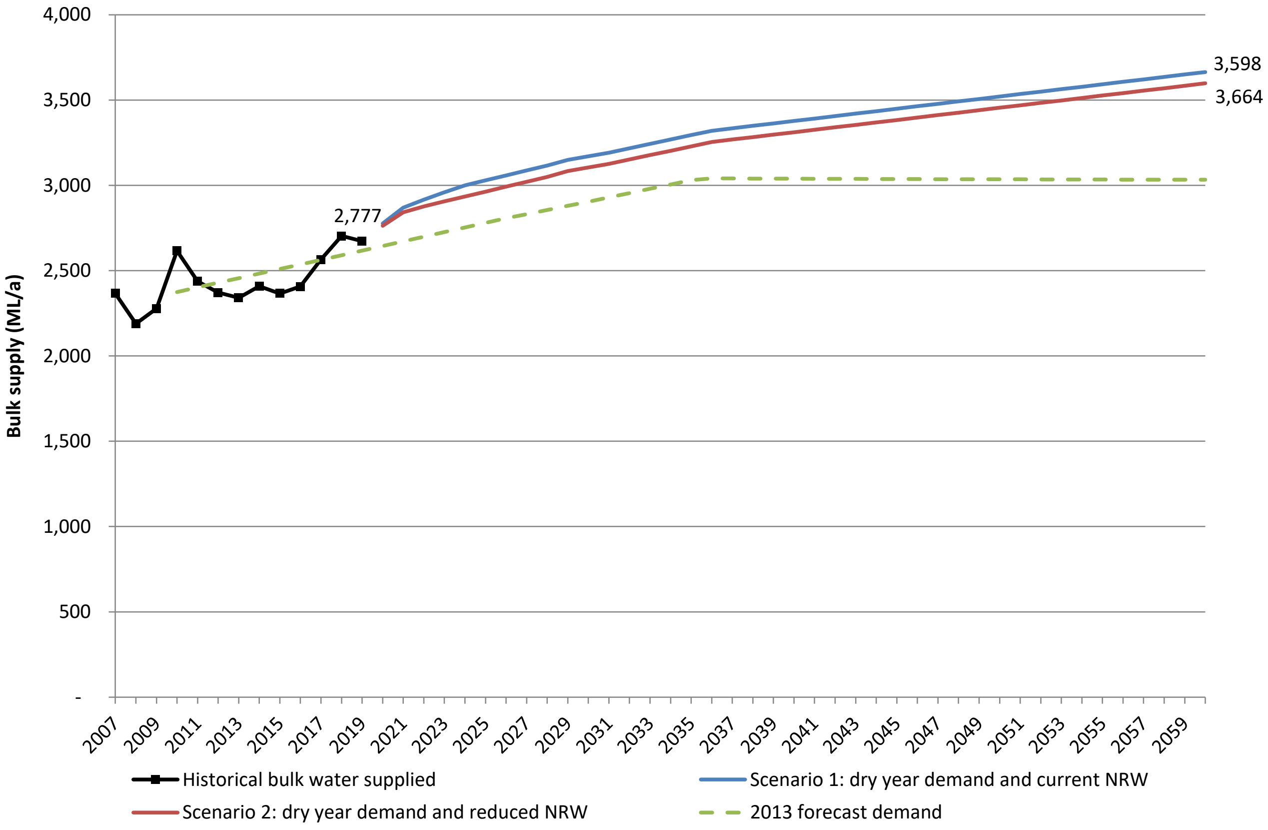

Figure 49: Average and dry year unrestricted demand forecast and comparison with 2013 forecast – Byron Shire

7. LISMORE CITY COUNCIL BULK SUPPLY AREA

7.1 Bulk Water Supply Area

The bulk water supply network within Lismore is shown on Figure 50.

7.2 Historical Connected Properties and Metered Consumption

LCC has provided data on quarterly metered consumption and number of meters between 2009/10 and 2018/19. Analysis of the data and advice from LCC indicates:

- These data could include replaced meters or multiple meters for a connected property and hence could overstate the number of active meters.
- When compared to data on residential connected properties reported to DPIE as part of annual performance reporting (adjusted for Nimbin), the number of residential meters is less than number of connected residential properties reported.
- For strata-subdivided multi-residential development it is usually the case that each unit will have its own meter and would be treated the same way as a detached single dwelling. Non-strata-titled multi-residential, older strata-titled multi-residential developments or developments that have been strata-subdivided after construction would only have a single master meter. In these cases, there is no record of the number of units on the property.
- When compared to data on metered consumption reported to DPIE as part of annual performance reporting (adjusted for Nimbin), the new consumption values are higher.
- When compared to bulk sales, the level of NRW is (average) 4% p.a. which is considered too low and therefore inaccurate (when compared to losses reported in the 2013 demand forecast).

LCC is unable to explain these data discrepancies.

The meter data is compared to the connected properties and metered consumption data reported to DPIE as part of annual performance reporting (adjusted for Nimbin) in Figure 51 and Figure 52.

As the new data on consumption appears to be high (when compared to annual performance reporting data and bulk sales), it is considered inaccurate to use the new data for consumption rates. Therefore the annual performance reporting data for consumption and connected properties is used with the NRW derived from the bulk supply data.

The data on connected properties and metered consumption (from annual performance reporting data excluding Nimbin) since 2007 are shown on Figure 53 and Figure 54.

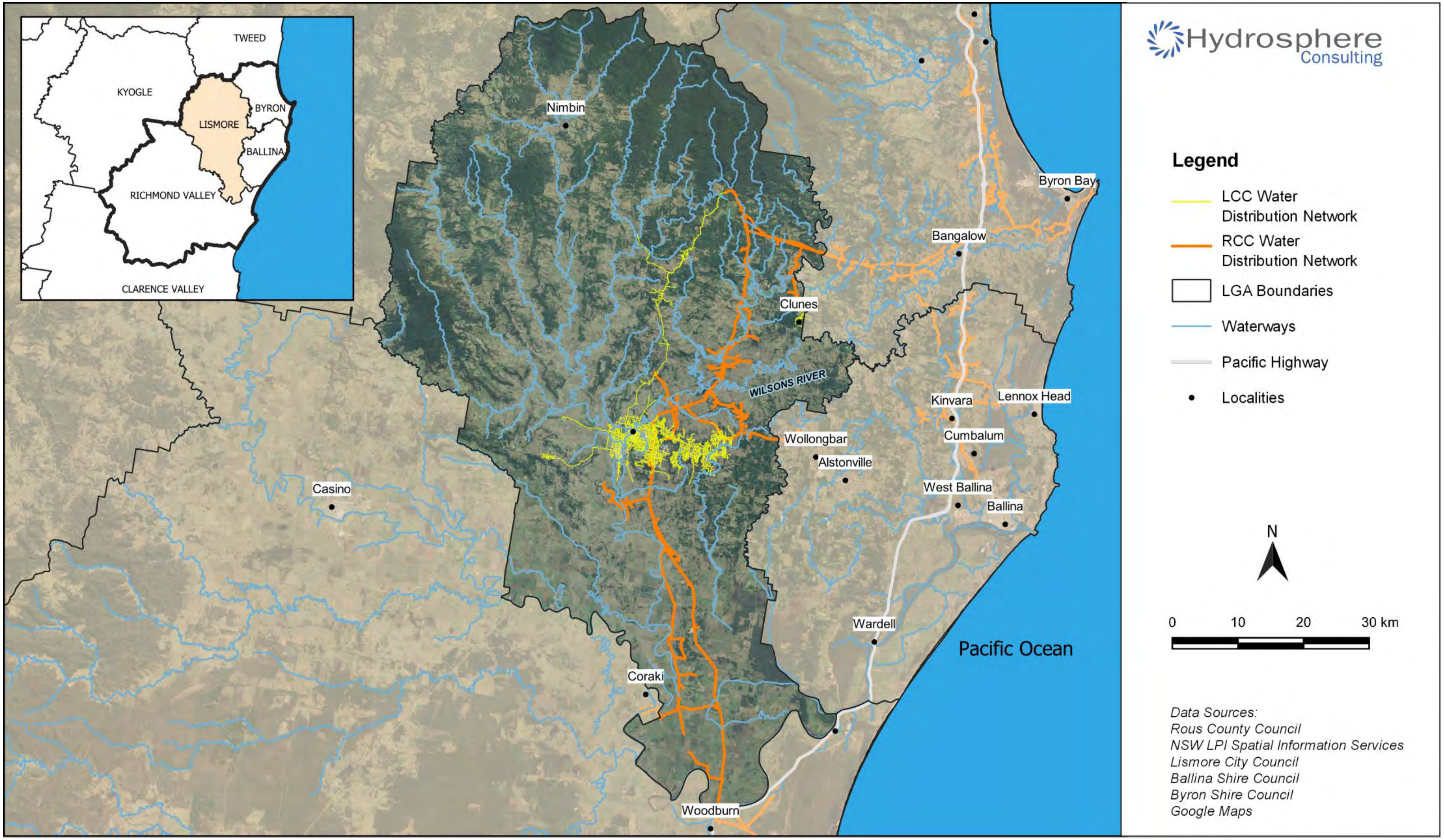

Figure 50: Bulk water supply network - Lismore

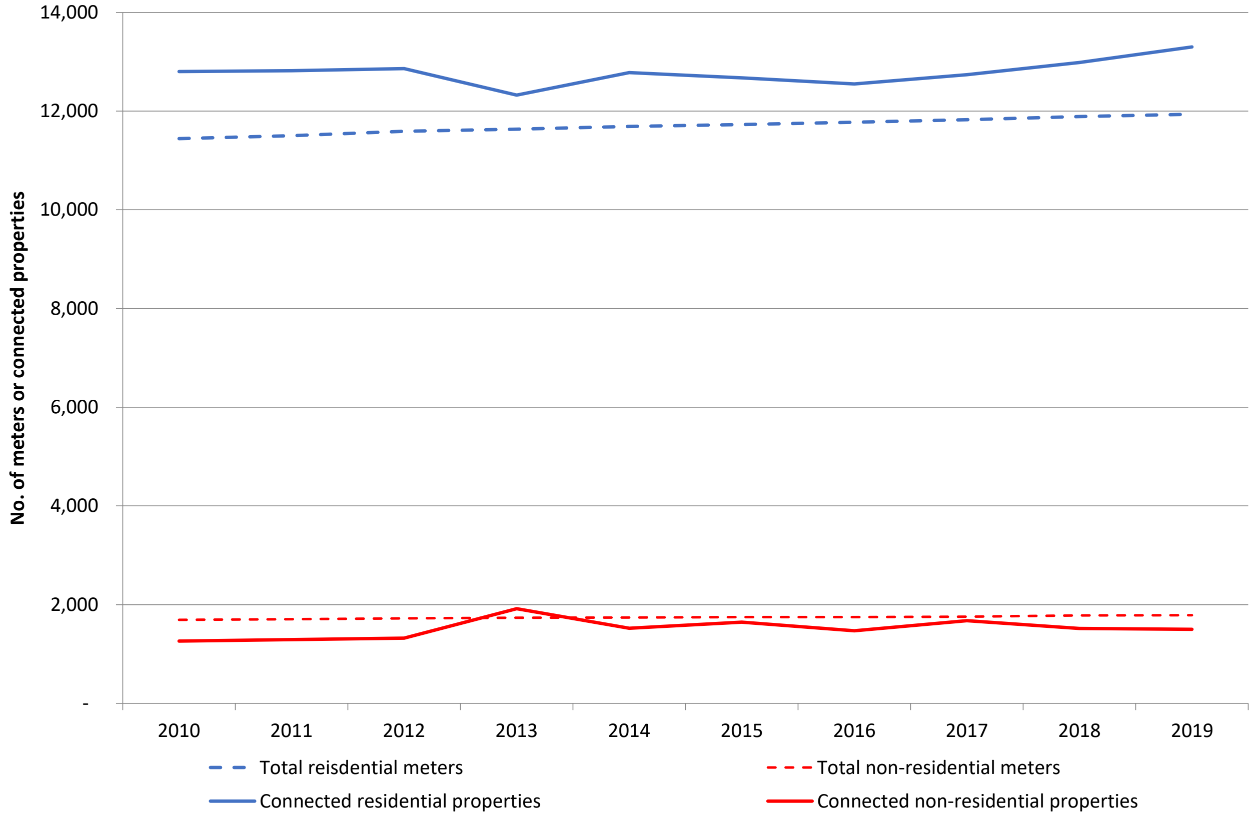

Figure 51: Comparison of data on meters and connected properties - Lismore

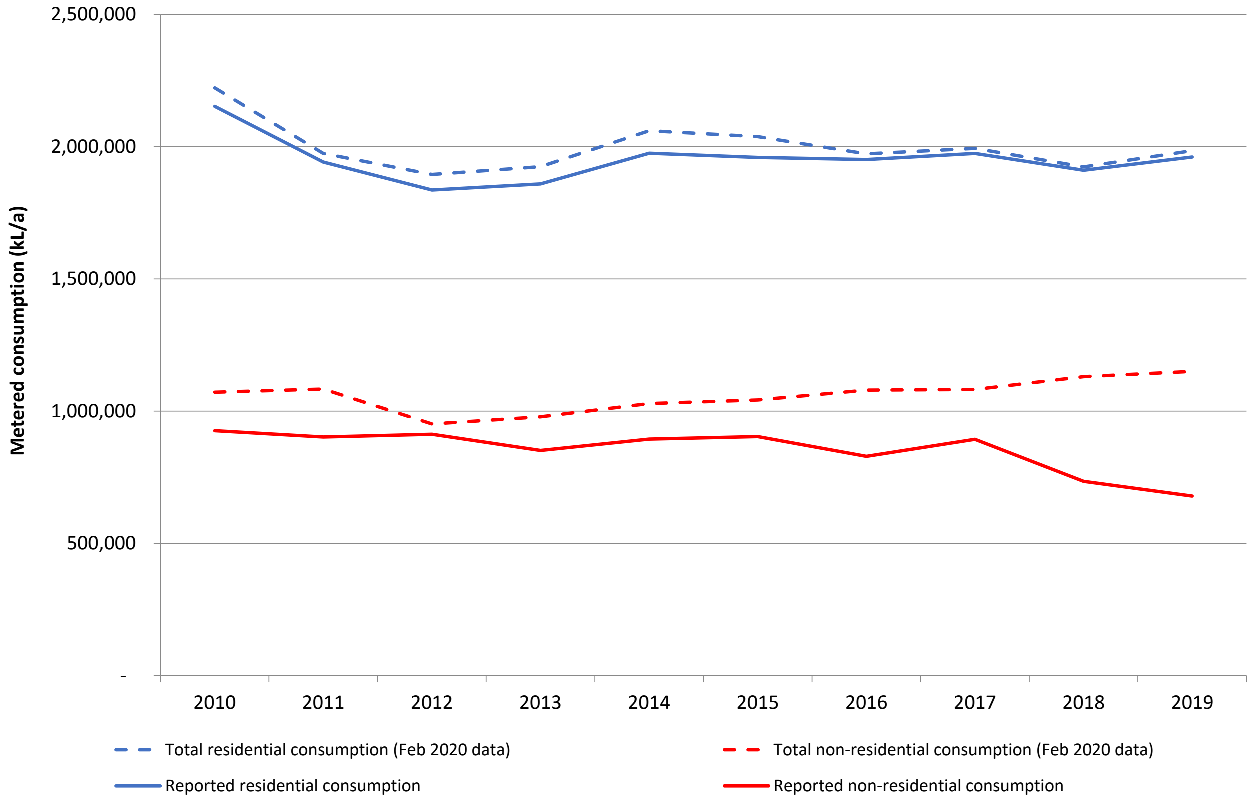

Figure 52: Comparison of data on metered consumption - Lismore

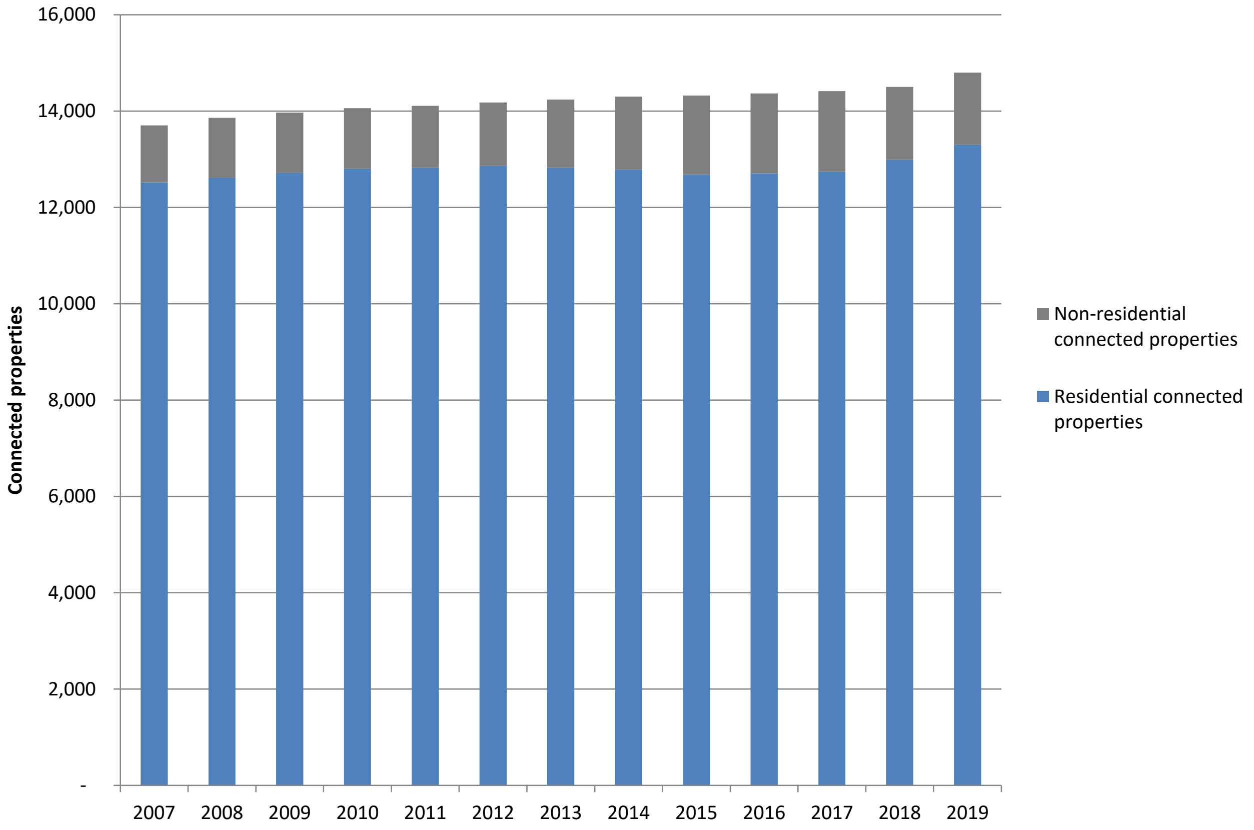

Figure 53: Historical connected properties - Lismore

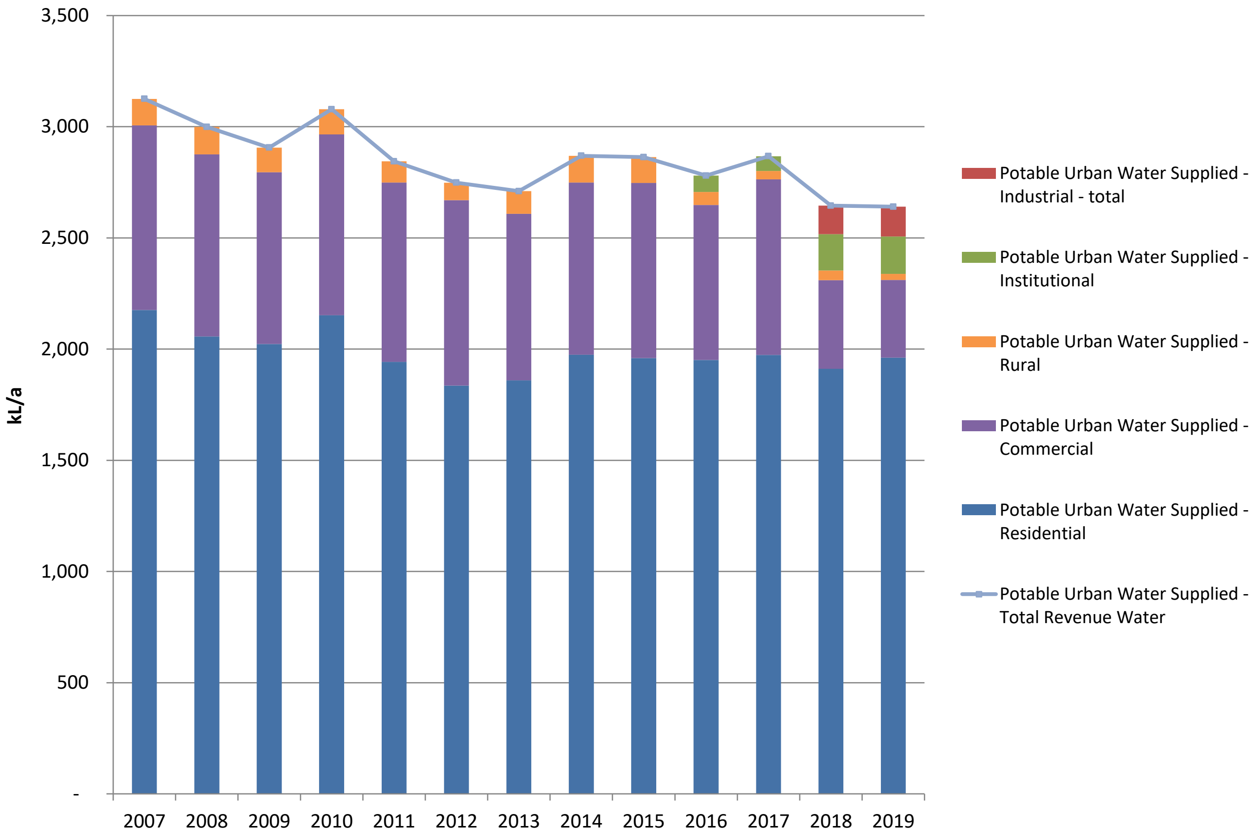

Figure 54: Historical metered consumption – Lismore

The breakdown of residential properties including BASIX and non-BASIX properties is given on Figure 55.

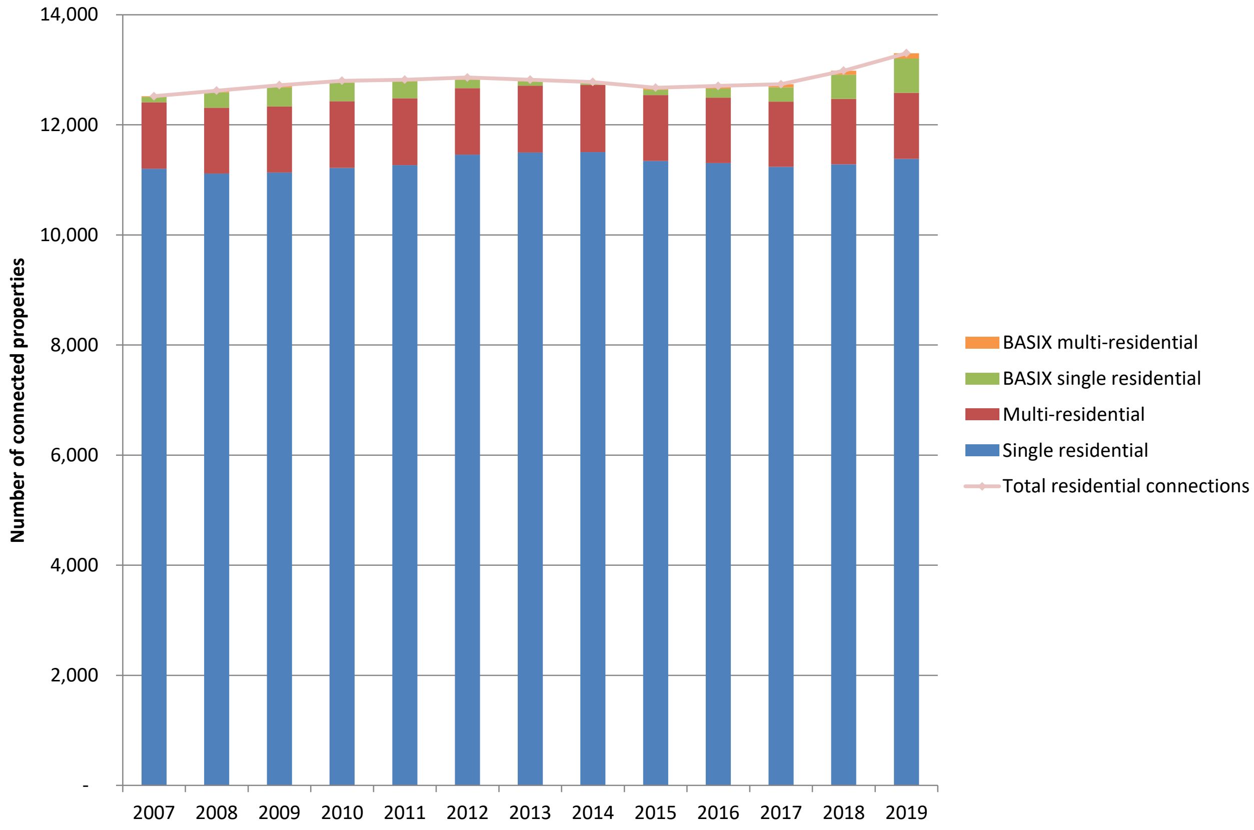

Figure 55: Historical connected residential properties (including BASIX) - Lismore

7.3 Factors Influencing Metered Consumption

The impact of the following factors on annual metered customer demand has been assessed:

- Number of connected properties (refer Figure 56). Despite a slight increase in connected properties, the consumption since 2007 is generally decreasing, particularly for non-residential consumption.

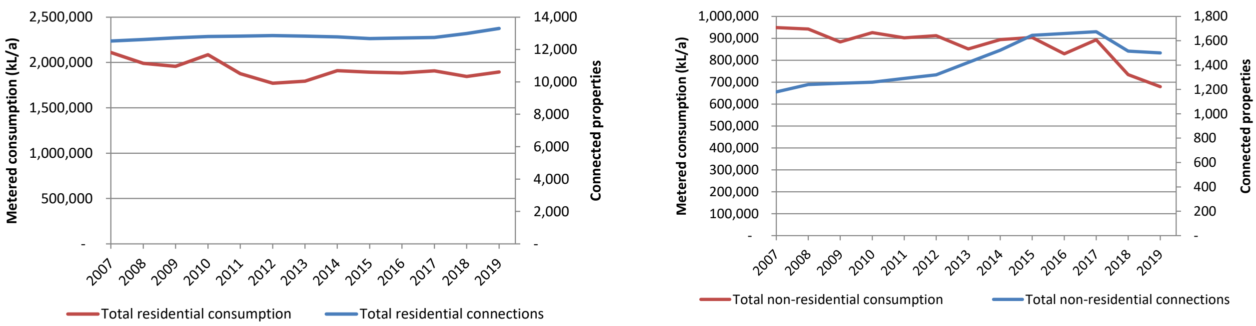

Figure 56: Comparison between connected properties and metered demand – Lismore

- Climate (average maximum temperature and annual rainfall at Lismore, refer Figure 57). There is no obvious relationship between climate and the annual metered consumption. Climate correction is discussed in Section 7.6 and Appendix 2.

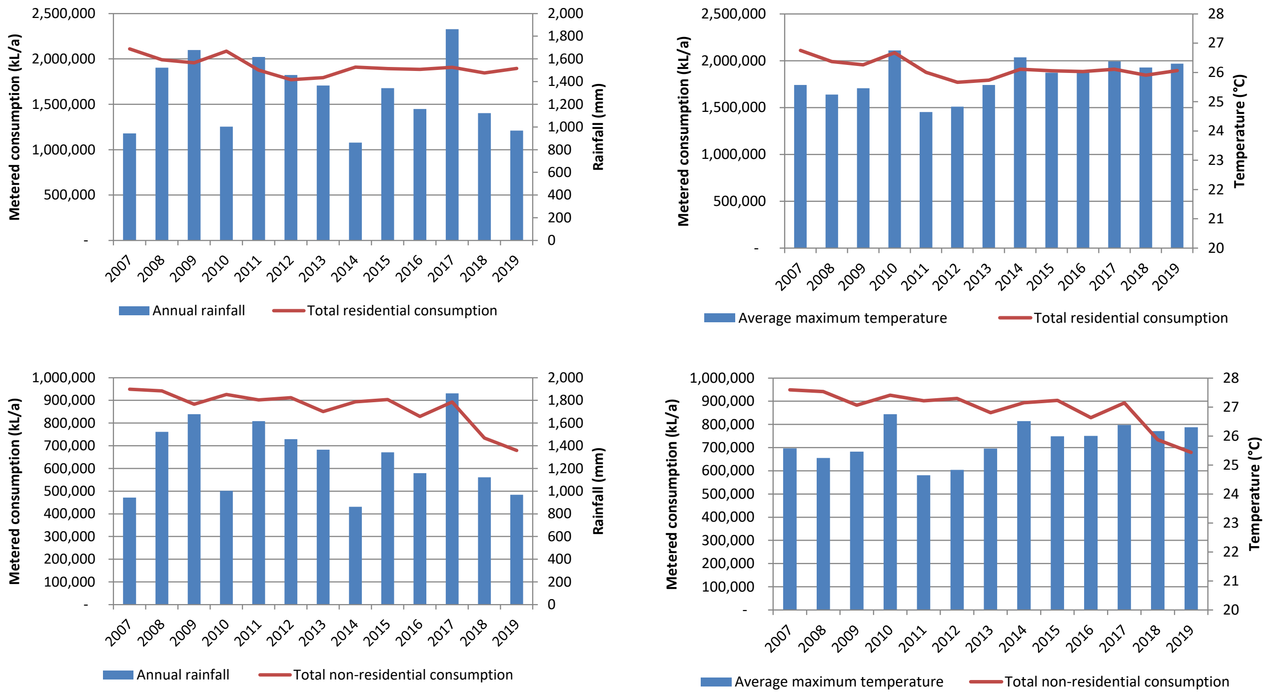

Figure 57: Comparison between climate and metered demand – Lismore

- Water pricing (usage charge, refer Figure 58). LCC has increased the price of water significantly since 2007 which may be the reason that the consumption per connection is generally decreasing.

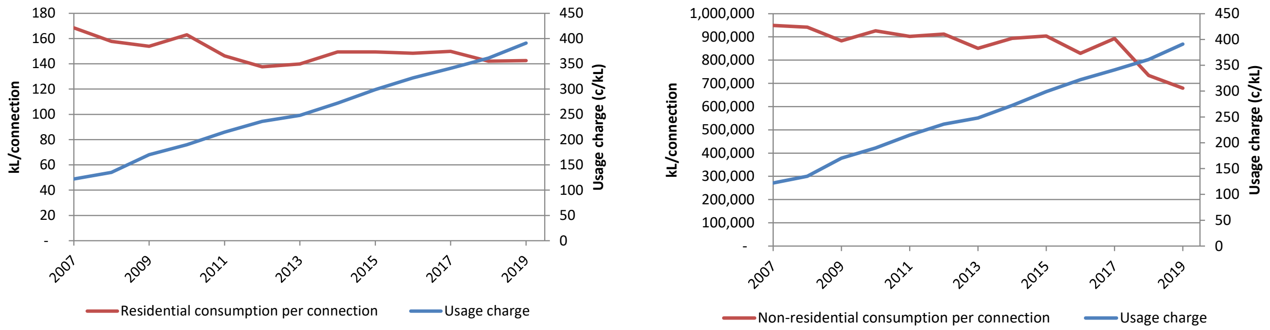

Figure 58: Comparison between usage charge and metered demand – Lismore

Drought restrictions are discussed in Section 7.4.

7.4 Bulk Supply from RCC

Daily bulk water supply to Lismore and restrictions imposed are shown in the following figure. Restrictions were successful in 2002/03 in reducing demand.

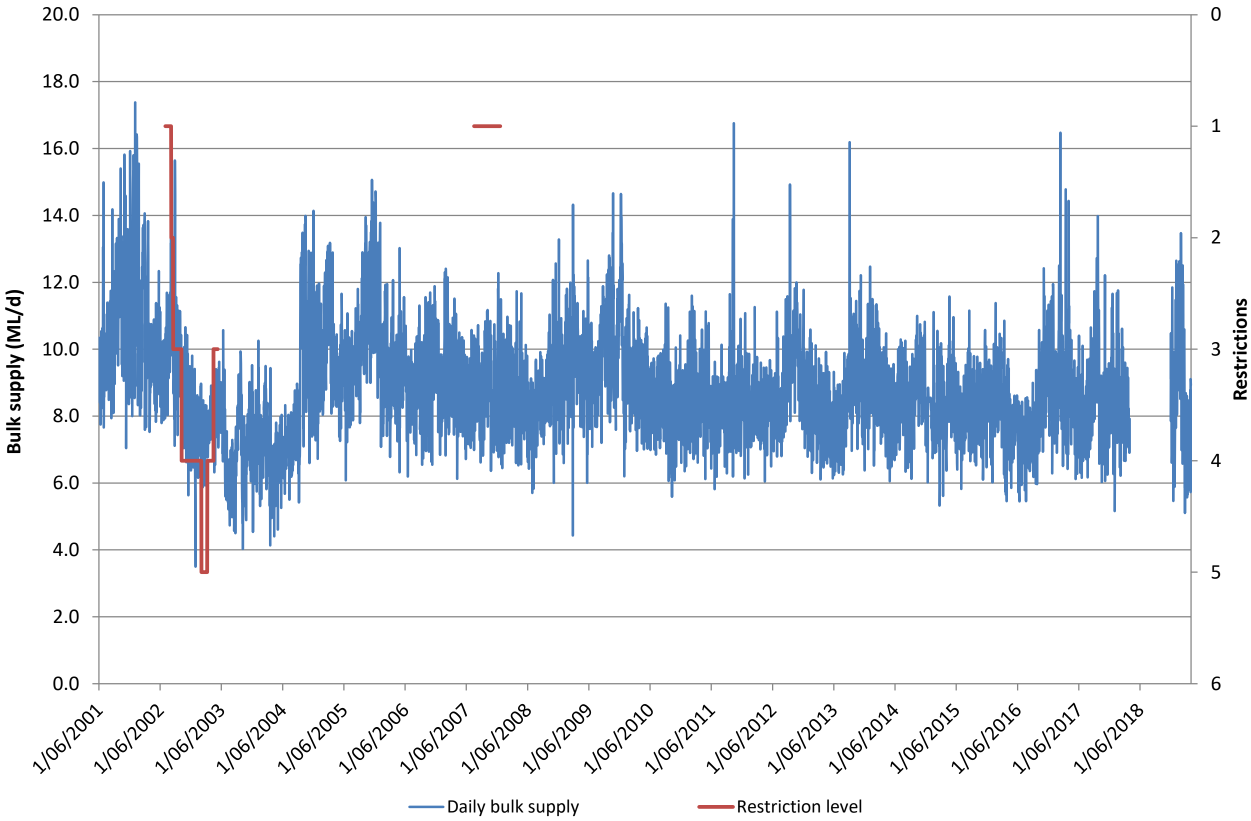

Figure 59: Daily supply to Lismore: 1/6/2001 – 31/3/2019

The daily bulk meter data for Lismore since 2001/02 was used to assess the ADD and PDD for each year. ADD, summer PDD and PDD:ADD ratio are shown in Table 17 and Figure 60 for each year.

Table 17: Summer period peak and average demand – Lismore

Summer period	PDD	ADD	PDD:ADD
2001/02	17.4	10.9	1.6
2002/03	9.8	8.5	1.2
2003/04	10.3	6.9	1.5
2004/05	14.1	9.5	1.5
2005/06	14.7	10.1	1.5
2006/07	12.4	9.1	1.4
2007/08	12.3	8.7	1.4
2008/09	14.3	9.2	1.6
2009/10	14.6	9.7	1.5
2010/11	11.6	8.4	1.4
2011/12	11.3	8.4	1.3
2012/13	11.8	8.6	1.4
2013/14	12.5	8.8	1.4
2014/15	11.1	8.5	1.3

Summer period	PDD	ADD	PDD:ADD
2015/16	11.4	8.2	1.4
2016/17	16.5	8.6	1.9
2017/18 (1)	11.8	8.5	1.4
2018/19 (1)	13.5	8.5	1.6
Average	-	8.8	-
Maximum	17.4	-	1.9

Note 1: Daily datasets are only available for the summer period of 2018 and 2019. The average of the previous 4 years ADD has been used here.

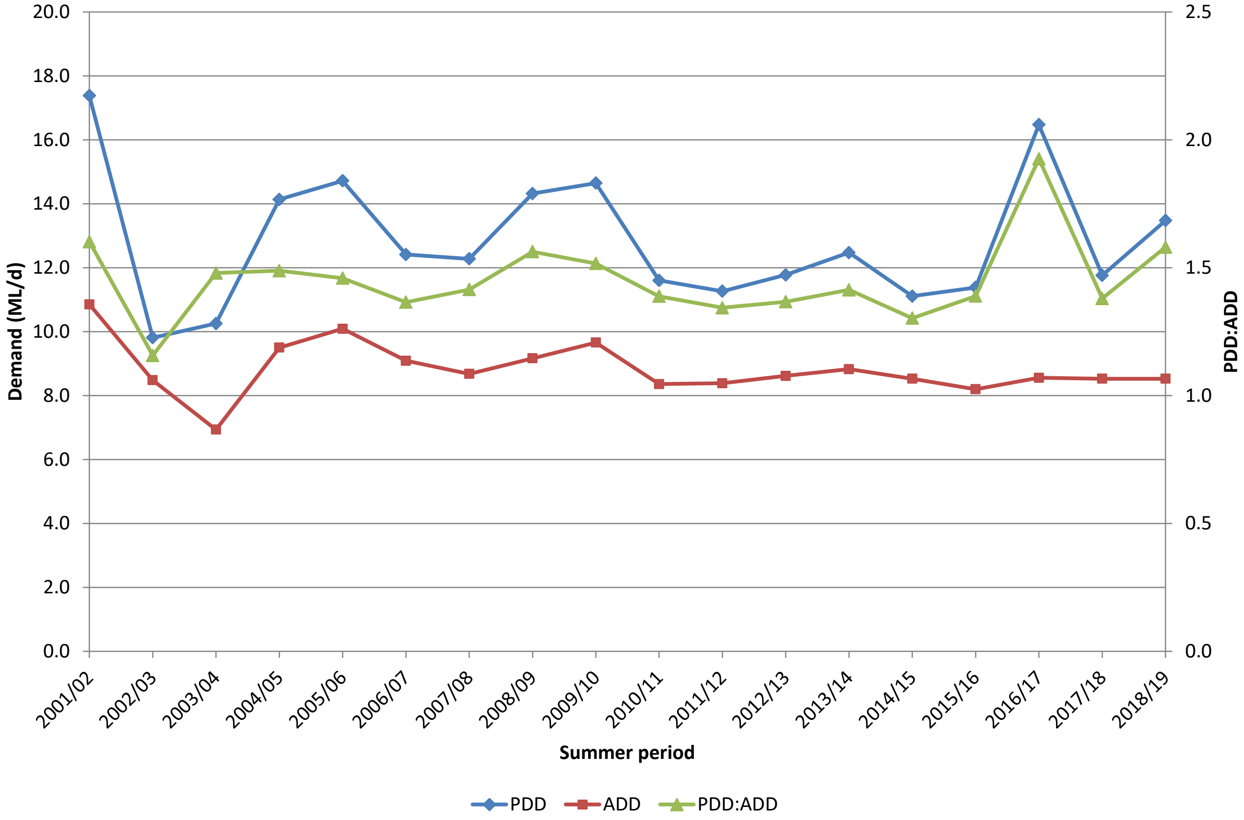

Figure 60: Summer period peak and average demand – Lismore

The highest demand was experienced in 2001/02 (17.4 ML/d) with a PDD:ADD ratio of 1.6. The maximum PDD:ADD was experienced in 2016/17 (1.9) with a PDD of 16.5 ML/d. Daily demand and rainfall for 2001/02 and 2016/17 (recorded at Tuncester BOM station) are shown in the following figures.

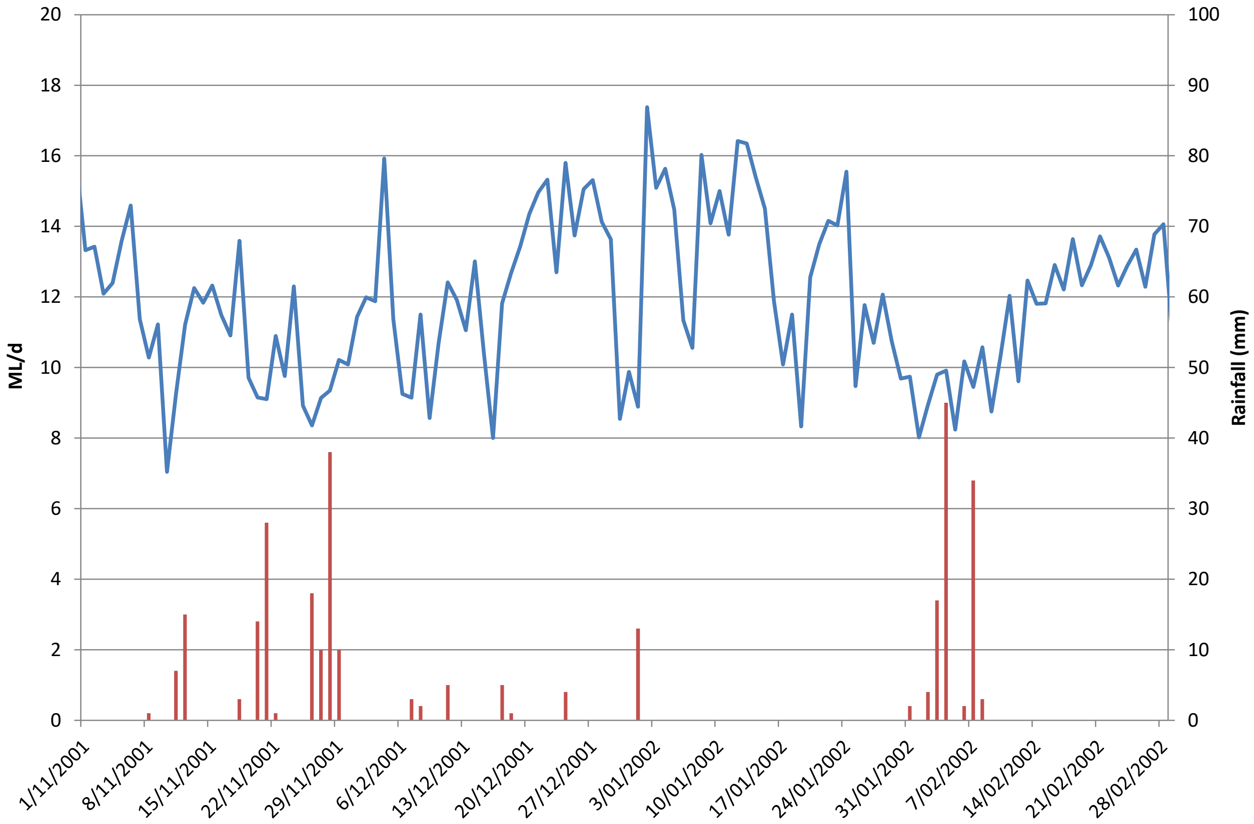

Figure 61: Daily demand and rainfall – Lismore: 2001/02

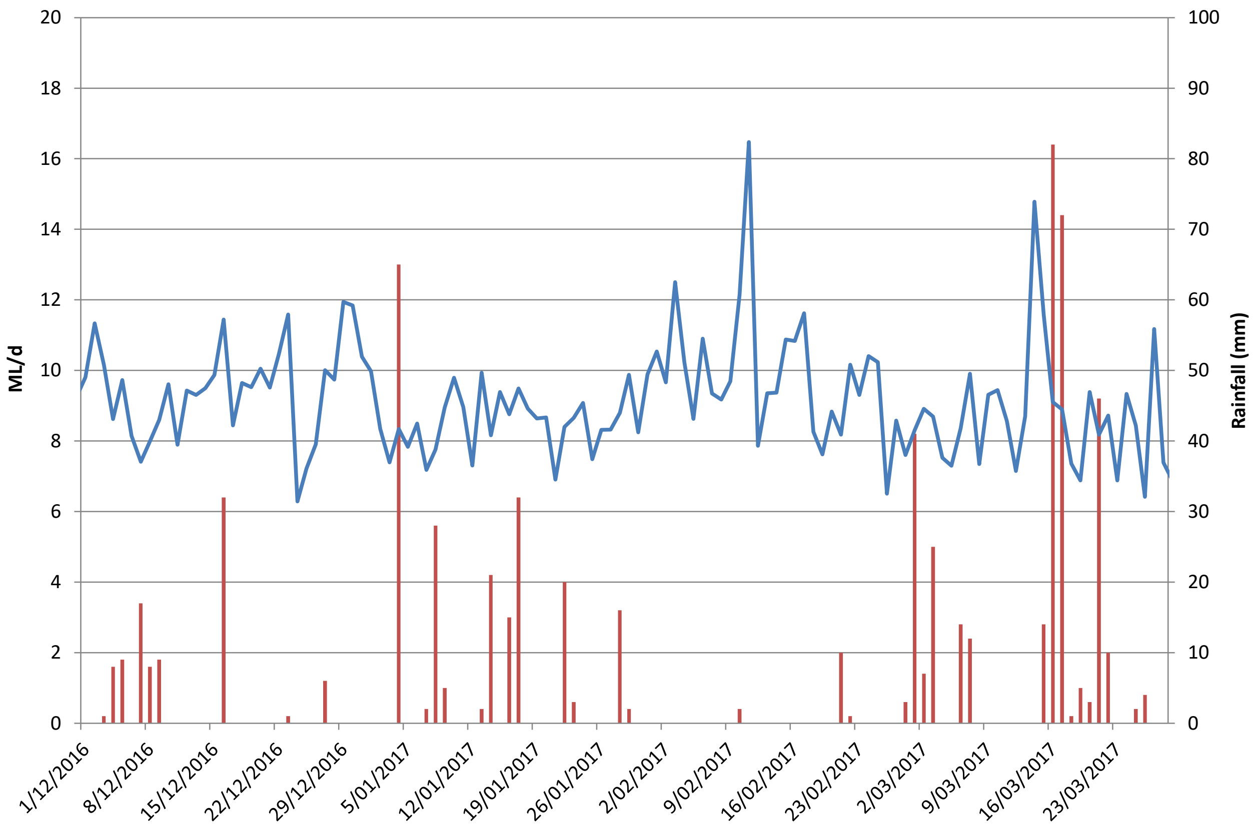

Figure 62: Daily demand and rainfall – Lismore: 2016/17

Figure 19 shows the persistence of the peak demand in 2001/02 and 2016/17 in comparison to the average and 95th percentile since 2002. The peak period in 2001/02 persisted for 14 days while the peak in 2017/18 only persisted for 7 days (then returned to average demand).

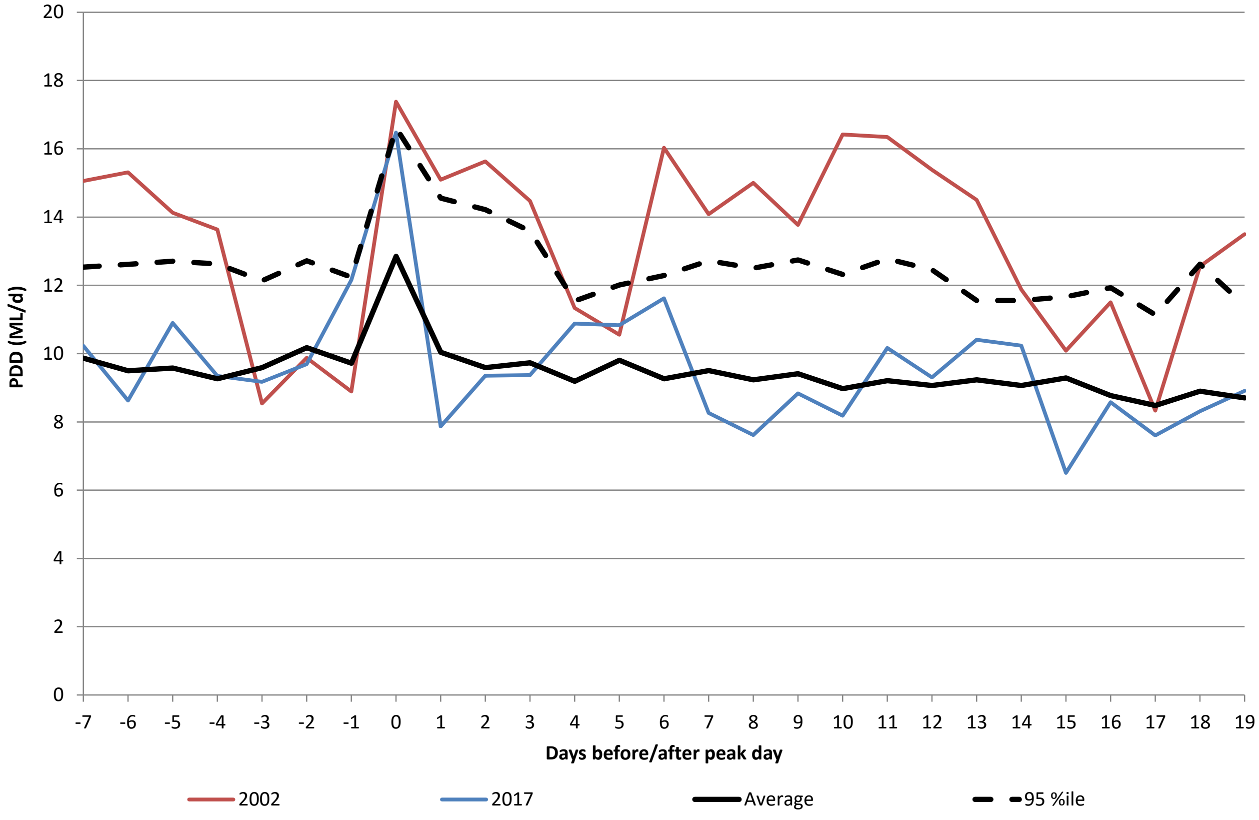

Figure 63: Peak demand pattern: Lismore

The highest summer PDD (17.4 ML/d) was recorded on 2 January 2002 with 17 mm rainfall in the previous 2 weeks (1.4 times the 2001/02 average demand). The highest PDD in 2016/17 (16.5 ML/d) was recorded on 11 February 2017 with 20 mm rainfall in the previous 2 weeks (1.9 times the 2017/18 average demand). A peak day to average day ratio of 1.9 is considered appropriate for the future peak demand forecast for the Lismore service area.

7.5 Non-Revenue Water

Metered consumption, bulk water supplied and NRW for Lismore is shown on Figure 42. Average NRW over the last 5 years was 489,886 kL/a or 15.4% of bulk supply. Between 2007 and 2010, NRW ranged from 8.4% p.a. to 16.9% p.a. (as reported in the 2013 Demand Forecast). The 2013 demand forecast assumed NRW would be 11% p.a. between 2020 and 2060 (based on the average losses between 2007 and 2010).

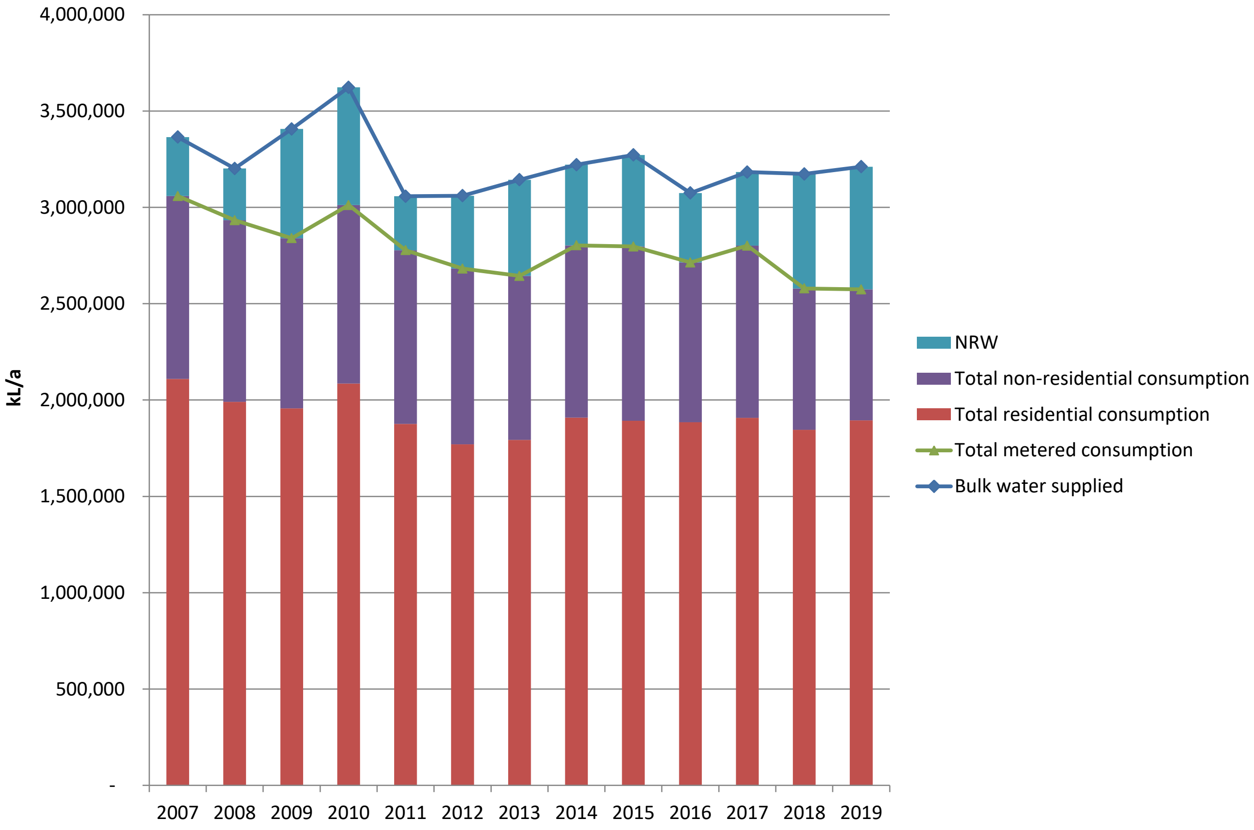

Figure 64: Bulk supply, metered consumption and NRW – Lismore

7.6 Average and Dry Year Demand

The climate correction analysis undertaken for Lismore bulk supply area suggests that the dry year demand is 5.8% higher than the average demand (Appendix 2). The historical metered consumption per connection for each customer type and the average, maximum and dry year consumption per connection are shown in Table 18. This table also shows the average consumption per connection used in the 2013 demand forecast. The revised residential consumption rates are lower than the 2013 rates used but the revised non-residential rates are lower.

Table 18: Consumption per connection – Lismore (kL/a)

Connection type	2015	2016	2017	2018	2019	5 year average	5 year maximum	Dry year	2013 forecast (average)
Non-BASIX residential	150	149	150	142	143	147	150	155	182
BASIX single residential	140	140	140	140	140	140	140	148	138
BASIX multi-residential	103	103	103	103	103	103	103	109	99
Total residential	*149*	*148*	*150*	*142*	*142*	*146*	*150*	*155*	*180*
Total non-residential	550	500	533	484	453	504	550	533	672

7.7 Predicted Growth

LCC has not yet adopted a growth management strategy but has advised that the growth in residential connected properties is expected to be 120 new dwellings per year based on historical growth since 2003. The 2013 demand forecast assumed a growth rate of 140 new dwellings per year on average (based on information provided by LCC at that time). A portion of the new dwellings are assumed to be multi-residential (9.7%) based on data used in the 2013 demand forecast. All new dwellings are assumed to be BASIX compliant.

LCC has advised that the growth in non-residential connected properties is expected to be 0.2% p.a. based on historical growth since 2003. The 2013 demand forecast assumed a growth rate of 1.2% p.a. (based on information provided by LCC at that time).

The resulting number of connections in each ten-year period is given in Table 19.

Table 19: Future connections – Lismore

Connection Type	2010	2020	2030	2040	2050	2060
Single residential	11,219	11,268	10,191	9,216	8,335	7,538
Multi-residential	1,210	1,188	1,075	972	879	795
BASIX single residential	335	845	3,006	5,063	7,028	8,908
BASIX multi-residential	37	118	349	568	778	979
Total residential connected properties	12,800	13,420	14,620	15,820	17,020	18,220
Non-residential connected properties	1,260	1,503	1,533	1,564	1,596	1,628
All connected properties	14,060	14,923	16,153	17,384	18,616	19,848
Bulk supply area growth (total connections) % p.a.	0.6%	0.8%	0.8%	0.7%	0.7%	0.6%

A comparison between the historical data, the revised forecast and the 2013 forecast is shown on the following figure. The longer-term projections are lower due to the lower estimates of development.

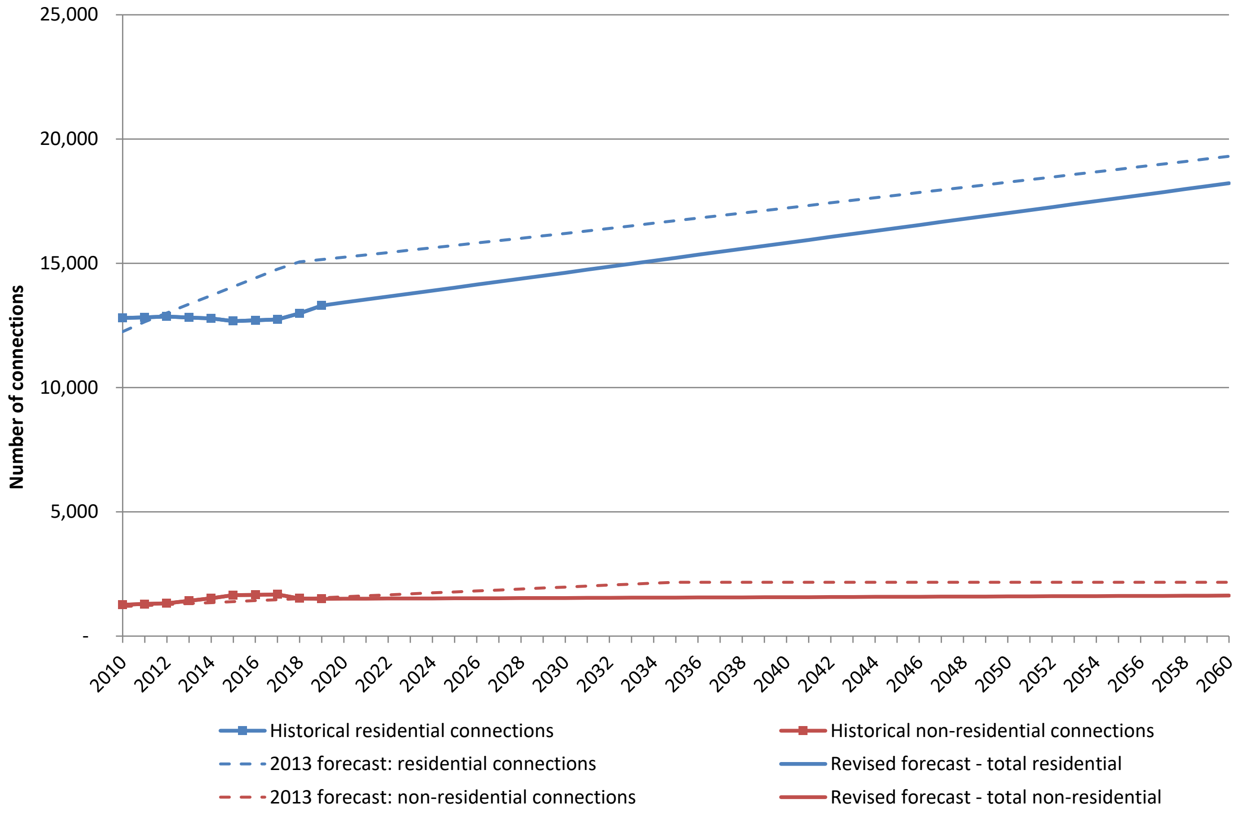

Figure 65: Forecast number of connections and comparison with 2013 demand forecast – Lismore

7.8 Predicted Future Demand

7.8.1 Consumption

The forecast average and dry year customer demand is shown on Figure 66 along with the 2013 forecast. The revised forecast is lower than 2013 forecast due to the reduction in demand experienced in recent years and the reduced rate of growth expected.

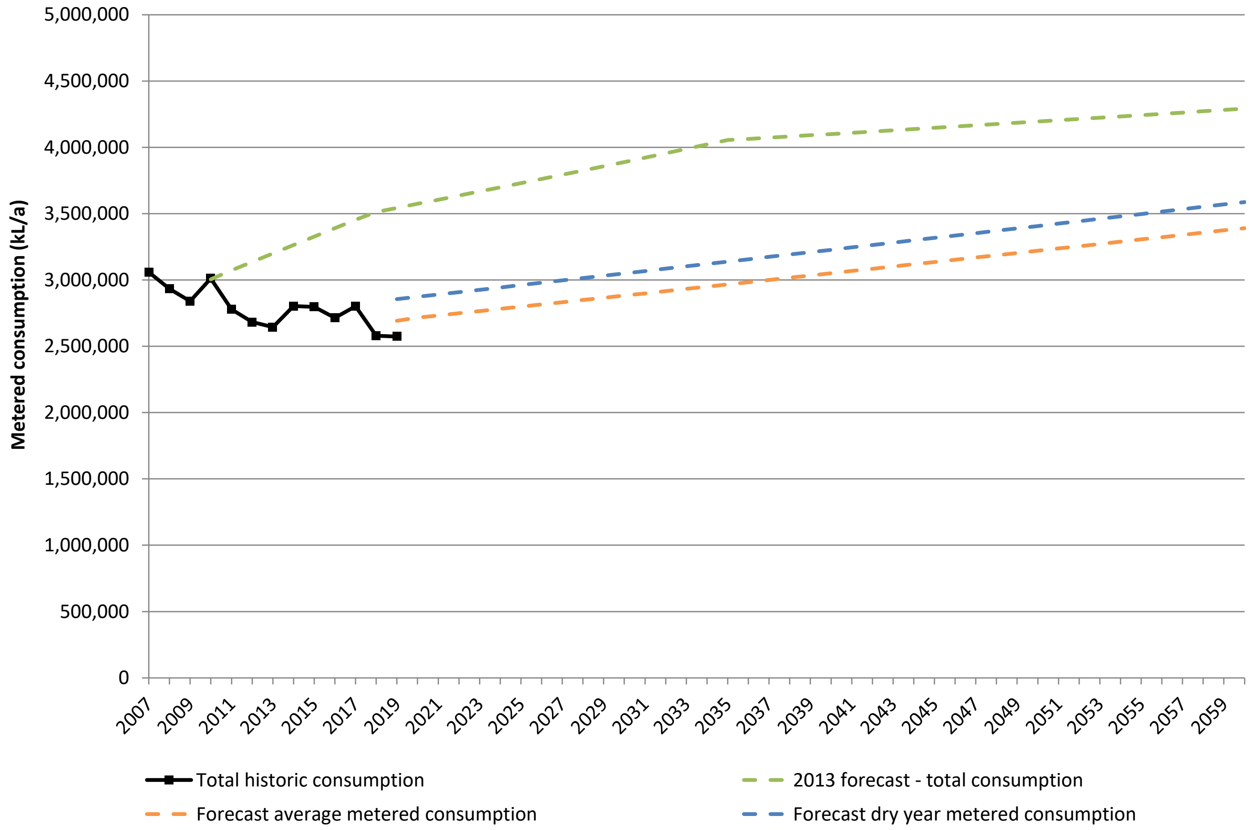

Figure 66: Revised forecast metered consumption and comparison with 2013 demand forecast – Lismore

7.8.2 Water loss management measures

Two scenarios have been developed for water savings due to demand management:

1. No water loss management – using current average NRW = 15.4% of bulk supply.
2. Predicted NRW with WLMP targets – NRW savings of 108 ML/a by 2024 (Table 5).

The forecast Lismore demand with scenarios 1 and 2 is shown on Figure 67 and also compared to the 2013 forecast.

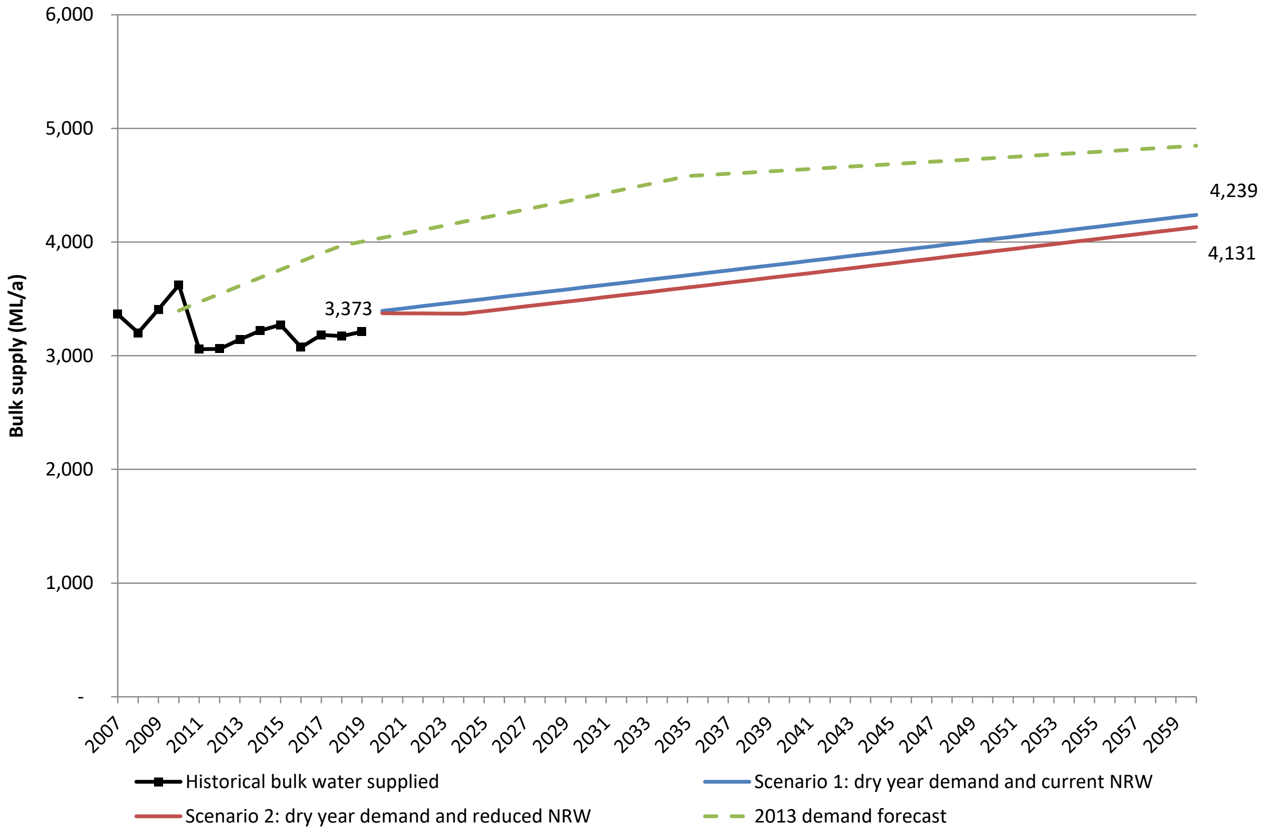

Figure 67: Average and dry year unrestricted demand forecast and comparison with 2013 forecast – Lismore

8. RICHMOND VALLEY BULK SUPPLY AREA

8.1 Bulk Water Supply Area

The bulk water supply network within Richmond Valley is shown on Figure 68.

8.2 Historical Connected Properties and Metered Consumption

RVC provided data on metered connections and consumption between 2010/11 and 2018/19. These data have been classified into connection types.

Annual connected property data since 2007 are shown on Figure 69. RVC implemented a new customer management system in 2011 and connection types were re-classified. The connections data since 2011 are considered to be more accurate and is used in the development of the demand forecast. The majority of non-residential connections are commercial properties. Annual metered consumption is shown on Figure 70.

Figure 68: Bulk water supply network – Richmond Valley

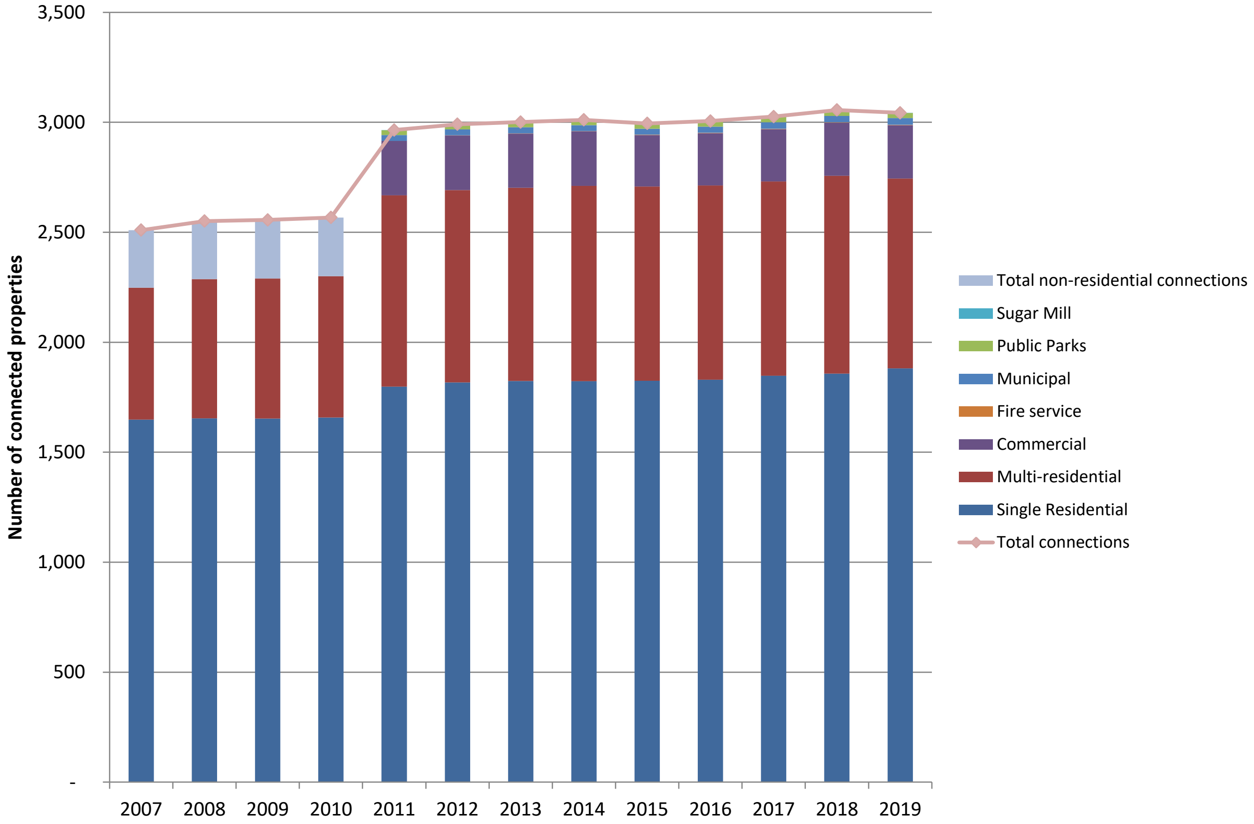

Figure 69: Historical connected properties - Richmond Valley

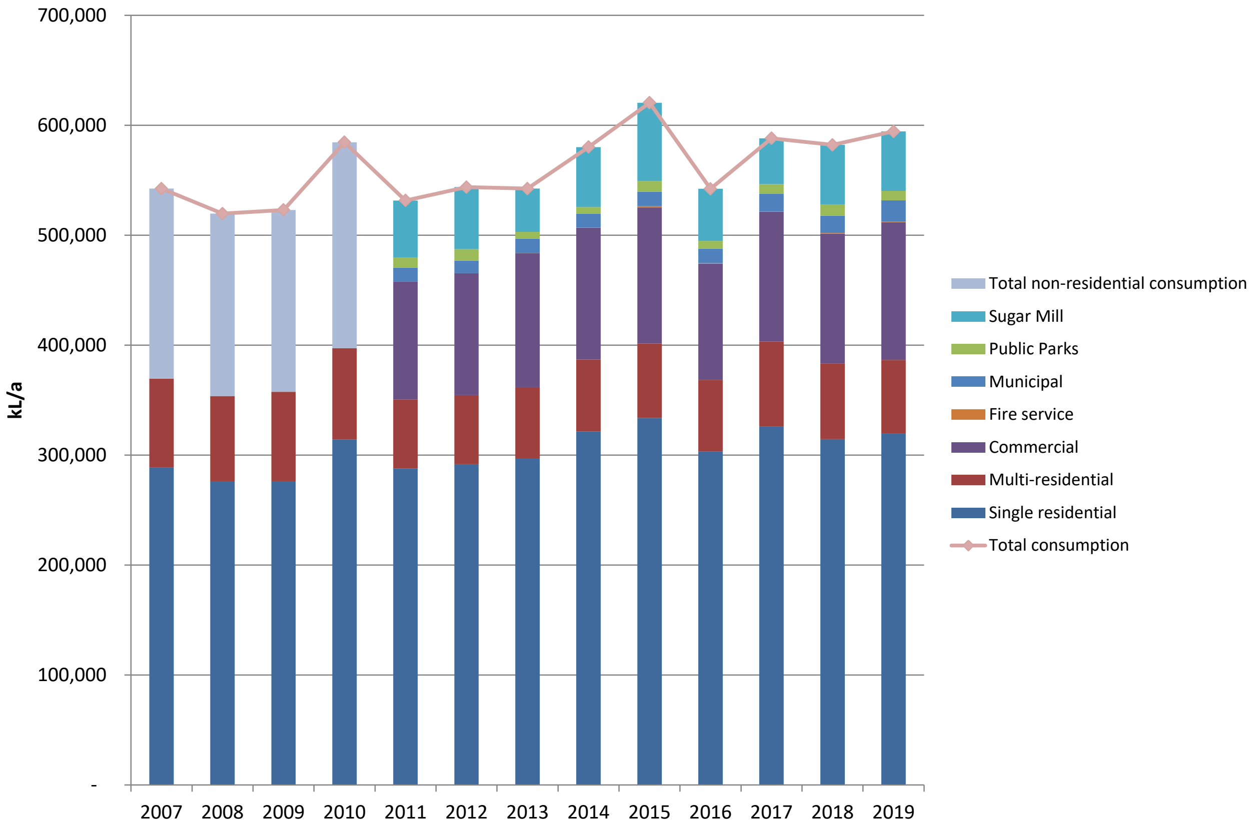

Figure 70: Historical metered consumption – Richmond Valley

The breakdown of residential properties including BASIX and non-BASIX properties is given on Figure 71.

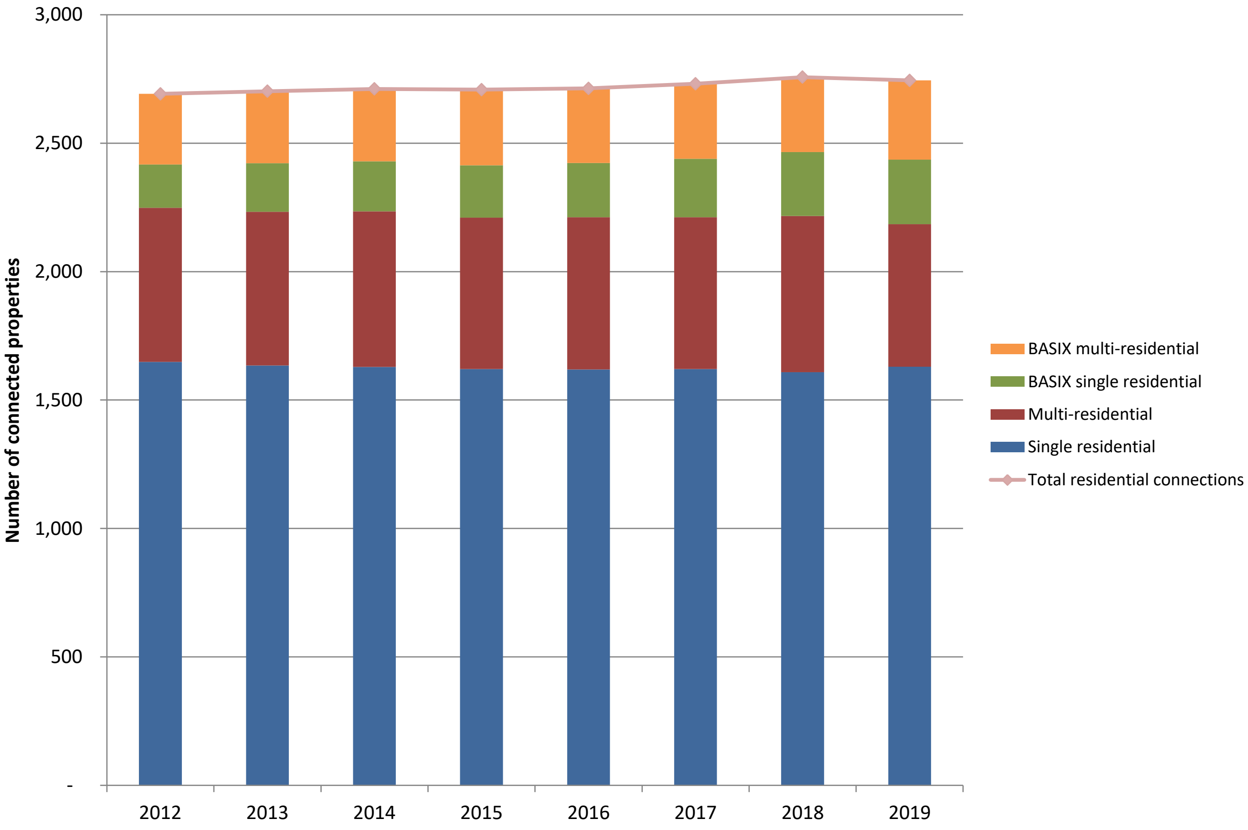

Figure 71: Historical connected residential properties (including BASIX) - Richmond Valley

8.3 Factors Influencing Metered Consumption

There is a slight increase in annual residential consumption between 2011 and 2019 but non-residential consumption has remained fairly constant (refer Figure 70).

The impact of the following factors on metered customer demand has been assessed:

- Number of connected properties (refer Figure 72). Residential consumption has increased slightly between 2011 and 2019 along with the number of residential connections but non-residential connections and consumption have remained fairly stable.

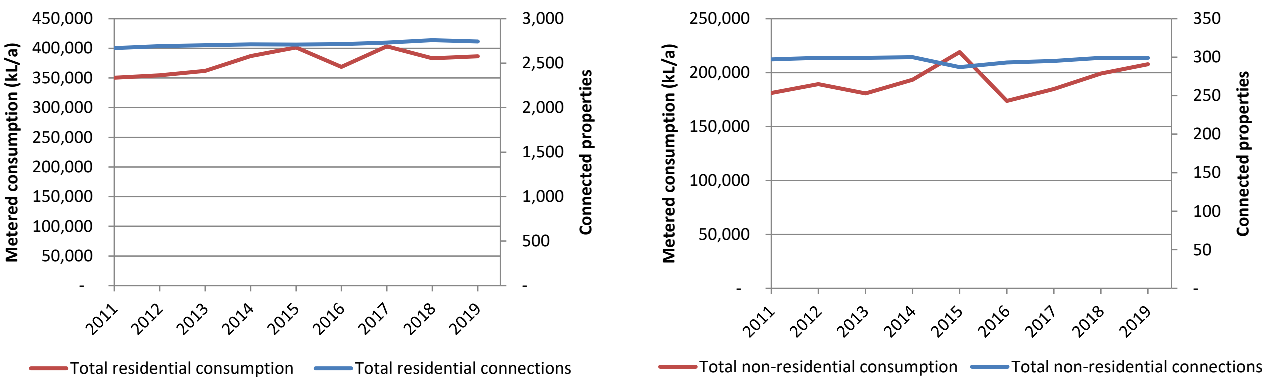

Figure 72: Comparison between connected properties and metered demand – Richmond Valley

- Climate (average maximum temperature and annual rainfall at Evans Head, refer Figure 73). Residential consumption appears to decrease with low rainfall and increase with high temperatures. Non-residential consumption appears to increase with low rainfall and high temperatures.

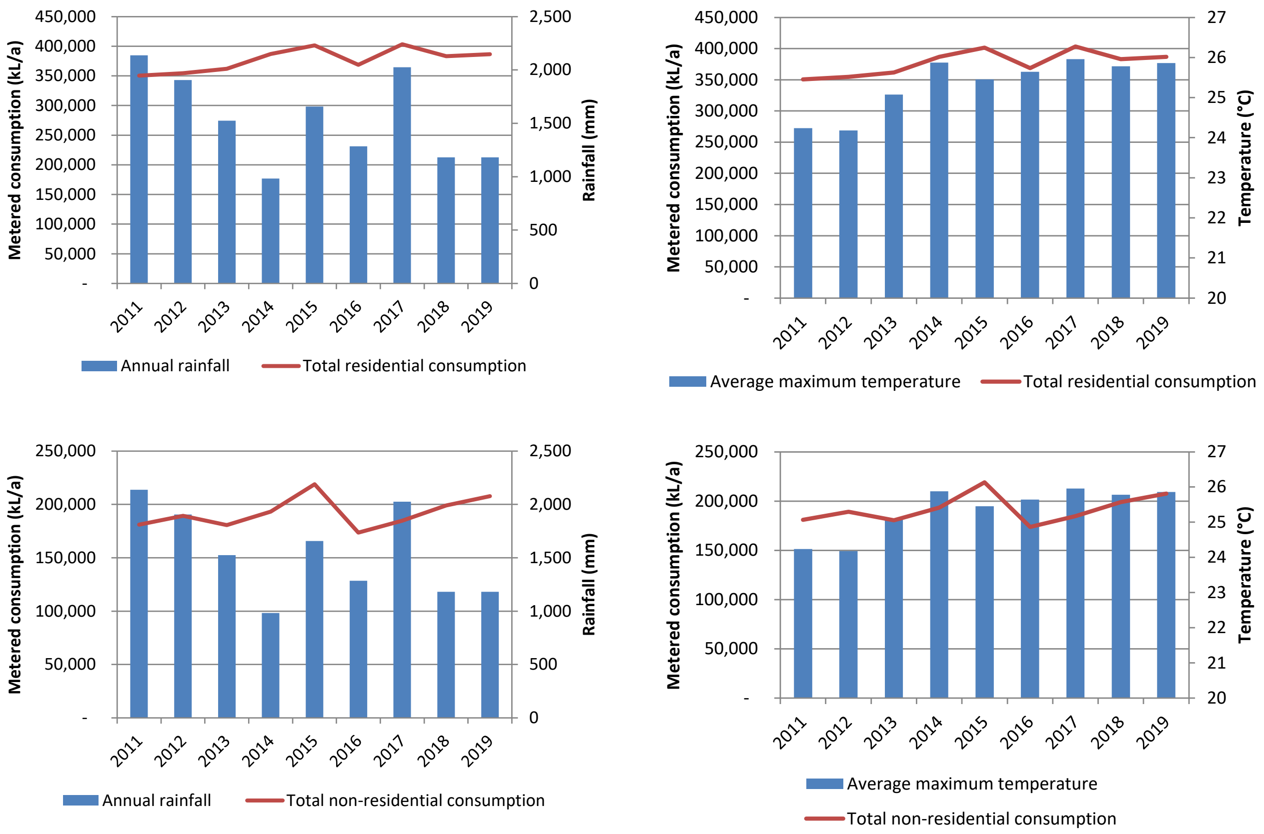

Figure 73: Comparison between climate and metered demand - Richmond Valley

- Water pricing (usage charge, refer Figure 74). Despite the increasing price of water since 2011, the consumption per connection has remained relatively stable.

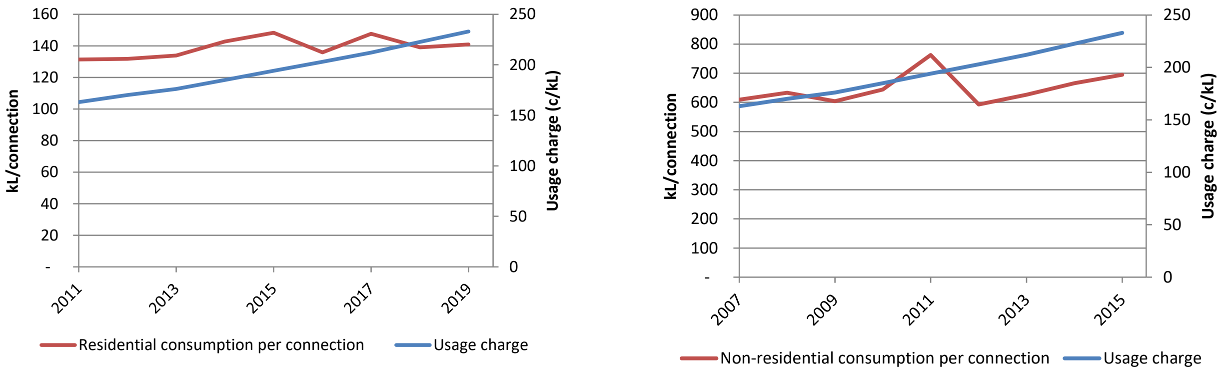

Figure 74: Comparison between usage charge and metered demand - Richmond Valley

8.4 Bulk Supply from RCC

Daily bulk water supply to Richmond Valley and restrictions imposed are shown on the following figure.

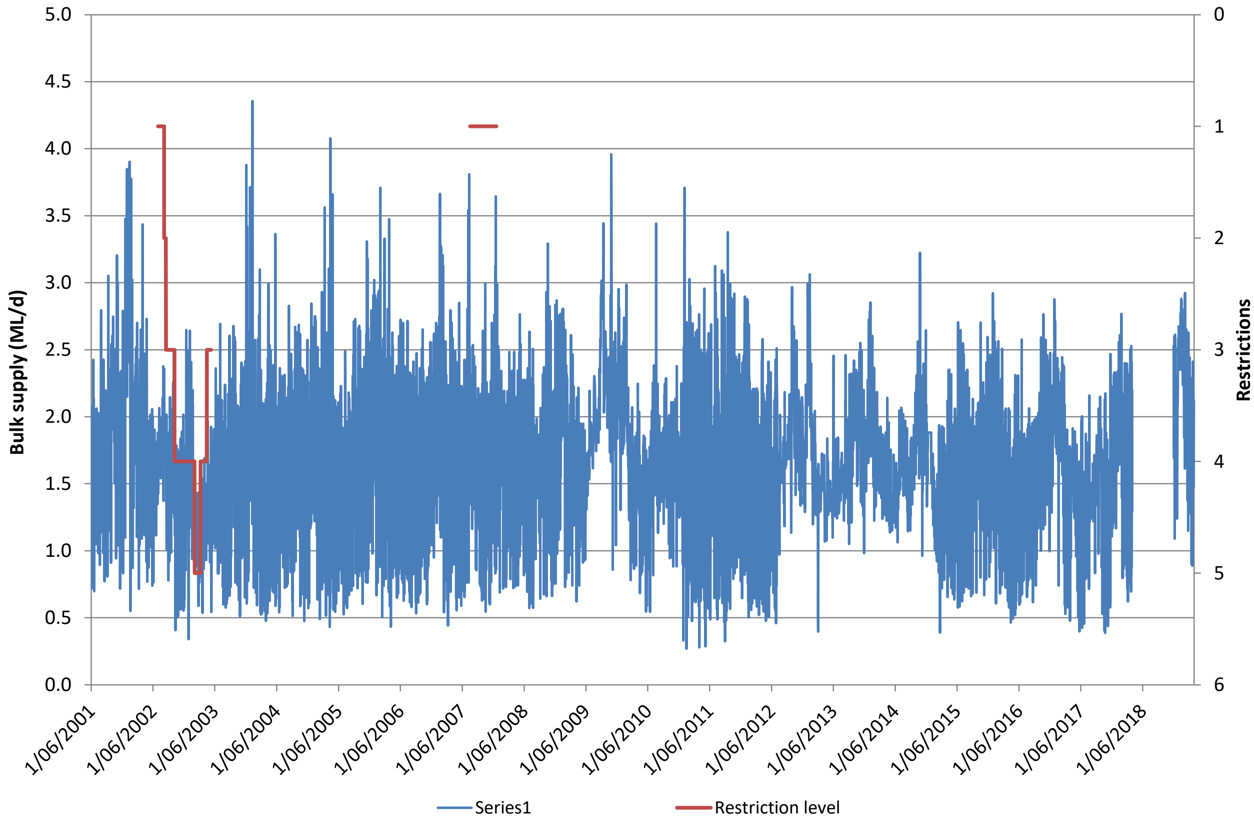

Figure 75: Daily supply to Richmond Valley: 1/6/2001 – 31/3/2019

The daily bulk meter data since 2001/02 was used to assess the ADD and PDD for each year. ADD, summer PDD and PDD:ADD are shown in Table 20 and Figure 76 for each year.

Table 20: Summer period peak and average demand – Richmond Valley

Summer period	PDD	ADD	PDD:ADD
2001/02	3.90	1.9	2.07
2002/03	2.65	1.4	1.86
2003/04	4.36	1.6	2.66
2004/05	2.93	1.6	1.79
2005/06	3.71	1.7	2.15
2006/07	3.66	1.7	2.14
2007/08	3.65	1.7	2.12
2008/09	2.87	1.7	1.68
2009/10	2.99	1.9	1.56
2010/11	3.71	1.6	2.34
2011/12	2.90	1.6	1.80
2012/13	3.06	1.7	1.80
2013/14	2.85	1.7	1.68
2014/15	2.09	1.6	1.31

Summer period	PDD	ADD	PDD:ADD
2015/16	2.92	1.5	1.90
2016/17	2.88	1.6	1.74
2017/18 (1)	2.77	1.6	1.71
2018/19 (1)	2.92	1.6	1.81
Average	-	1.7	-
Maximum	4.4	-	2.7

Note 1: Daily datasets are only available for the summer period of 2018 and 2019. The average of the previous 4 years ADD has been used here.

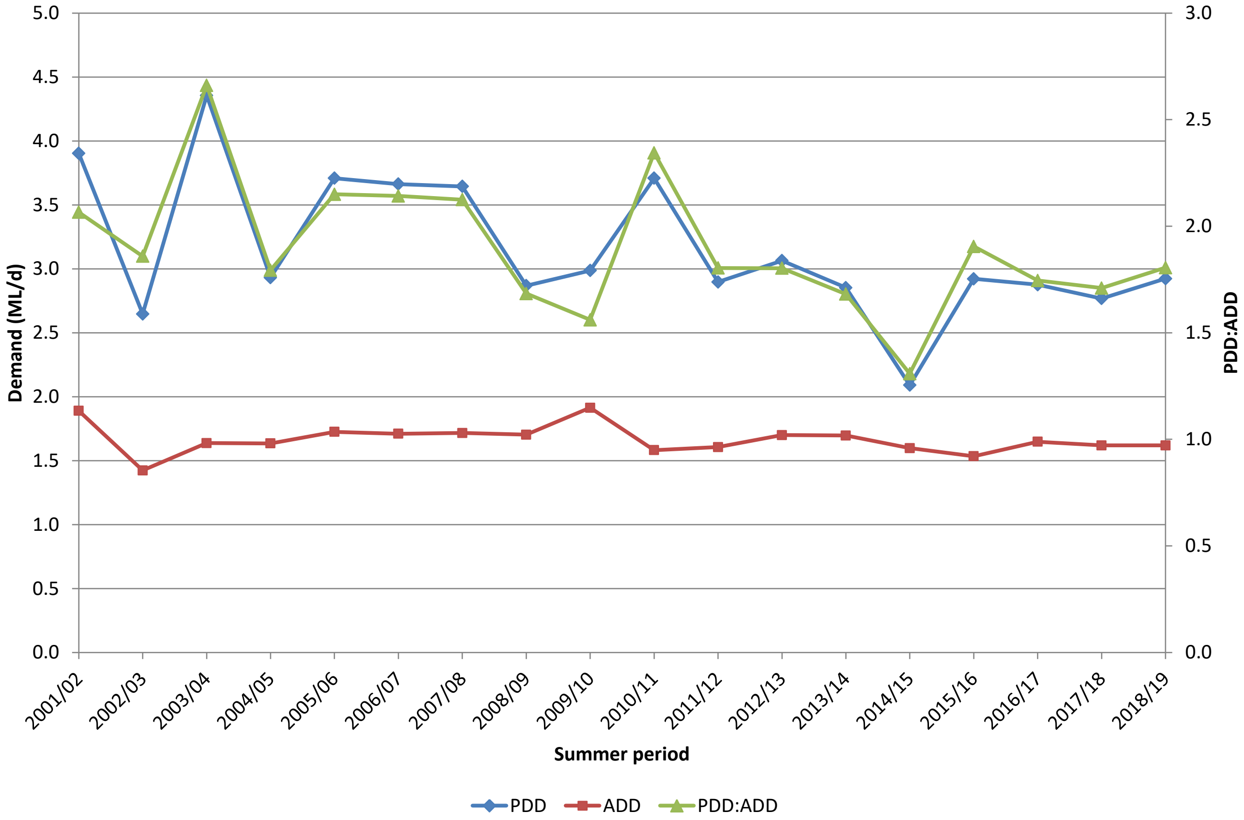

Figure 76: Summer period peak and average demand – Richmond Valley

The highest summer demand was experienced in 2003/04 (4.4 ML/d) with a PDD:ADD ratio of 2.7. Daily demand and rainfall for 2003/04 (recorded at Evans Head RAAF Bombing Range AWS) is shown in the following figures.

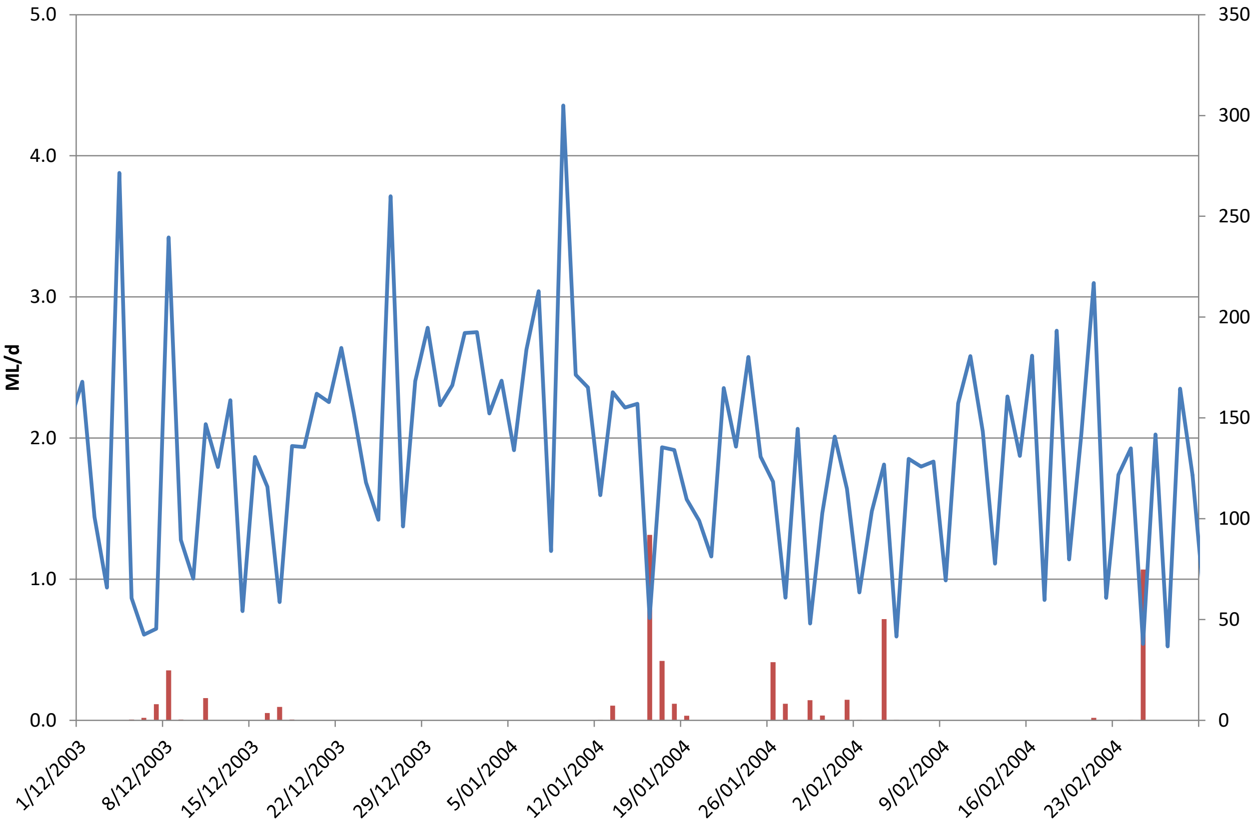

Figure 77: Daily demand and rainfall – Richmond Valley: 2003/04

The highest recorded summer PDD (4.4 ML/d) was recorded on 9 January 2004 with nil rainfall recorded in the previous 2 weeks (2.7 times the 2003/04 average demand). A peak day to average day ratio of 2.7 is considered appropriate for the future peak demand forecast for the RVC service area. It is noted that the previous peak day demand forecast (Hydrosphere Consulting, 2013b) identified a higher peak day to average day ratio of 4.0 as that study also considered non-summer periods. Within the Richmond Valley bulk supply area, the Broadwater Sugar Mill demand can peak during harvest periods and this should be considered in infrastructure planning.

8.5 Non-Revenue Water

Metered consumption, bulk water supplied and NRW is shown on Figure 78. Average NRW over the last 5 years was 60,349 kL/a or 9.0% of bulk supply. Between 2007 and 2010, NRW ranged from 14.0% p.a. to 17.7% p.a. (as reported in the 2013 Demand Forecast). The 2013 demand forecast assumed NRW would be 16% p.a. between 2020 and 2060 (based on the average losses between 2007 and 2010).

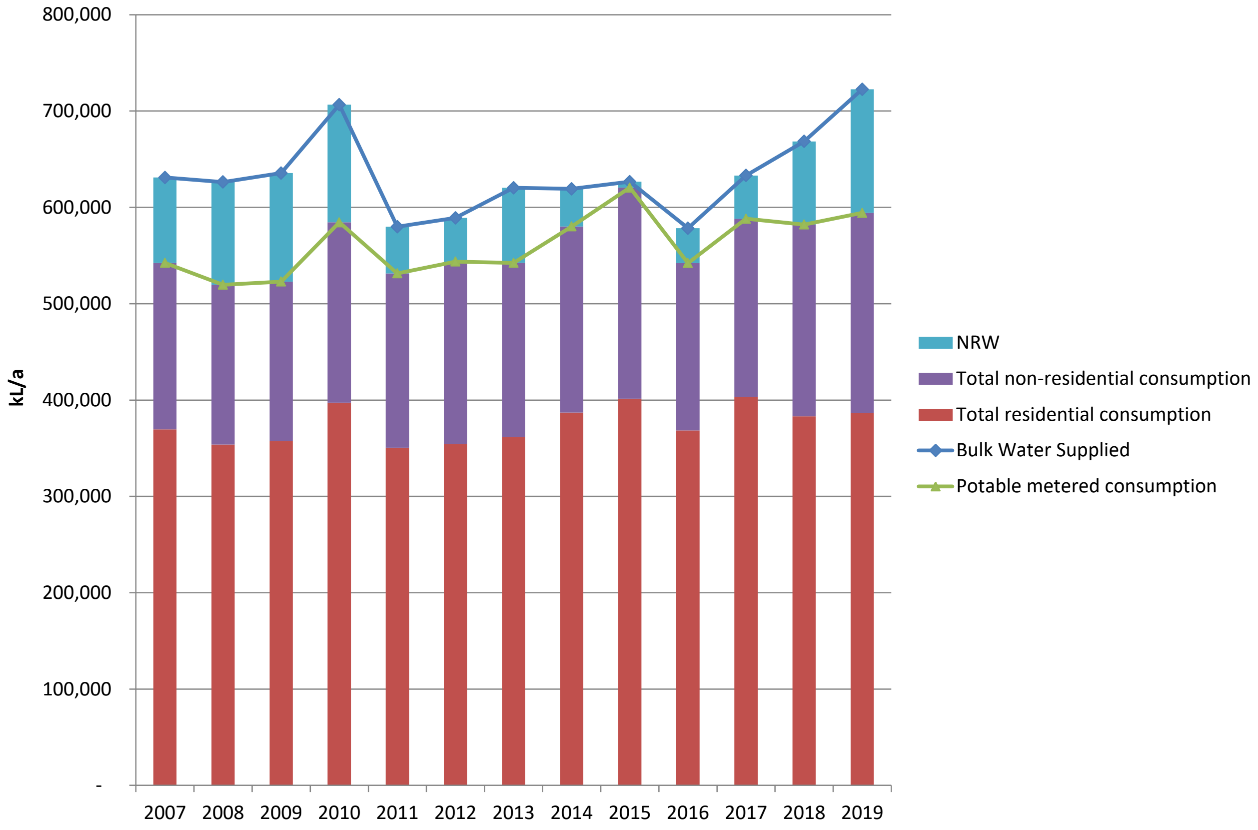

Figure 78: Bulk supply, metered consumption and NRW – Richmond Valley

8.6 Average and Dry Year Demand

The climate correction analysis undertaken for Richmond Valley bulk supply area suggests that the dry year demand is 5.5% higher than the average demand (Appendix 2). The historical metered consumption per connection for each customer type and the average, maximum and dry year consumption per connection are shown in Table 21. This table also shows the average consumption per connection used in the 2013 demand forecast. The revised consumption rates are lower than the 2013 rates used.

Table 21: Average consumption per connection – Richmond Valley bulk supply area (kL/a)

Connection type	2015	2016	2017	2018	2019	5 year average	5 year maximum	Dry year	2013 forecast (average)
Single residential	192	173	186	178	179	181	192	191	179
Multi-residential	64	60	80	64	64	66	80	70	122
BASIX single residential	112	112	112	112	112	112	112	118	137
BASIX multi-residential	102	102	102	102	102	102	102	107	99
Total residential	*148*	*136*	*148*	*139*	*141*	142	148	149	162

Connection type	2015	2016	2017	2018	2019	5 year average	5 year maximum	Dry year	2013 forecast (average)
Commercial	529	444	496	491	515	495	529	520	
Fire service	524	176	97	390	195	276	524	290	
Municipal	493	490	564	538	652	547	652	575	not used
Public Parks	416	281	340	400	378	363	416	381	
Sugar Mill	71,277	47,348	41,710	54,025	53,934	53,659	71,277	56,342	
Total non-residential	*763*	*593*	*626*	*666*	*695*	*668*	*763*	*702*	*653*

8.7 Predicted Growth

RVC has not yet adopted a growth management strategy. Development projections have been derived from:

- Evans Head Sewerage Strategy, GHD, 2008.
- The development application for Iron Gates (Evans Head).
- Woodburn Sewerage Strategy, GHD, 2008.
- Review of Broadwater Peak Day Demand (Hydrosphere Consulting, 2018a)
- Information from RVC on vacant lots and other potential developments.

The basis of the development assumptions is given in Table 22.

Table 22: Anticipated development – Richmond Valley bulk water supply areas

Area	Future development	Assumed timing
Evans Head – Iron Gates	175 new residential lots	2022 - 2031
Evans Head – vacant land	147 new residential lots	2020 - 2060
Evans Head – manufactured home estate (Lot 1&2 DP1238103)	199 lots, 0.75 ET/lot	2022 - 2031
Broadwater and Rileys Hill – residential land releases	219 ET	2020 - 2060
Development of single lots	21 ET	2020 - 2060
Development of vacant lots	11 ET	
Future single lots	11 ET	
School development	2 ET	
Woodburn – Trustrums Hill	100 ET	2020 - 2060
Woodburn – infill	57 ET	2020 - 2060

The resulting number of connections in each ten-year period is given in Table 23.

Table 23: Future connections – Richmond Valley (excluding Casino)

Connection Type	2010	2020	2030	2040	2050	2060
Single residential	1,628	1,614	1,459	1,320	1,255	1,194
Multi-residential	596	549	497	449	427	406
BASIX single residential	30	280	760	1,047	1,237	1,424
BASIX multi-residential	46	319	521	637	716	795
Total residential connected properties	*2,300*	*2,762*	*3,237*	*3,453*	*3,636*	*3,819*
Commercial		245	287	306	322	338
Fire service		2	2	2	2	2
Municipal		30	30	30	30	30
Public Parks		23	23	23	23	23
Sugar Mill		1	1	1	1	1
Non-residential connected properties	267	301	343	362	378	394
All connected properties	2,567	3,063	3,580	3,814	4,014	4,213
Bulk supply area growth (total connections) % p.a.	0.4%	0.5%	1.3%	0.5%	0.4%	0.4%

A comparison between the historical data, the revised forecast and the 2013 forecast is shown in the following figure. The longer-term projections are higher due to the higher number of historical connections used.

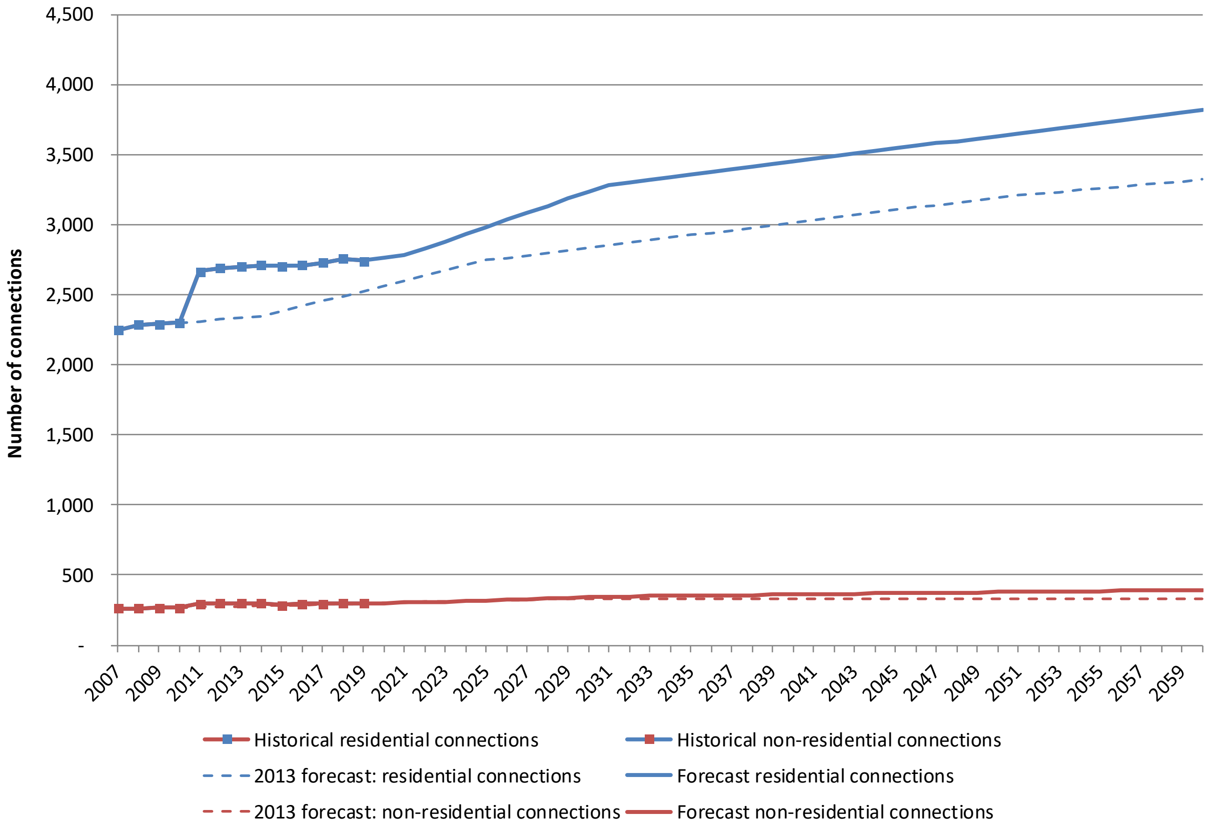

Figure 79: Forecast number of connections and comparison with 2013 demand forecast – Richmond Valley

8.8 Predicted Future Demand

8.8.1 Consumption

The forecast average and dry year customer demand is shown on Figure 80 along with the 2013 forecast. The revised forecast is higher than the 2013 forecast.

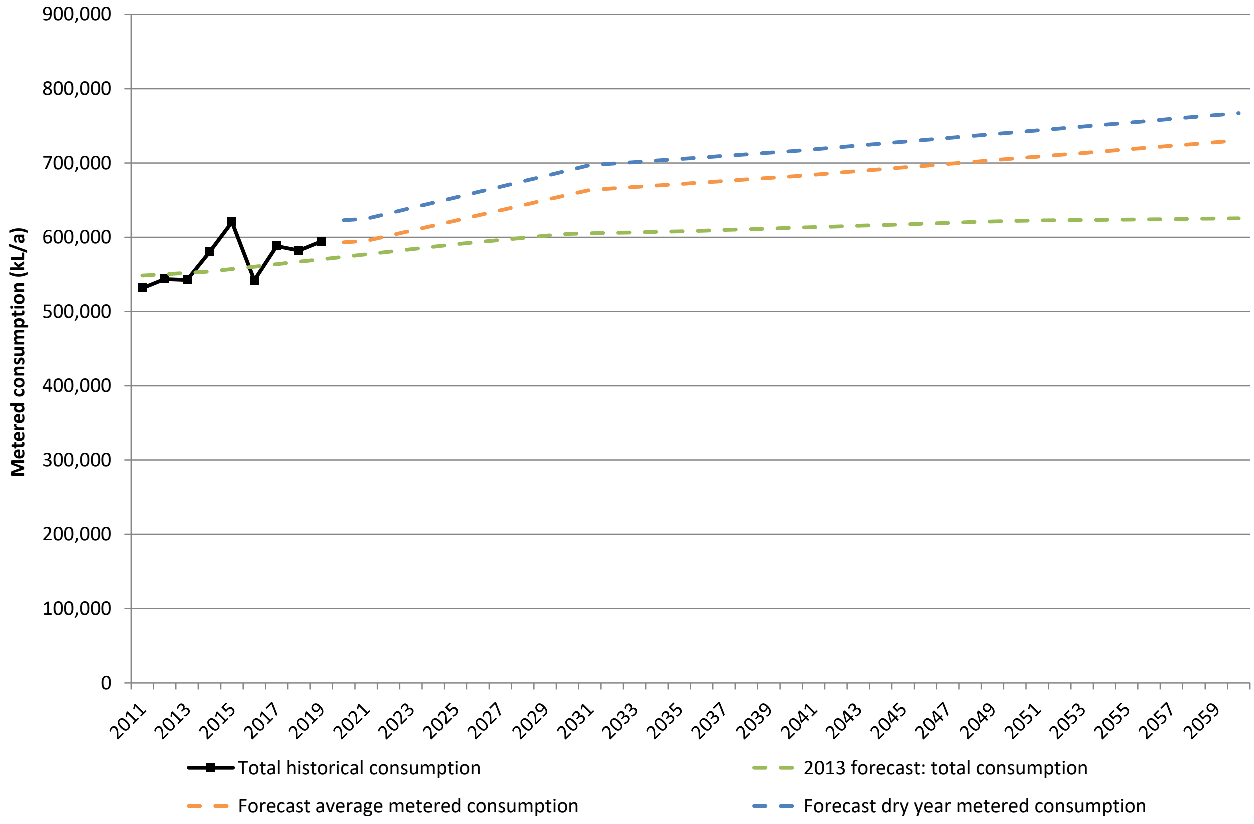

Figure 80: Revised forecast metered consumption and comparison with 2013 demand forecast – Richmond Valley

8.8.2 Water loss management measures

Two scenarios have been developed for water savings due to demand management:

1. No water loss management – using current average NRW = 9.0% of bulk supply.
2. Predicted NRW with WLMP targets – NRW savings of 20 ML/a by 2024.

The Richmond Valley demand with scenarios 1 and 2 is shown on Figure 49 and also compared to the 2013 forecast.

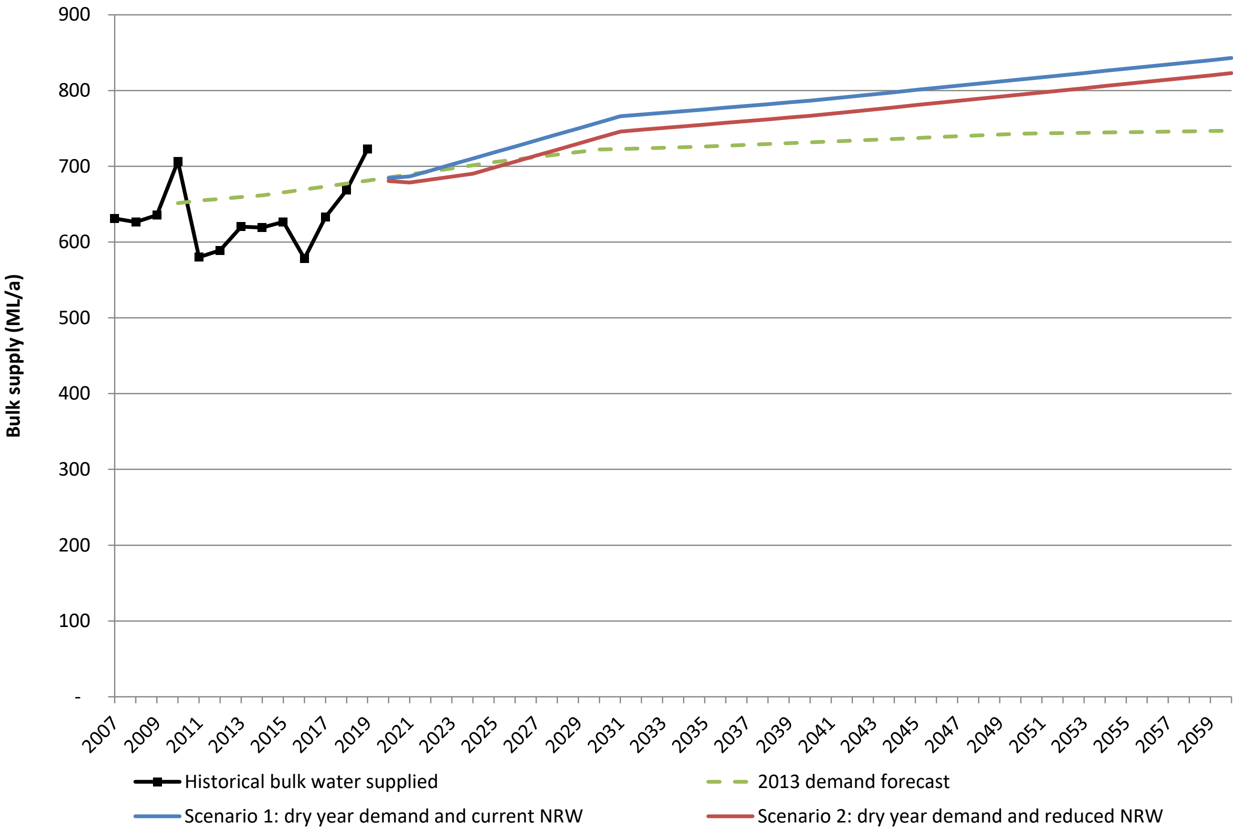

Figure 81: Average and dry year unrestricted demand forecast and comparison with 2013 forecast – Richmond Valley

9. ROUS RETAIL SUPPLY AREA

9.1 Historical Connected Properties and Metered Consumption

RCC provided data on connected retail properties and consumption between 2006/07 and 2018/19. The 2013 demand forecast presented the connections data between 2007 and 2010 as number of customer meters. The new connected property data is used in the demand forecast.

RCC serves a wide range of retail customer types and end uses for these customers are not always known or consistent (rural, semi-rural etc.). As this is only a small component of bulk supply demand, more detailed analysis is not considered to be necessary.

Annual connected property data since 2007 are shown on Figure 82. Annual metered consumption is shown on Figure 83. Annual metered consumption per retail connection is on average 464 kL/a with a maximum of 757 kL/a in 2011.

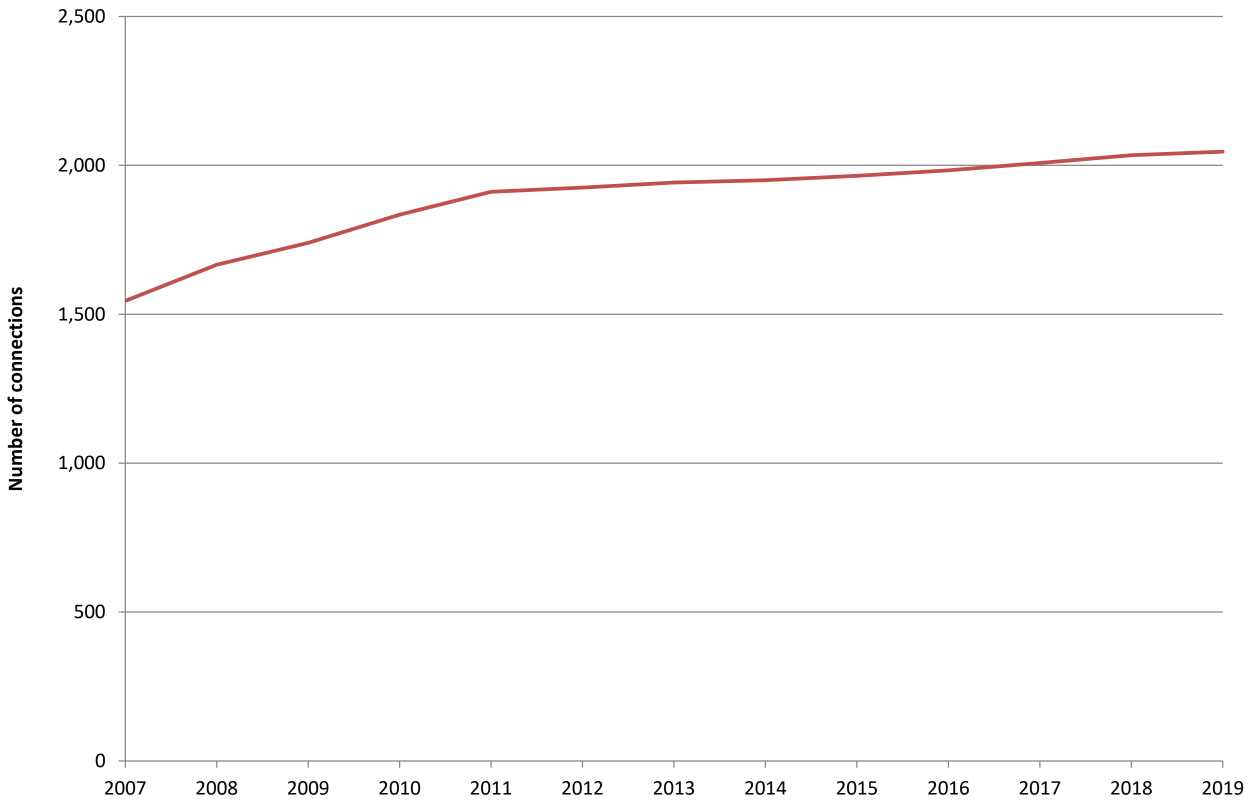

Figure 82: Historical connected properties – RCC retail

Figure 83: Historical metered consumption – RCC retail

RCC has collected some data on the types of properties connected to the retail network for a backflow risk assessment project. These data suggest that 70% of retail connections are residential, 3% are commercial, 22% are farms, 1% are industrial and the remainder are unknown. Consumption for each retail connection type cannot be determined with the available data. However, an analysis of the consumption data shows that the consumption of the individual meters has been variable between 2007 and 2019. This is probably due to the high proportion of rural/external water usage which is dependent on climate. In addition, there is a large variability in the rate of consumption per connection, reflecting the wide range of water uses.

The breakdown of BASIX and non-BASIX properties is given on Figure 71.

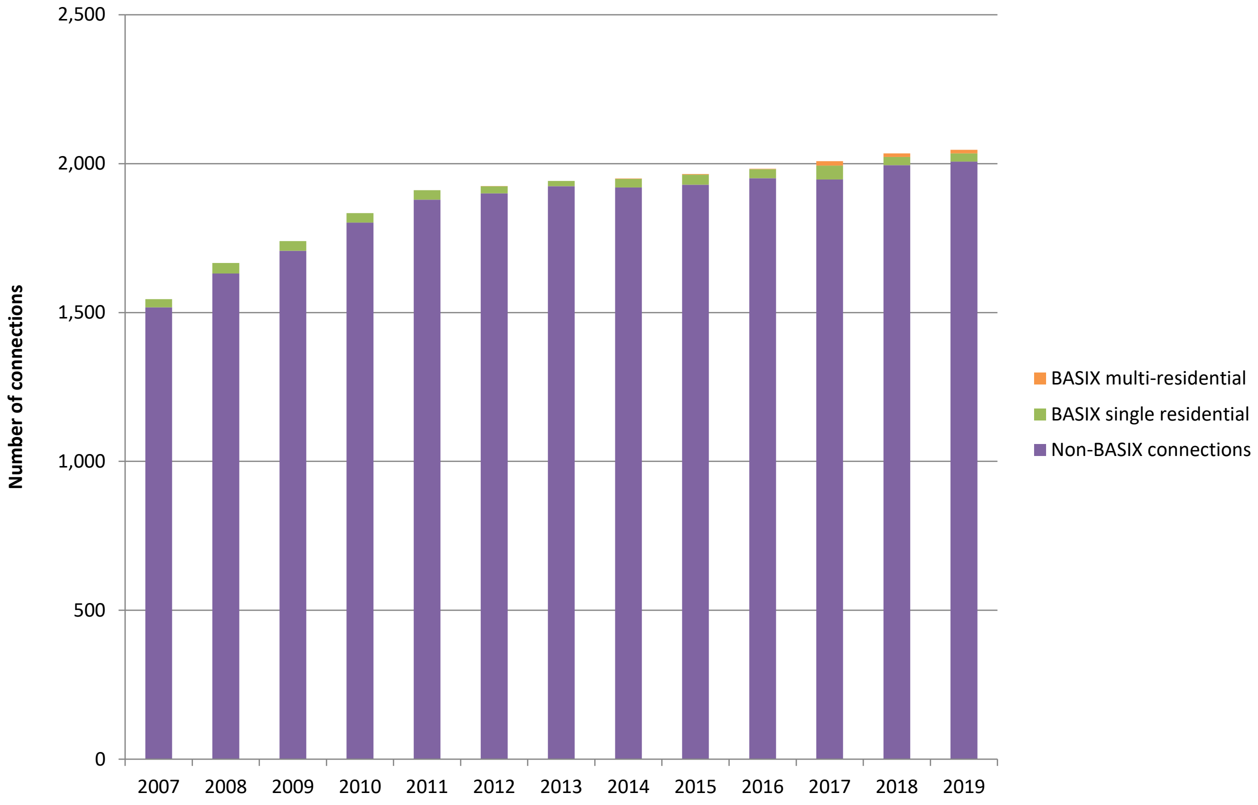

Figure 84: Historical BASIX and non-BASIX properties – RCC retail

9.2 Average and Dry Year Demand

The average dry year demand increase across all bulk supply areas has been applied to the retail customers (5.2%, Appendix 2). The historical metered consumption per connection for each customer type and the average, maximum and dry year consumption per connection are shown in Table 21. This table also shows the average consumption per connection used in the 2013 demand forecast. The revised consumption rates are higher than the 2013 rates used.

Table 24: Average consumption per connection – Richmond Valley bulk supply area (kL/a)

Connection type	2015	2016	2017	2018	2019	5 year average	5 year maximum	Dry year	2013 forecast (average)
BASIX connections	110	110	109	109	108	109	110	115	339
Non-BASIX connections	456	379	397	402	421	411	456	432	

9.3 Predicted Growth

Growth projections for Rous retail supply areas have been assumed based on constituent council growth planning as follows:

- Ballina Shire - the 2013 demand forecast assumed three new connections per year. There are no new data from BaSC on rural growth.

- Byron Shire – The growth management strategies suggest the following:
    - o Ewingsdale infill - 96 dwellings (2022-2024).
    - o Tyagarah infill - 23 large lot residential (2029 - 2033).
    - o Area 3 Tyagarah industrial - 9 ha, 70 premises (2022-2024).
    - o Area 4 Tyagarah industrial - 14.4 ha, 115 premises (2022-2024).
- Lismore - the 2013 demand forecast assumed Bexhill and Wyrallah would develop at six new houses per year until 2031. There is no new data from LCC on village growth.
- Richmond Valley – nil assumed.

All new rural residential connections are assumed to be BASIX compliant. The resulting number of connections in each ten-year period is given in Table 19.

Table 25: Future connections – RCC retail

Connection Type	2010	2020	2030	2040	2050	2060
BASIX connections	40	88	495	762	911	1,050
Non-BASIX connections	1,794	1,987	2,172	2,172	2,172	2,712
Total connections	1,834	2,075	2,667	2,934	3,083	3,222

A comparison between the historical data, the revised forecast and the 2013 forecast is shown on Figure 85.

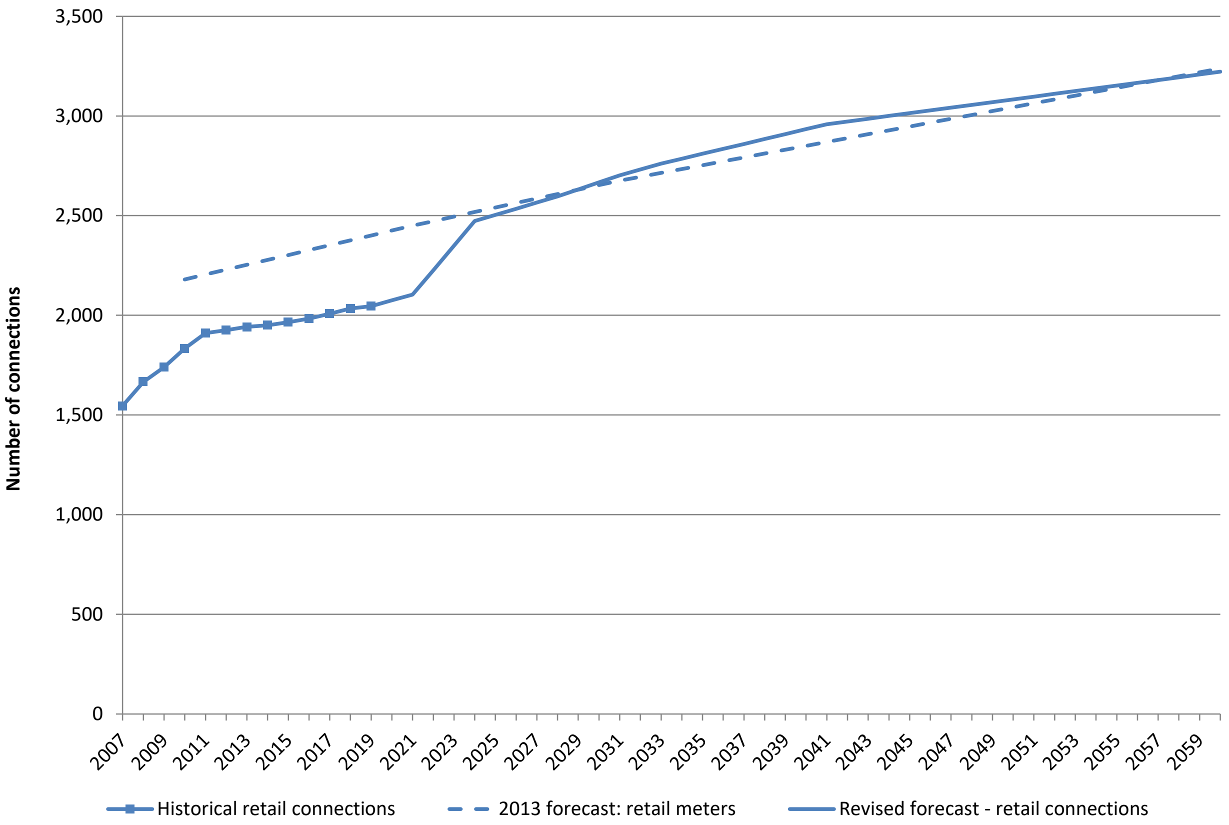

Figure 85: Forecast connected properties – RCC retail

9.4 Predicted Future Demand

The forecast average and dry year customer demand and the 2013 forecast are shown on Figure 86. The revised forecast is lower than 2013 forecast due to the reduction in demand experienced in recent years and the reduced rate of growth expected.

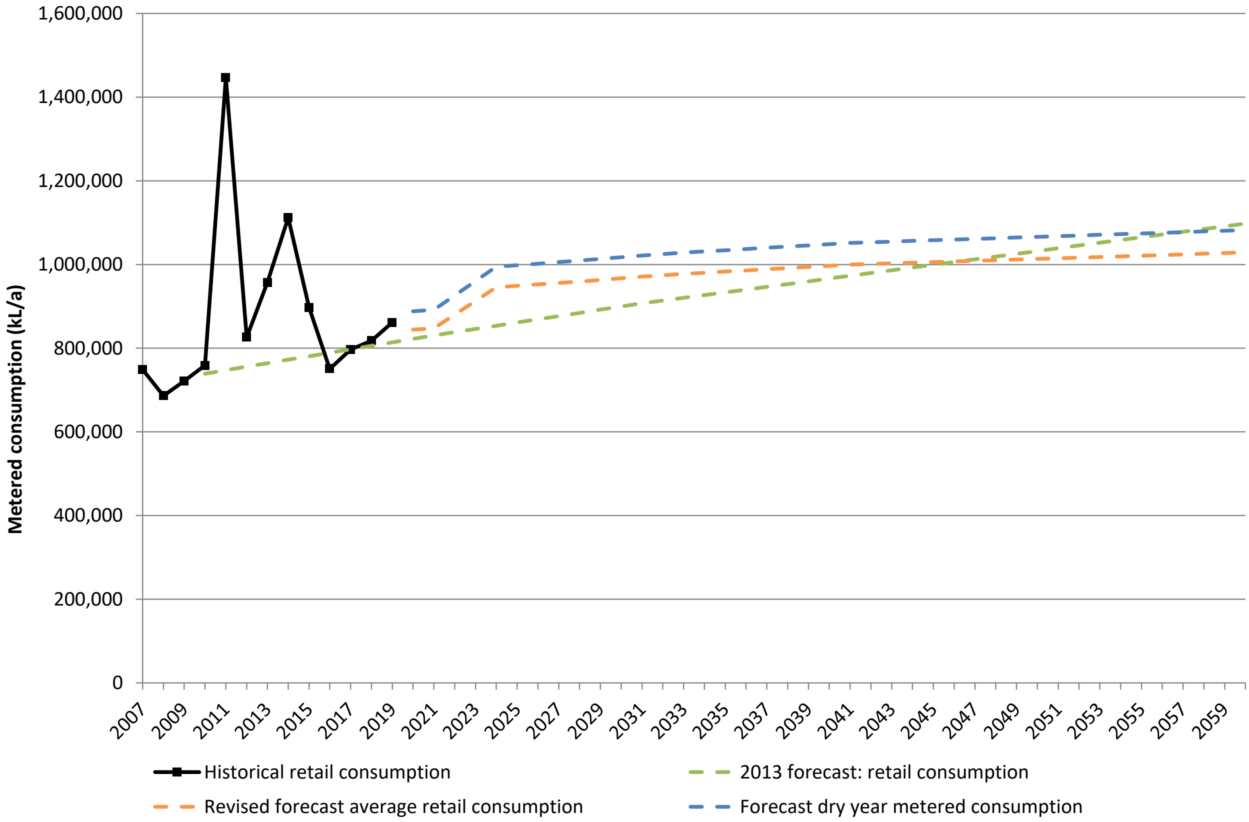

Figure 86: Revised forecast metered consumption and comparison with 2013 demand forecast – Rous retail

10. ROUS BULK SUPPLY AREA

10.1 Historical Connected Properties

The data on total connections within the Rous bulk supply area, compiled from the previous sections, are shown on Figure 87.

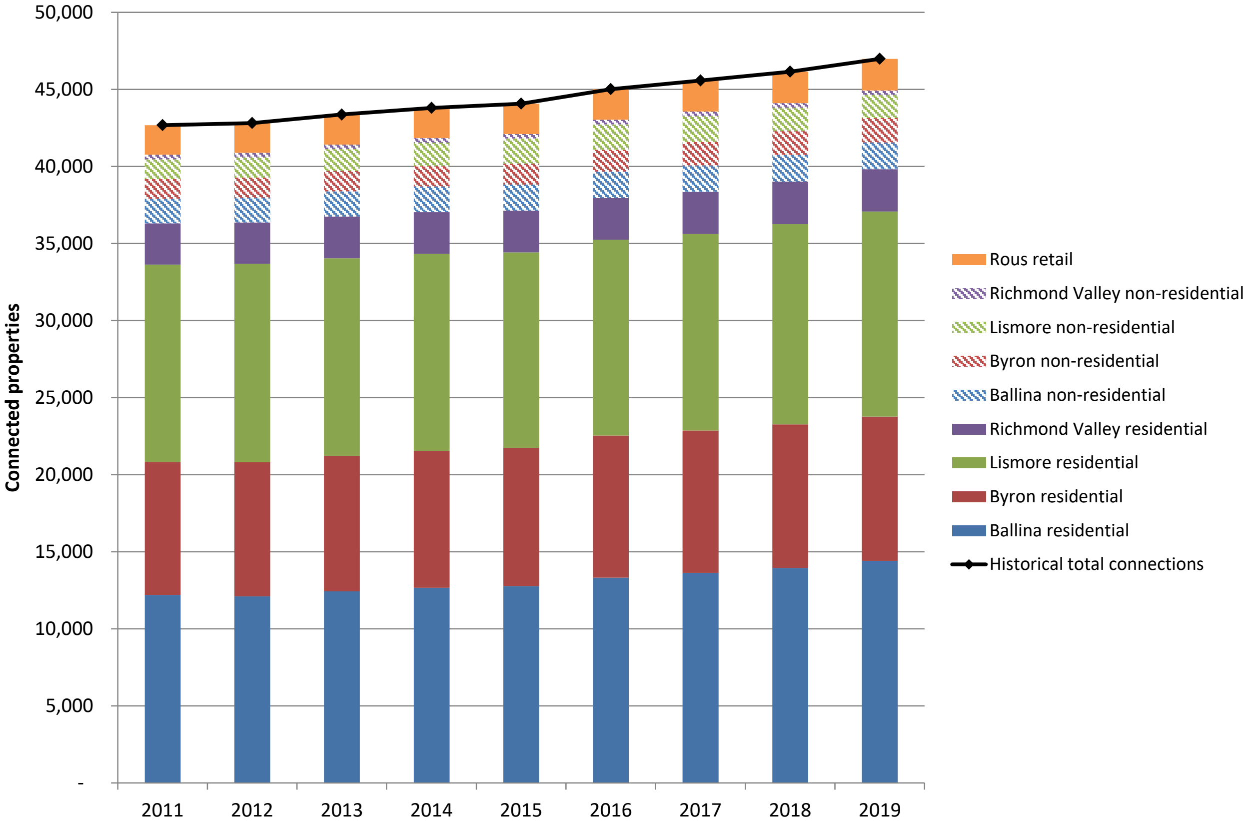

Figure 87: Historical Rous bulk supply area connections

10.2 Bulk Supply and Losses

RCC has provided data on the bulk production, total bulk water supplied to the councils, filling station sales and the water supplied to retail properties. The bulk supply (Rous) losses are calculated as the difference between bulk production and total bulk water supplied. This includes unmetered supply for the retail customers which may consist of retail meter errors, leakage from retail pipes and fittings, unbilled water (including water used by RCC for maintenance), bulk meter errors (at RCC supply sources) and differences in time periods (meter reading etc.).

The historical bulk water production, metered consumption, NRW and Rous losses are shown on Figure 88. Average Rous losses over the last 5 years were 333,705 kL/a or 3.0% of bulk production. The 2013 forecast assumed the Rous losses were (on average) 252,000 kL/a or 1.8% of bulk production.

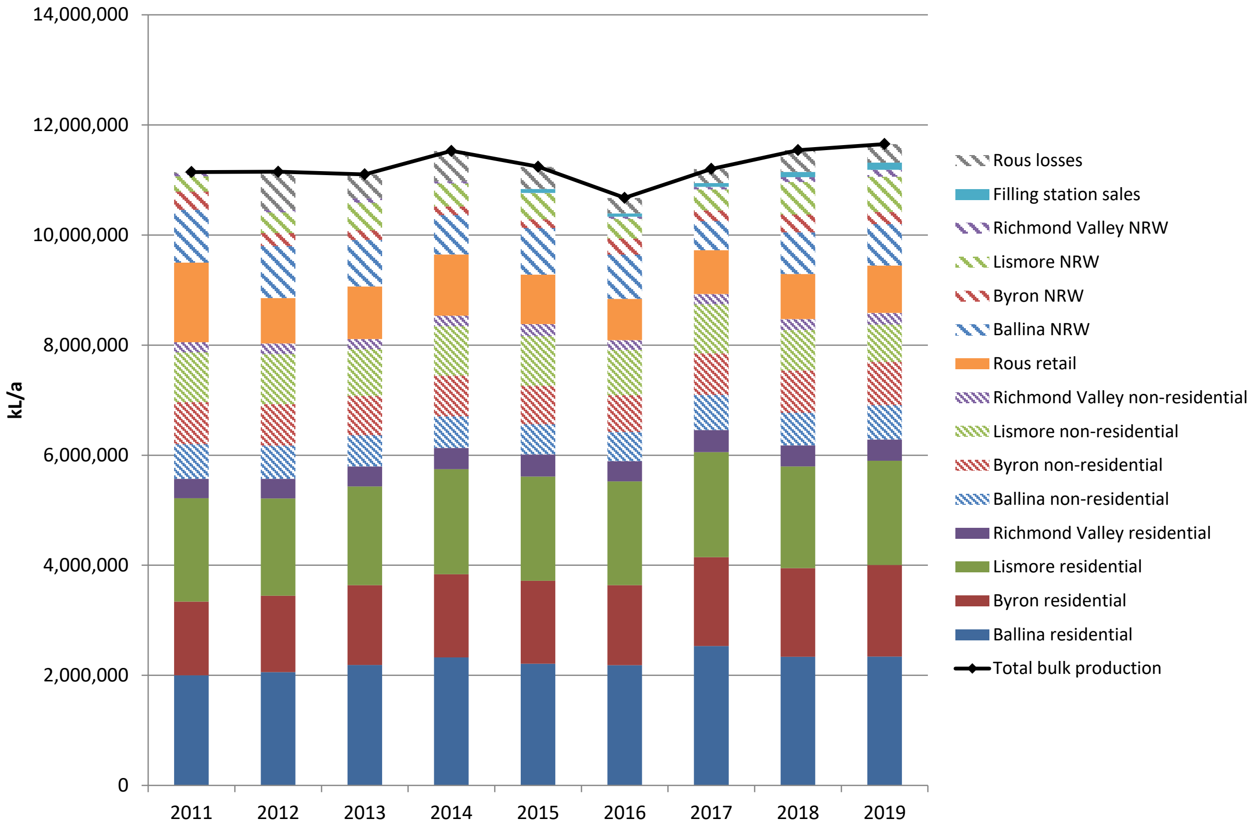

Figure 88: Historical Rous bulk supply, sales and losses

10.3 Peak Day Demand

RCC has provided daily production data from all sources (January 2011 – November 2019). The daily supply and PDD and ADD for each month are shown on Figure 89. PDD, ADD and peaking factors for each month are shown on Figure 90. The highest daily demand and average demand were experienced in January 2019 (Figure 91).

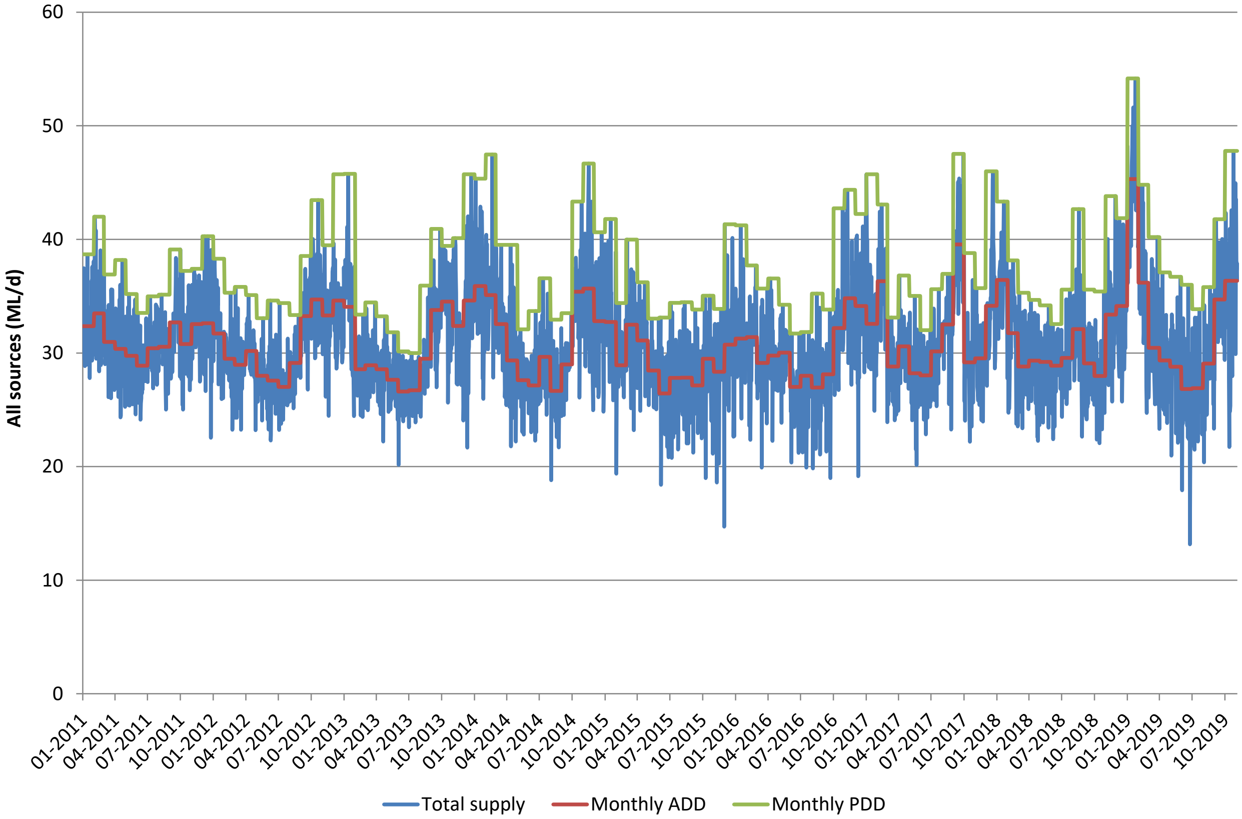

Figure 89: RCC bulk supply from all sources – daily

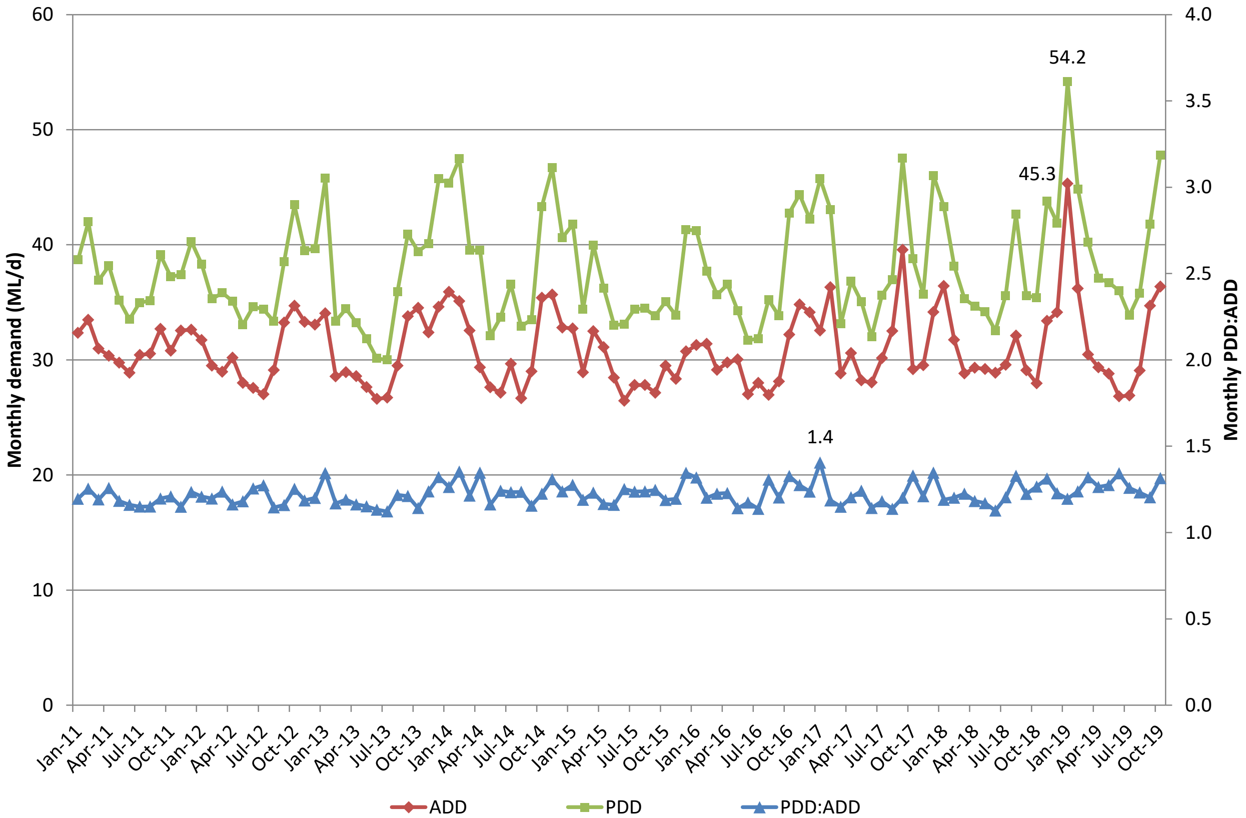

Figure 90: RCC bulk supply from all sources – monthly PDD and ADD

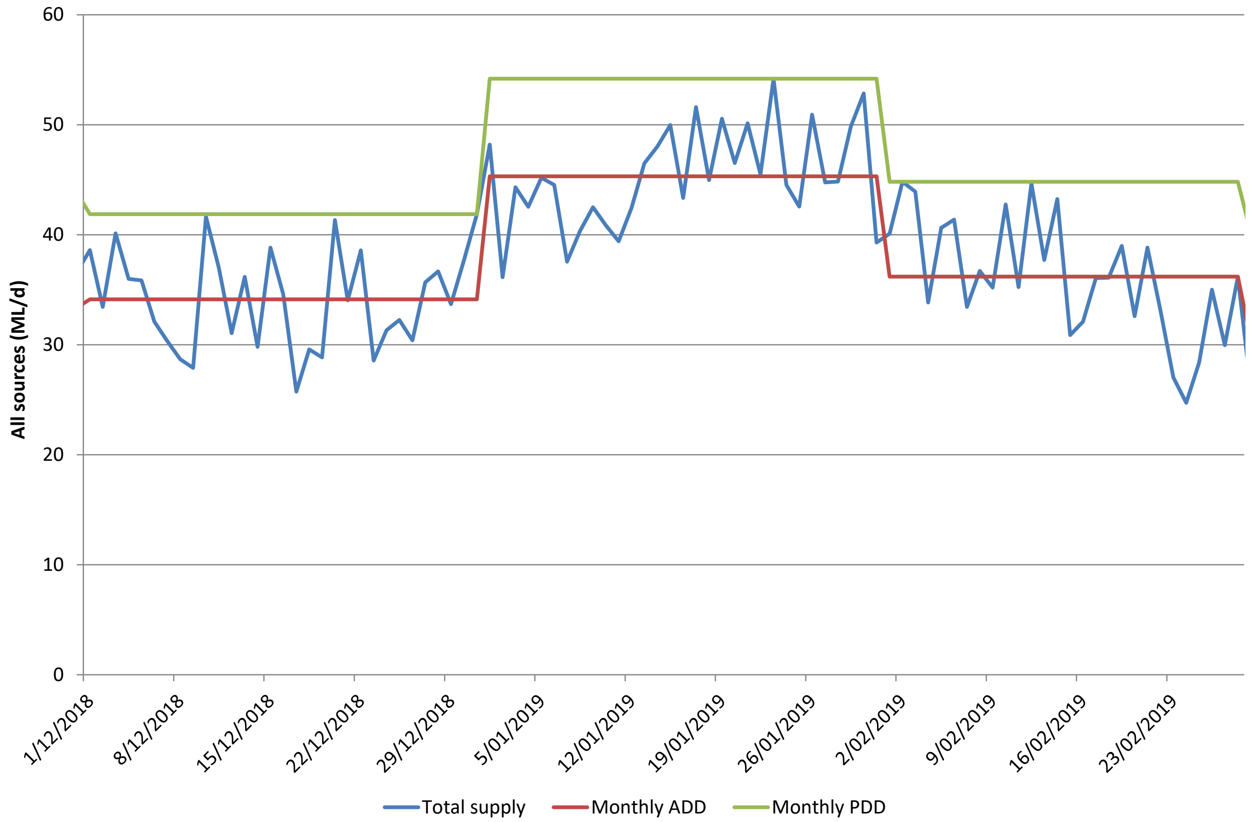

Figure 91: RCC bulk supply from all sources – summer 2019

RCC has reviewed the daily demand data for summer 2019 and determined that the PDD experienced was not representative of the true peak demand due to:

- Significant main breaks during the period (>3.5 ML in one day).
- High Rous retail consumption and issues associated with meter reading lag over that month.
- High filling station usage.
- A potential increase in water theft during that period.

The next highest recorded PDD (47.8 ML/d) was recorded on 25 October 2019 with a peak day to average day ratio of 1.31 for that month. A peak day to average day ratio of 1.35 was experienced in February 2014 and December 2017 and that ratio is considered appropriate for the future peak demand forecast for the Rous bulk supply area.

10.4 Predicted Growth

The historical and forecast future bulk supply area connections and comparison with the 2013 demand forecast are shown on Figure 92 for Scenario A (estimated Ballina lot yield) and Scenario B (upper estimated Ballina lot yield). The historical number of connections and revised forecast are lower than the 2013 forecast over the 40 year period.

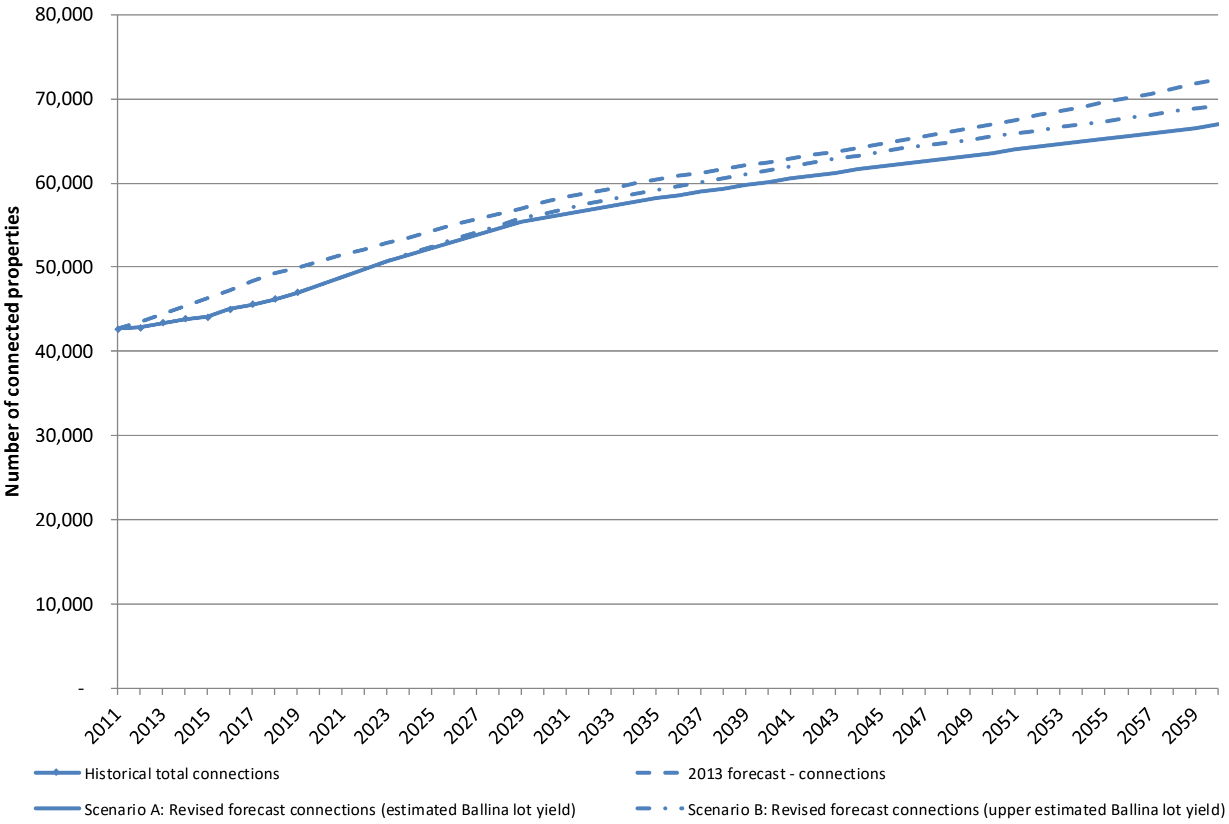

Figure 92: Forecast connected properties and comparison to 2013 forecast – Rous bulk supply area

The breakdown of connections in each five-year period is shown on Figure 93. The annual number of connections in each year for each scenario is provided in Appendix 3.

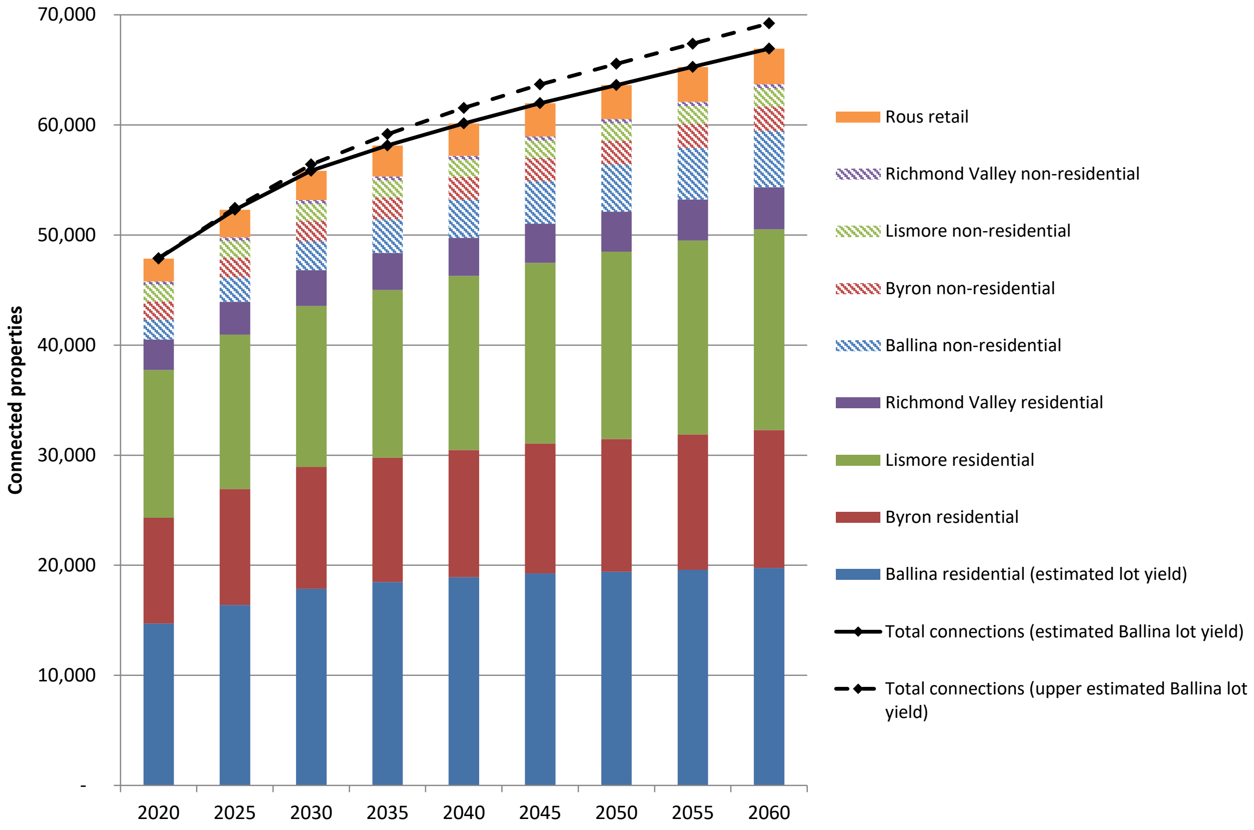

Figure 93: Forecast connected properties – Rous bulk supply area

10.5 Predicted Future Demand

Two scenarios have been developed for water savings due to demand management:

1. No water loss management – using current average Rous losses = 3.0% of bulk production.
2. Predicted NRW with WLMP targets – NRW savings of 120 ML/a by 2024.

The historical and forecast total bulk supply demand (bulk production) for each scenario, forecast average demand and comparison with the 2013 demand forecast are shown on Figure 94. The historical bulk production is lower than the 2013 forecast between 2010 and 2019. As a result, the revised forecast average demand is lower than the 2013 demand forecast.

The revised forecast dry year demand is higher than the 2013 forecast (average) demand. This is due to the following assumptions used in the revised forecast:

- Dry year demand was used in the revised forecast (with dry year metered demand 5.2% p.a. greater than average metered demand).
- Increased Rous losses (3.0% p.a. of bulk production compared to 1.8% p.a. in the 2013 demand forecast).
- Increased constituent council losses (apart from Richmond Valley):
  - Ballina Shire: + 3.3% p.a.
  - Byron Shire: + 4.3% p.a.
  - Lismore: + 4.4% p.a.
  - Richmond Valley: -10% p.a.

- Consumption per connection (dry year) is higher in Ballina Shire and retail supply areas than the 2013 forecast (average) although they are lower in Byron Shire, Lismore and Richmond Valley.
- The future growth rate is higher for Byron Shire non-residential development and Richmond Valley residential development but lower in Ballina and Lismore.

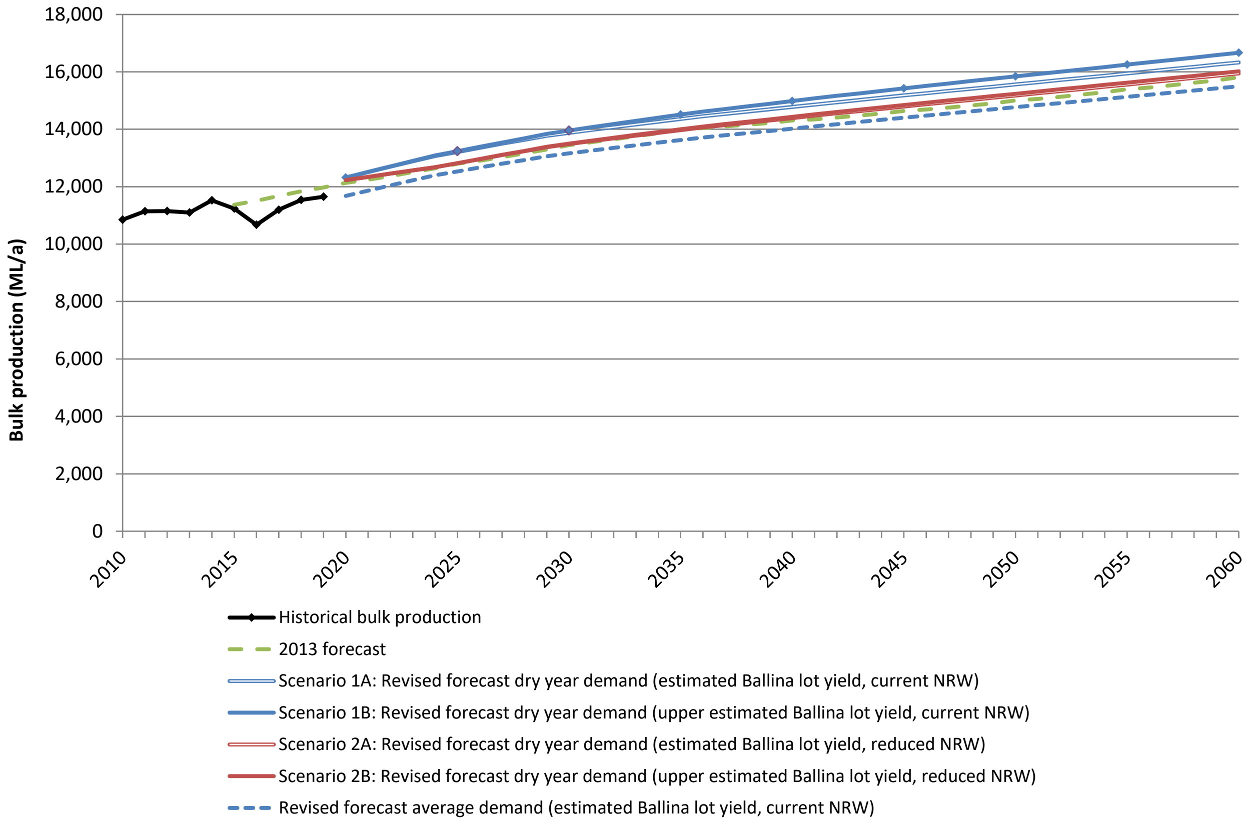

Figure 94: Forecast demand and comparison to 2013 forecast – Rous bulk supply area

The breakdown of bulk supply in each five-year period for Scenario 1A is shown on Figure 95. The annual demand in each year for each scenario is provided in Appendix 3.

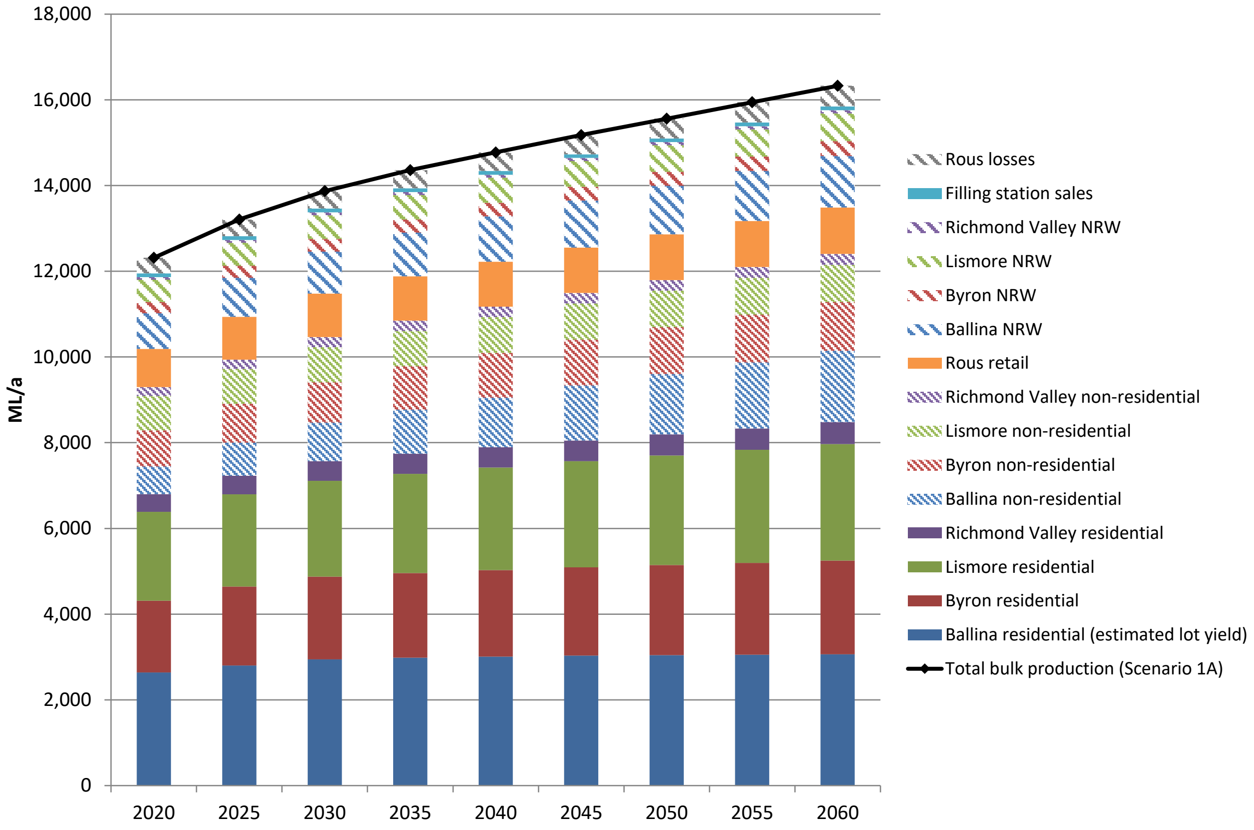

Figure 95: Forecast demand – Rous bulk supply area: Scenario 1A

11. LOCAL SUPPLIES

The constituent councils operate local water supplies in Wardell (BaSC), Nimbin (LCC), Casino (RVC) and Mullumbimby (BySC). RCC's future water supply planning will consider the potential connection of these water supply areas to the Rous regional supply in future. Annual demand in each year for these local supplies is provided in Appendix 3.

The analysis for the local supplies is only intended to provide an estimate of the future bulk supply demand if these supplies were connected to the RCC regional supply in future. They are currently the responsibility of the constituent councils and therefore more detailed analysis is not considered to be necessary or possible for RCC at this time.

11.1 Wardell

BaSC has supplied data on daily Marom Creek WTP production since 2015/16. The average annual WTP production was 139 ML and the maximum was 175 ML.

BaSC has prepared a Master Plan for Marom Creek WTP (servicing Wardell) (CWT, 2018) which included a demand forecast to 2036. The maximum annual water demand at 2036 was reported as 275 ML/a. Based on the growth assumptions used in the development of the local growth management strategy, there is no development predicted for Wardell beyond 2035. Therefore the 2060 demand is assumed to be 275 ML/a for Wardell.

The total demand of Wardell at 2060 is approximately 1.7% of the forecast bulk supply area demand.

11.2 Mullumbimby

A demand forecast will be prepared as part of future planning for the Mullumbimby water supply, however the outcomes are not yet available. The previous demand forecast was prepared as part of the *Byron Shire Council Water Supply and Sewerage Strategic Plan: 2017 Review* (Hydrosphere Consulting, 2017). The forecast future WTP production to 2045 is shown on Figure 96. The demand forecast has been extended to 2060 using the long-term growth rate of 1.4% p.a. The maximum Mullumbimby demand at 2060 would be 841 ML/a. This is expected to be a conservative estimate as development in Mullumbimby beyond 2036 is likely to be restricted, based on the outcomes of BySC's growth management strategies.

The total demand of Mullumbimby at 2060 is approximately 5.3% of the forecast bulk supply area demand.

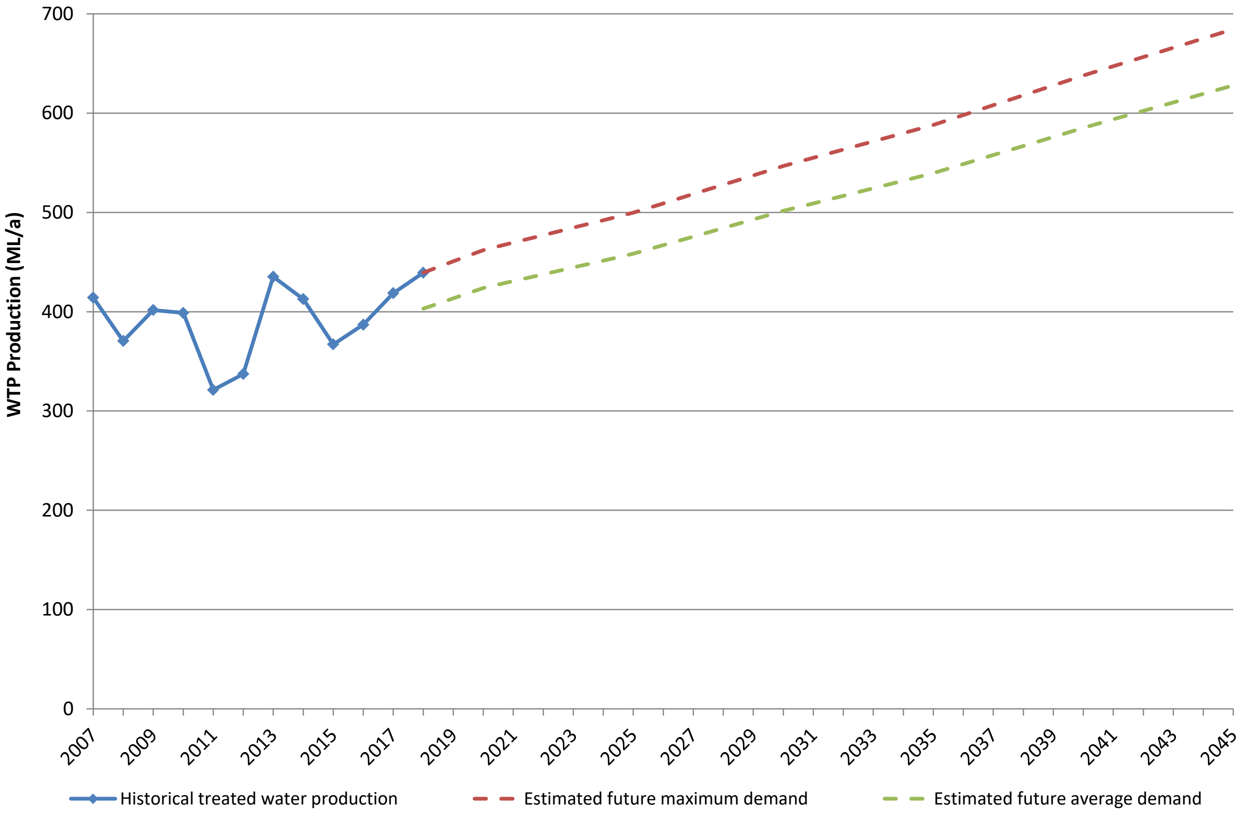

Figure 96: Mullumbimby water supply demand forecast

Source: Hydrosphere Consulting (2017)

11.3 Casino

RVC has supplied data on daily Casino WTP production since 2009/10. The average annual WTP production was 2,254 ML and the maximum was 2,473 ML.

A water supply demand forecast was prepared as part of the *Water Supply and Sewerage Strategic Plan* (Hydrosphere Consulting, 2018b) based on data provided in the *Northern Rivers Regional Bulk Water Supply Study* (Hydrosphere Consulting, 2013c). The demand for raw water (with water losses as 10% of raw water supply) was predicted to remain fairly constant (approximately 2,360 ML/a) with a slight increase in connections (1.3% p.a.) along with predicted water efficiency measures (Figure 97). The Casino water supply demand at 2060 was reported as 2,410 ML/a in that study (similar to current demand).

The total demand of Casino at 2060 is approximately 15.1% of the forecast bulk supply area demand.

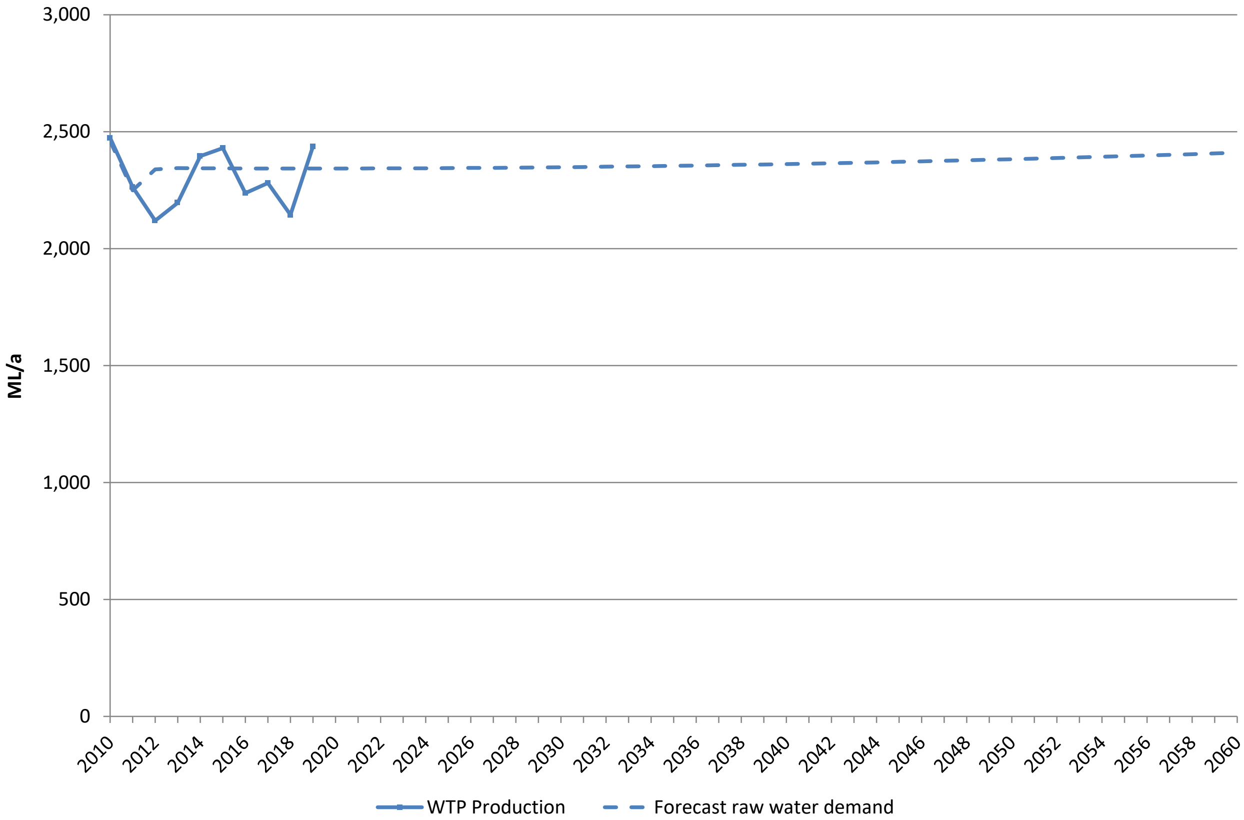

Figure 97: Casino water supply demand forecast

Source: Hydrosphere Consulting (2018b)

11.4 Nimbin

LCC has provided data on metered supply from D.E. Williams dam at Nimbin to the Nimbin treated water reservoir since October 2019 which includes periods of restrictions during summer of 2019/20. However, the demand of rural customers connected to the trunk main is not included in these volumes.

The *Northern Rivers Regional Bulk Water Supply Study* (Hydrosphere Consulting, 2013c) assumed a growth rate of 0.7% p.a. for Nimbin urban areas and 10% water losses. The Nimbin water supply demand (rural and urban) at 2060 was reported as 88 ML/a in that study (Figure 98).

The total demand of Nimbin at 2060 is approximately 0.6% of the forecast bulk supply area demand.

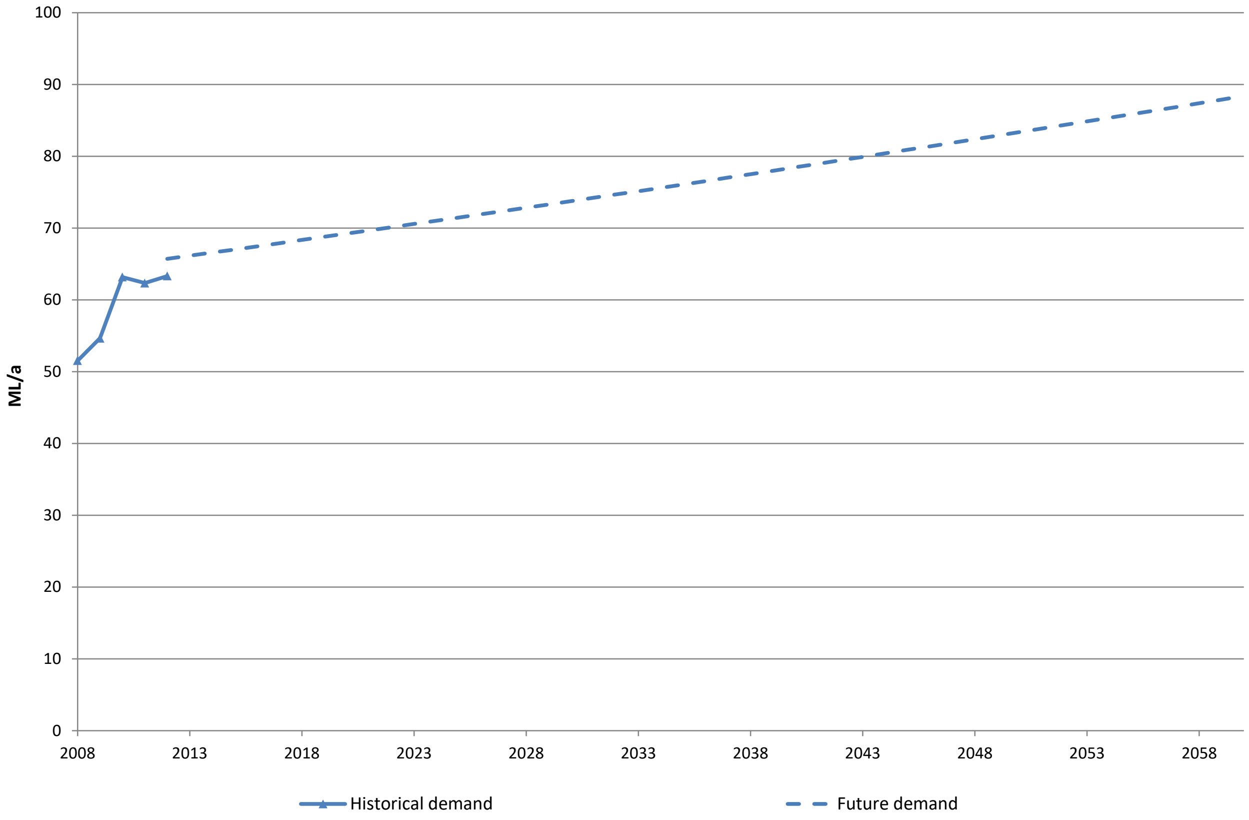

Figure 98: Nimbin water supply demand forecast

Source: Hydrosphere Consulting (2013c)

12. MONITORING REQUIREMENTS

This report has documented the available data as well as many assumptions regarding connection growth and demand for each connection type. It is important that the appropriateness of these assumptions are monitored and reviewed regularly so that the future demand profile can be updated. In addition, the connected property and metered consumption datasets used in this report were generally difficult to obtain and analyse and there are many inconsistencies in the datasets between supply areas which results in reduced confidence in the accuracy of the demand forecast.

The 2013 demand forecast included recommended data collection and monitoring activities to improve the accuracy of the demand forecasting. Since then, the RDMP (Hydrosphere, 2018) has been adopted including a Monitoring, Evaluation and Reporting action with a standardised reporting program in accordance with the best-practice requirements (Appendix 1) with:

- Bulk water production by service area/zone.
- Number of connections by customer/connection type.
- Number of connections with alternative water supplies.
- Accurate estimation of the numbers of multi-residential and multi-non-residential connections and their consumption.
- Total consumption by connection type in each zone/service area.
- Total volume of metered water use by connection type.

Similar reporting requirements have been included in the Service Level Agreements between RCC and the constituent councils. The RDMP action is still considered appropriate. In addition, definitive long-term growth strategies are required across the regional supply area to more accurately predict future demand.

It is recommended that the demand forecast is reviewed every eight years or more frequently if improved datasets are available.

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GLOSSARY AND ABBREVIATIONS

ADD	Average day demand
BASIX	Building Sustainability Index
BaSC	Ballina Shire Council
BySC	Byron Shire Council
DPIE	(NSW) Department of Planning, Infrastructure and Environment
kL	Kilolitres
kL/a	Kilolitres per annum
L	Litres
L/d	Litres per day
LCC	Lismore City Council
ML	Megalitres
ML/a	Megalitres per annum
NRW	Non-revenue water
PDD	Peak day demand
RVC	Richmond Valley Council
RCC	Rous County Council
WTP	Water treatment plant

Appendix 1. IWCM CHECKLIST – DEMAND MANAGEMENT COMPONENTS

Table 26: IWCM checklist requirements

Outcome to be achieved	Approach
5. 30-Year Population and Demographic Projection - For each service reservoir zone in each of your potable and non-potable water supply systems provide the following where practicable:	
A. The number of existing connected properties (residential and non-residential) and assessments (since 1996) obtained using your LWU's water customer billing database and reservoir zone layers (linked to Geographic Information Systems (GIS) where practicable).	Connected property data were provided by RCC and the constituent councils for the bulk supply areas (constituent council LGAs) and retail customers. Assessment datasets are not used in the demand forecast. Connected property datasets are generally not linked to the council Geographic Information Systems.
B. An estimate of the existing unoccupied and seasonally occupied (e.g. holiday dwellings) connected residential properties obtained from sources such as the local real estate agent or Council staff or tourist information services or customer billing database or Australian Bureau of Statistics (ABS) C-data.	This data is not collected by the constituent councils or RCC.
C. An estimate of the connected permanent residential population including household size using ABS C-data.	This data is not collected by the constituent councils or RCC apart from estimates reported in annual performance reporting. ABS-C data does not always accurately align with water supply areas. Population data have not been used in the demand forecast.
D. For the non-residential sector the number of existing commercial, industrial, rural, and institutional, hospital, school, hotel/motel, public swimming pools, council premises, and urban public parks and gardens connections.	Non-residential connected property data were provided by RCC and the constituent councils for bulk supply areas (constituent council LGAs) and retail customers. Detailed information on customer categories is not available for all councils apart from the data reported in annual performance reporting (commercial, municipal and industrial). The Regional Demand Management Plan includes an action to implement standardised definitions of connection types across the region.
E. Nature of major water using and/or discharging industries.	Council consumption data were generally provided as totals for each customer category. Where data is available, the consumption of a particular (high use) sector is provided.

Outcome to be achieved	Approach
F. An estimate of the total number of existing and new beds in connected tourist premises (e.g. motels/hotels, cabins/caravans, etc.) obtained from sources such as the local real estate agent or Council staff or customer billing database or premise operators or ABS data.	Tourism accommodation data is not collected by the constituent councils or RCC.
G. An estimate of the vacant lots, lot yield from larger lots that are likely to be subdivided within the existing zoned urban areas, lot yield from redevelopment areas, and lot yield from the new release area(s) that are to be serviced by each reservoir {establish using the reservoir zone, cadastre and Local Environment Plan (LEP) zone layers (linked to GIS where practicable) and their timing and take-up rate. Provide a map and table summarising the development type with details in an appendix.	The development of vacant lots, infill and new release areas has been included in growth projections provided by the constituent councils.
H. The number of existing (since 1996) and new connected residential and non-residential properties and assessments, and the permanent and peak population to be served by each reservoir for the next 30 years.	As above. Assessment and population data have not been used.
I. The number of existing (since 1996) and new connected residential and non-residential properties and assessments, and the permanent and peak population to be served by each scheme's headworks for the next 30 years.	
6. 30-Year Water Cycle Analysis and Projection - For each scheme's potable and non-potable water supply headworks systems establish the following where practicable:	
A. A time series graph showing the actual and corrected historical daily, monthly and annual production as well as annual consumption of potable and non-potable (if present) water.	Bulk supply data have been provided (potable only).
B. The factors/trends (such as demographic, climatic, economic, lot size, water efficiency, restriction impacts, pricing, etc.) that have affected historic water production and consumption.	Previous studies have been discussed in this report as well as analysis of new data for each council area.
C. The volume of non-revenue water (NRW) [represented as L/connection/d]. This comprises real losses (mostly leakage), apparent losses (under-registration of customers' meters and illegal use) and authorised unbilled water (e.g. mains flushing and firefighting).	Developed from bulk supply data and consumption data for each supply area and overall Rous losses.
D. The climatic and other factors/trends corrected unrestricted annual dry year demand per connected residential property.	Climate correction has been applied to consumption rates.
E. The climatic and other factors/trends corrected unrestricted average annual residential water supplied per connected property.	
F. The climatic and other factors/trends (e.g. reservoir effect, etc.) corrected unrestricted peak day demand per connected property.	Review of peak day production data and peaking factors for each bulk supply area has been undertaken.
G. The historical persistence of daily demand leading up to and after the peak day demand event.	
H. The unrestricted annual and peak day water demands of each non-residential connection type with climatic and other factors/trend correction if possible. For the non-residential sector, the total water supplied should be recorded for each of commercial, industrial, rural, institutional, public parks and gardens and non-revenue water (NRW).	As above. Non-residential connections are not consistently categorised as discussed above.

Outcome to be achieved	Approach
The following 30-year water demand projections taking account of the reservoir level analysis information, the impact of natural propagation of water efficiency, BASIX, water pricing and other current and planned LWU water efficiency measures:	
I. Total unrestricted annual dry year demand aggregated from the residential and non-residential connections for sizing of headworks infrastructure such as a dam, etc.; J. Total unrestricted annual average year demand aggregated from residential and non-residential connections for licensing and revenue requirements prediction; and	Annual demands have been developed.
P. Includes brief analysis of the impact of climate variability on the unrestricted annual and peak day demand projections.	As above.
For each scheme's potable and non-potable service reservoir zones establish the following where practicable:	
K. Total unrestricted peak day demand aggregated from residential and non-residential connections for sizing of water treatment works, pumping facility, etc.	Peaking factors have been developed for each bulk supply area.
L. The unit demands of connected residential property and of each non-residential connection type and NRW using the bulk flow meter/ pumping records and consumer meter records.	As above.
M. The total current peak and average day demands aggregated from the residential and non-residential connections for each reservoir zone.	
N. The 30-year total unrestricted peak day demand aggregated from the residential and non-residential connections for each reservoir zone for sizing of reservoirs, distribution mains, booster pumping facility, etc.	
O. Check that the water savings due to implementation of best-practice pricing (refer to Circular LWU11 of March 2011) and BASIX requirements have been accounted for in the annual and peak day demand projections.	Constituent council pricing has been discussed including influences on demand. BASIX has been accounted for in different connection types.
Q. Lists all the unserviced urban centres/areas within the local government area or LWU's area of operation and includes for each unserviced urban centre/area the projected 30-year peak day and annual demands aggregated from the residential and non-residential occupied properties.	Local council supplies have been included.

Source: NSW Government (2019)

Appendix 2. CLIMATE CORRECTION METHODOLOGY AND RESULTS

Previous studies on predicting demand due to climate variability

The 2013 demand forecast (Hydrosphere Consulting, 2013a) included a review of the influence of climatic variables to determine if there was a quantifiable linkage to bulk production, and whether these climatic variables during the 2006/07 – 2009/10 period were representative of a 'normal' period. Previous work on climate correction, tracking and demand prediction has been undertaken for the Rous Water system by AWT (2002) and by Rous Water (2011c). These studies form a logical starting point for evaluating the influence of climate.

The AWT (2002) study utilises multi-variable regression of various daily climate factors against RCC production for the duration of one year. The factors consisted of:

- Daily rainfall (same day as well as 1-day lag).
- Daily evaporation (same day as well as 1-day lag).
- Maximum daily temperature (same day as well as 1-day lag).
- Soil Moisture Index (SMI).

All of the climatic variables tested are short-term, except for the synthetic soil moisture index which is based on a simple water balance model that was adjusted to maximise correlation with observed RCC production levels. The resulting regression model was found to be able to account for 64% of the variability in production (implied demand) for the 'coastal' zone and 52% for the Lismore zone for the 365 days of the model calibration period. The factors contributing to this correlation where found to be temperature and SMI related in the coastal zone whereas all the factors listed above were shown to influence the production in the Lismore zone. It should be noted however that the SMI would logically produce a high correlation as part of the derivation of this index is to adjust this parameter to achieve the best fit with the observed production data. The results of this study indicate that 20-25% of the coastal zone demand and 10-20% of the Lismore demand was 'seasonal' (variable in response to climate). Although raw modelling data were not available for review, residual error plots show that the correlation error (up to +/- 40%) is often far greater than the predicted variability due to the above factors.

The Rous Water (2011c) study also identified a number of factors that were linked to historical per-connection demand. Based on more recent analysis of council connection data, it appears that this study did not allow for identification of non-RCC areas or multi-residential connections. Despite this, the overall methodology does provide insight into the potential climatic factors influencing demand. Those with significant influence in the study were found to be:

- Seasonality.
- Influence of restrictions:
    - o The multi-year period prior to major restrictions in 2002/03 versus a similar duration afterwards.
    - o The level of restriction.
- Deviation in average maximum temperatures from the monthly norm.
- Rainfall:
    - o Deviation in average rainfall from the monthly norm.
    - o Deviation in the number of rain days from the monthly norm.

Other factors such as the passage of time were also included in the model.

This study incorporated longer-term factors and derives more complex indices in an attempt to better explain the variability in the RCC production data. The factors based on restrictions cannot be used predictively in any model without consideration of the climate and demand factors leading up to such restrictions. Hence, whilst reasonable correlation was achieved in hind-casting (where the restriction period and levels are known), these factors have no real utility for prediction where prior knowledge of such events is not available. One key implication of the “pre-post restriction” variable identified by Rous Water (2011c) is that demand patterns, in particular, seasonal variability, altered significantly following the 2002/03 restrictions and this indicates that behavioural changes (in association with other demand management measures) have had a long-lasting influence which is likely to continue into the future. It follows that any future demand projections should only utilise demand/production data post-2003 to reflect this.

The remaining factors relating to seasonality, rainfall and temperature are of interest as these were also identified in the AWT (2002) study and can be logically linked to water use behaviour. Some further analysis of production statistics and climatic factors was undertaken for the 2013 demand forecast to evaluate the representativeness of the 2006/07 – 2009/10 period. It is known for instance that the El Nino Southern Oscillation can have significant influence on long-term cycles in rainfall and that other factors such as the 11-year solar activity (sun spot) cycle can also potentially influence climate on a global scale.

Fast Fourier Transform (FFT) of the RCC production data was undertaken in order to detect any repeating cycles in demand. This analysis confirmed that seasonal demand patterns with a 3-4 month period (as clearly identified by Rous Water, 2011c) as well as annual and decadal cycles were evident, however, the applicability of these relationships to future long-term demand projection is limited. Comparison with the Southern Oscillation Index (SOI, refer Figure 99) also did not provide any clear relationship to total production data, but may show higher correlation to the Lismore only demand as rainfall, which was shown by AWT (2002) to influence Lismore demand, is known to be related to SOI. Both the FFT and SOI analyses indicated that the 2006/07 – 2009/10 period was ‘typical’ of the post-2003 restriction period.

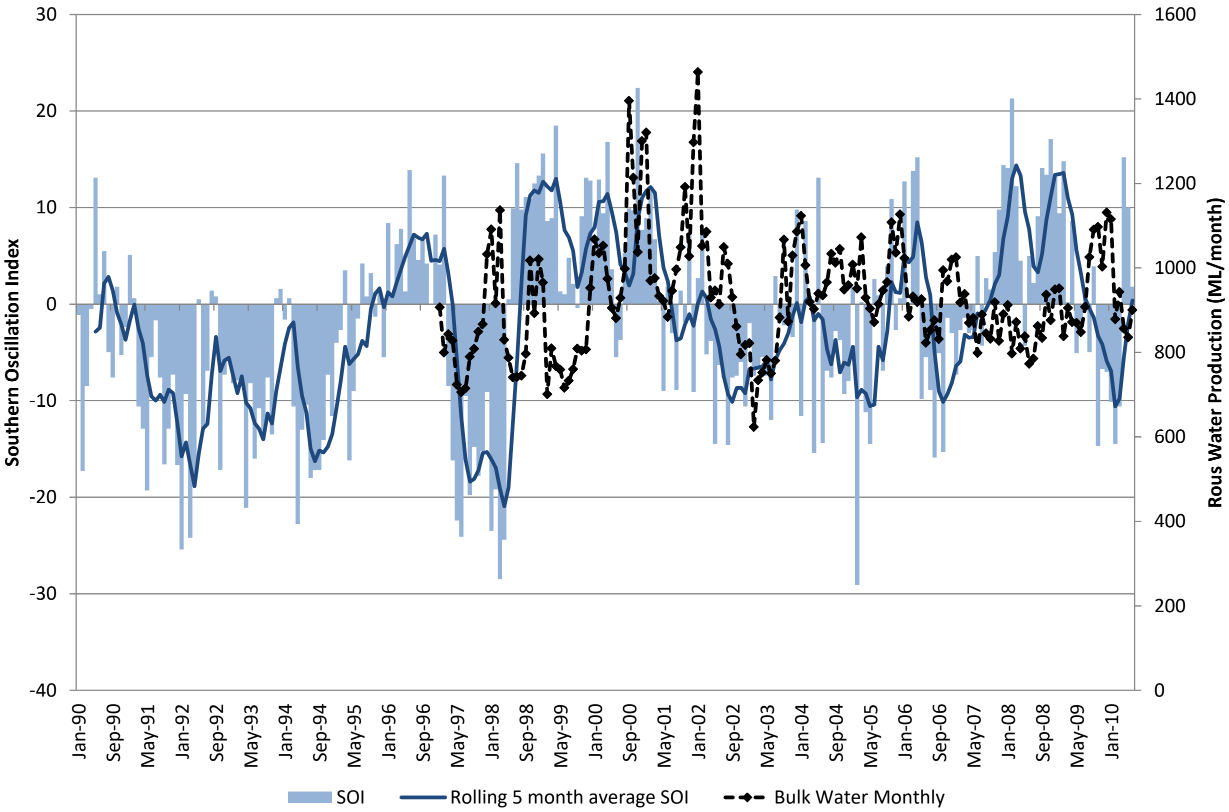

Figure 99: RCC production in relation to the Southern Oscillation Index

Source: Hydrosphere Consulting (2013a)

Figure 100 shows that spikes in water demand are often associated with increases in temperature above the long-term average. Climate data shown here represent the coastal areas, with data sourced from the Bureau of Meteorology SILO data for Ballina. This is consistent with AWT (2002) and Rous Water (2011c) which showed that temperature, particularly for the coastal distribution areas, is a key driver in demand. Whilst production appears to be positively linked with abnormally warm conditions, the corresponding decrease for abnormally cool conditions is not apparent. Developing correlation models that relate production to temperature is problematic in this situation as there appear to be temperature thresholds at which different levels of demand are stimulated, however the exact contribution of the underlying water uses (e.g. pool top up, increases in shower use, garden watering) is not known.

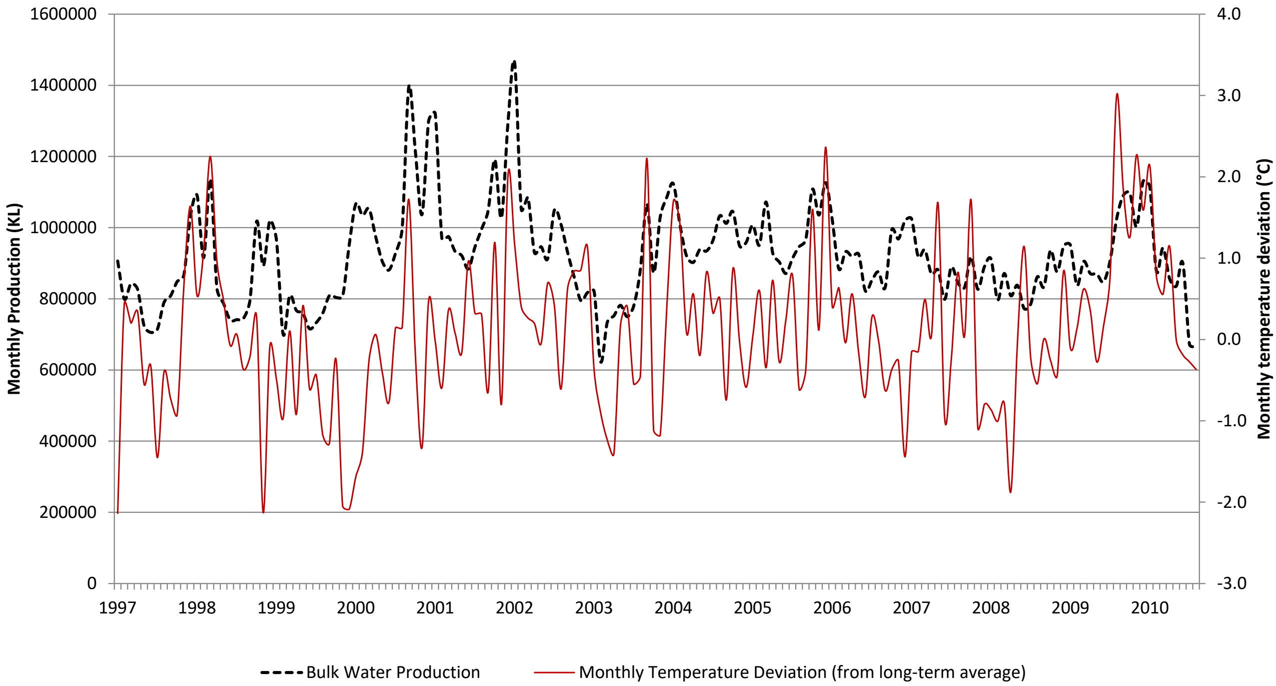

Figure 100: RCC production in relation to monthly temperature deviation

Source: Hydrosphere Consulting (2013a)

Climate Correction Methodology and Results

As discussed above, daily water demand patterns are highly variable and are likely to be influenced by a broad range of factors. Further analysis of some influences on annual demand has been undertaken for each Council in this report (Sections 5.3, 6.3, 7.3 and 8.3). Despite variability in the data there is an intuitive connection between climate and water demand which has been considered in the development of the demand forecast.

Using the current NSW Security of Supply Methodology, water security is achieved if the secure yield of a water supply is at least equal to the unrestricted dry year annual demand (NSW Office of Water, 2013). Modelling has been undertaken to attempt to correlate key climate influencing factors such rainfall, temperature and evaporation to changes in demand. This has been used to estimate the unrestricted dry year annual demand.

Daily correlation of climate factors to daily water demand is difficult due to factors such as:

- Variable household demand patterns, overall water requirements and thresholds for water use.
- Variable thresholds for factors that may trigger increased water use.
- Variable timing of response to climatic factors.

- Complex inter-actions between climatic factors.

Correlation of a broad range of factors, over variable timeframes, for variable thresholds etc. is not practical and is likely to be very specific to a particular data set. For a methodology that can be applied to multiple situations, it is considered more appropriate to determine whether broad combinations of climatic factors can be used to predict periods of increased water usage.

The adopted methodology has been developed with the following assumptions:

- Dry weather (indicated by low rainfall or low net rainfall) will increase outdoor water use (mainly irrigation) once a duration threshold has been reached. This is likely to be due actual or perceived low soil moisture or visible signs of plant stress.
- Hot weather will increase water usage. This is likely to be due to increased use of pools, showers after visiting the beach etc. and perceived garden irrigation needs during periods of high temperature. This is likely to be a shorter-term effect than dry weather and is not necessarily linked to soil moisture.
- High evaporation rates will increase outdoor water use when there is no rainfall. Such conditions would occur during periods of low humidity, high wind, high temperatures etc. This is considered to be linked to actual or perceived plant evaporation stress.

A simplified method has been adopted which investigates the ability of a sub-set of environmental factors to predict periods of increased water usage. A tool (excel macro) has been developed which allows identification of time periods where combinations of the following factors occur for a user-specified period:

- Rainfall.
- Temperature.
- Evaporation.
- Net rainfall.
- Humidity.

Various combinations of climate factors and thresholds are tested to determine whether these can independently identify the water usage peaks. The simplest combination which is considered to adequately predict these peaks is then used as the basis for further analysis.

Water usage data for peak usage periods are identified and the average water usage during these periods is compared to average water usage for periods of non-peak use. The additional usage is calculated as a percentage increase which is applicable to these dry/hot weather events.

Data used in the analysis and results are shown in Table 27 and the following figures.

Utilising the same thresholds and analysis techniques, it is possible to identify the extent of such climate occurrences for predicted future data sets with application of the daily climate factor. However, at this time, there are no available data on future climate parameters and future prediction of climate corrected demand has not been undertaken.

In this demand forecast, the increase in demand due to dry weather (from Table 27) has been applied to the average consumption for each connection type. The average for the previous five years has been used to remove any influences due to pricing and water efficient behaviour over longer periods. Due to the expected increase in outdoor use the residential consumption is likely to increase during hot/dry weather, although due to the lack of short-term consumption data and the expected influence of other factors (such as pricing, demographics, lot type and size and soil types), the impact on consumption for each customer type, particularly non-residential customers is not quantifiable. Hence as a conservative approach, the increase in consumption during a dry year has been applied to all customer types.

In some cases, the maximum metered demand per connection over the previous five years is higher than the dry year demand. This may be due to the other factors that influence demand as discussed above but may also be a result of the lack of short-term consumption data available for the analysis.

The 2013 demand forecast assumed that the average per connection demand for each connection type will remain static throughout the 50 year period and this was the basis of the long-term forecast of consumption. This review of the demand forecast presents the long-term demand based on both the average metered consumption and the dry year consumption.

Table 27: Climate correction data, parameters and results

Council area	Climate data[1]	Bulk supply data[2]	Average % of time with hotter/drier weather events (%)[3,4]	Additional usage during peak times compared to non-peak usage (%)[3,5]	% correlation of prediction[6]	% of time demand with hotter/drier weather events (%) in "worst case" year[4,7]	Predicted "dry weather" increase in demand (%)[8]
Ballina Shire	Lat: -28.85 Long: 153.55	1/7/2003 – 30/11/2017	27%	27%	75%	49% (2019)	5.9%
Byron Shire	Lat: -28.65 Long: 153.60	1/7/2003 – 30/11/2017	32%	22%	77%	48% (2019)	3.5%
Lismore	Lat: -28.80 Long: 153.30	1/7/2003 – 31/12/2017	18%	20%	77%	47% (2019)	5.8%
Richmond Valley	Lat: -29.10 Long: 153.40	1/7/2003 – 30/11/2017	26%	29%	75%	45% (2019)	5.5%

1. Sourced from Queensland Government (2020) from 1/1/1970 to the present.

2. RCC has provided daily bulk supply data from 2001 to 2017. Due to development of a new database, daily data is not available beyond 2017. Restrictions were imposed until May 2003, therefore only data since 1 July 2003 have been used.

3. For all years of climate and bulk supply data.

4. "Hotter/drier weather events" are the days which meet the climate variables which best predict usage increases for the respective Council area.

5. 'Peak' usage defined as when the 14 day average daily demand per connection is greater than the average demand per connection for the entire data set and the 90 day average demand is greater than the 360 day average demand per connection.

6. % of time that "hotter/drier weather events" (based on the climate variables selected) accurately predict periods of increased water demand.

7. "Worst case" year is the year with the highest number of days of "hotter/drier weather events".

8. Additional usage during peak times x additional time with hotter/drier events.

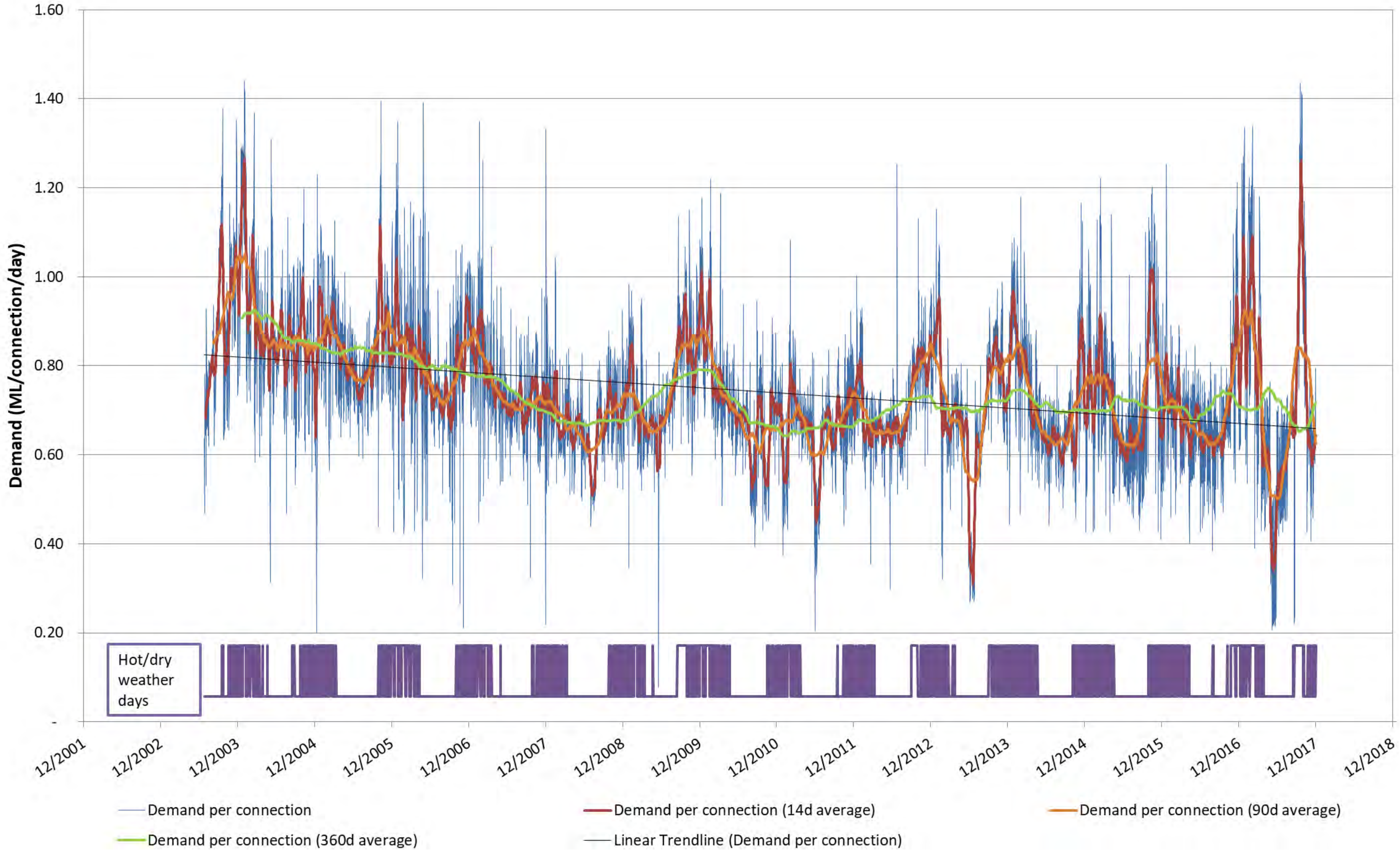

Figure 101: Climate correction analysis – Ballina Shire

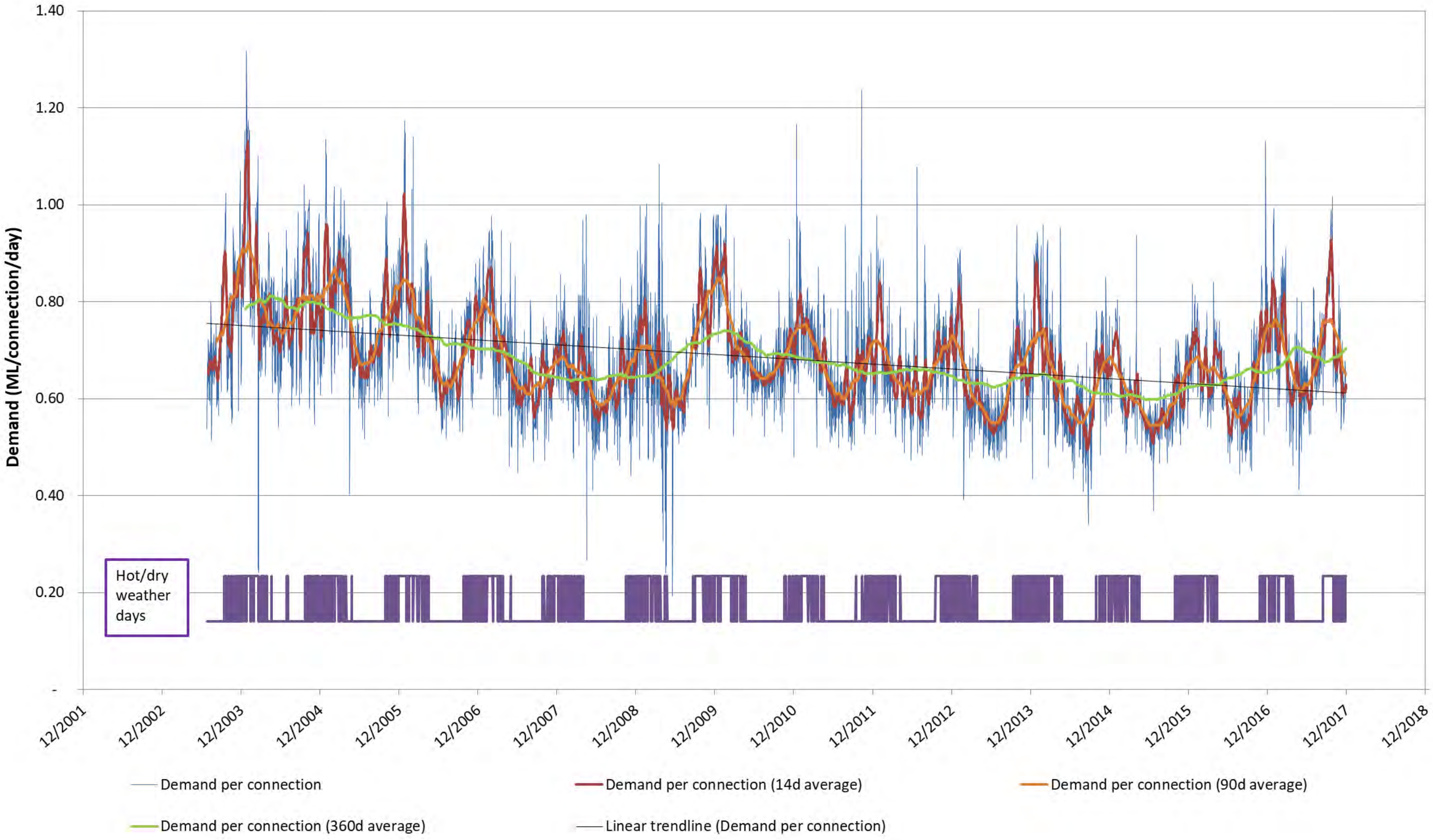

Figure 102: Climate correction analysis – Byron Shire

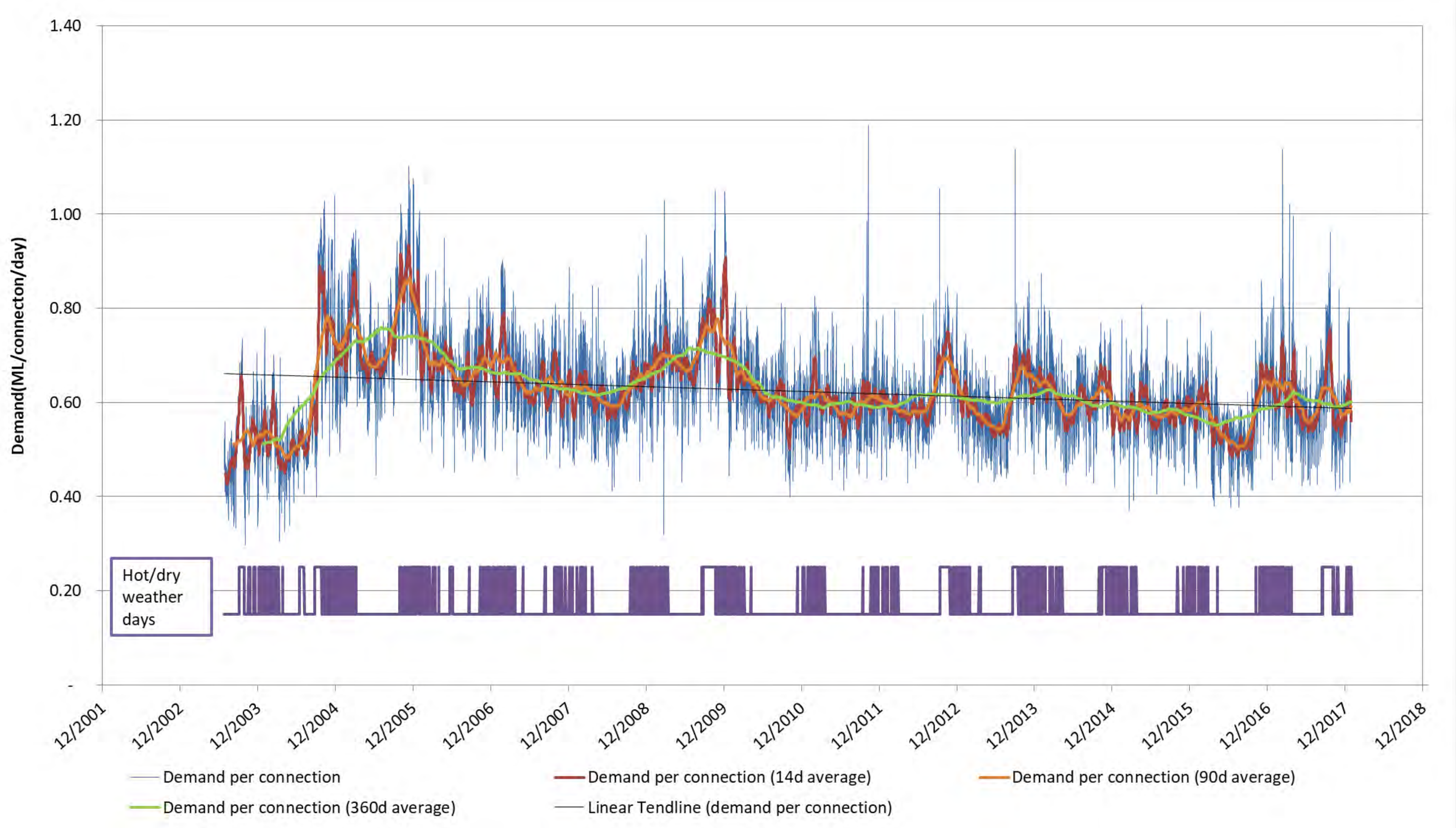

Figure 103: Climate correction analysis - Lismore

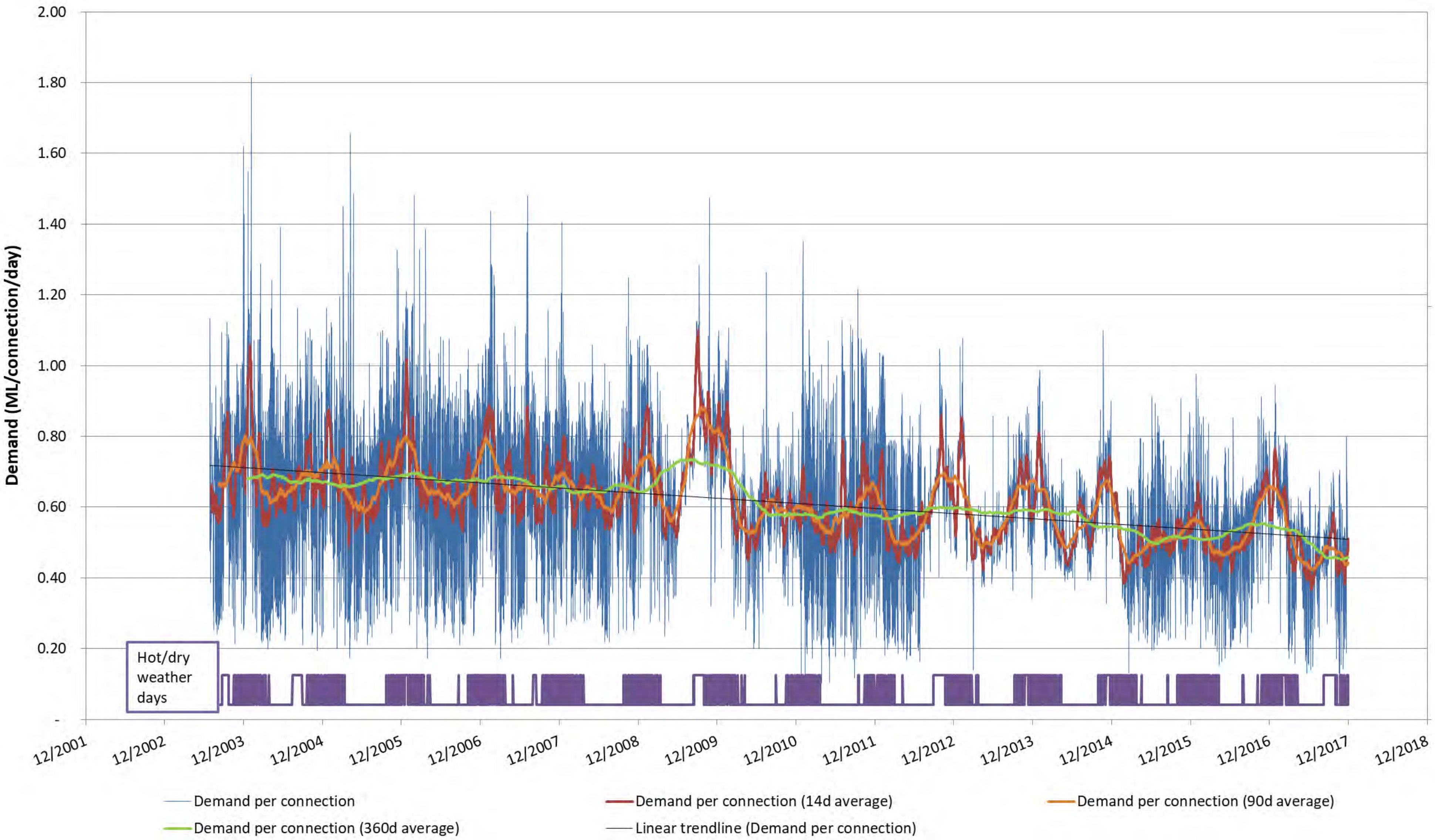

Figure 104: Climate correction analysis – Richmond Valley

Appendix 3. ANNUAL DEMAND FORECASTS

Table 28: Forecast connections

Scenario A: Revised forecast connections (estimated Ballina lot yield)	2020	2025	2030	2035	2040	2045	2050	2055	2060
Ballina residential (estimated lot yield)	14,721	16,395	17,881	18,488	18,928	19,270	19,431	19,599	19,772
Byron residential	9,603	10,533	11,058	11,303	11,548	11,793	12,038	12,283	12,528
Lismore residential	13,420	14,020	14,620	15,220	15,820	16,420	17,020	17,620	18,220
Richmond Valley residential	2,762	2,984	3,237	3,361	3,453	3,544	3,636	3,727	3,819
Ballina non-residential	1,822	2,232	2,643	3,053	3,463	3,874	4,284	4,694	5,105
Byron non-residential	1,655	1,786	1,858	1,995	2,059	2,103	2,146	2,190	2,234
Lismore non-residential	1,503	1,518	1,533	1,549	1,564	1,580	1,596	1,612	1,628
Richmond Valley non-residential	301	320	343	354	362	370	378	386	394
Rous retail	2,075	2,504	2,667	2,810	2,934	3,014	3,083	3,153	3,222
Total	*47,862*	*52,292*	*55,839*	*58,133*	*60,131*	*61,968*	*63,612*	*65,264*	*66,922*

Scenario B: Revised forecast connections (upper estimated Ballina lot yield)	2020	2025	2030	2035	2040	2045	2050	2055	2060
Ballina residential (upper estimated lot yield)	14,743	16,559	18,440	19,510	20,335	20,976	21,361	21,707	22,069
Byron residential	9,603	10,533	11,058	11,303	11,548	11,793	12,038	12,283	12,528
Lismore residential	13,420	14,020	14,620	15,220	15,820	16,420	17,020	17,620	18,220
Richmond Valley residential	2,762	2,984	3,237	3,361	3,453	3,544	3,636	3,727	3,819
Ballina non-residential	1,822	2,232	2,643	3,053	3,463	3,874	4,284	4,694	5,105
Byron non-residential	1,655	1,786	1,858	1,995	2,059	2,103	2,146	2,190	2,234
Lismore non-residential	1,503	1,518	1,533	1,549	1,564	1,580	1,596	1,612	1,628
Richmond Valley non-residential	301	320	343	354	362	370	378	386	394
Rous retail	2,075	2,504	2,667	2,810	2,934	3,014	3,083	3,153	3,222
Total	47,884	52,456	56,399	59,155	61,538	63,674	65,542	67,372	69,219

Table 29: Forecast demand (dry year bulk production, kL/a)

Scenario 1A: Revised forecast dry year demand (estimated Ballina lot yield, current NRW)	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**
Ballina residential consumption (estimated lot yield)	2,638,492	2,802,745	2,946,040	2,986,610	3,009,693	3,035,026	3,042,959	3,052,008	3,062,168
Byron residential consumption	1,676,377	1,838,725	1,930,373	1,973,142	2,015,912	2,058,681	2,101,450	2,144,219	2,186,988
Lismore residential consumption	2,071,988	2,151,940	2,232,216	2,312,801	2,393,681	2,474,840	2,556,265	2,637,943	2,719,862
Richmond Valley residential consumption	412,868	433,393	457,858	467,720	474,088	482,583	491,127	499,719	508,356
Ballina non-residential consumption	647,091	774,572	902,054	1,029,535	1,157,017	1,284,498	1,411,980	1,539,461	1,666,943
Byron non-residential consumption	841,182	907,765	944,360	1,013,993	1,046,494	1,068,696	1,090,898	1,113,101	1,135,303
Lismore non-residential consumption	801,352	809,398	817,524	825,732	834,023	842,396	850,854	859,397	868,025
Richmond Valley non-residential consumption	210,049	220,229	231,902	237,606	241,819	246,031	250,243	254,455	258,667
Rous retail consumption	888,196	998,433	1,017,440	1,034,184	1,048,617	1,057,977	1,066,069	1,074,161	1,082,253
Ballina NRW	834,674	908,786	977,575	1,020,267	1,058,516	1,097,337	1,131,738	1,166,423	1,201,389
Byron NRW	258,952	282,499	295,690	307,252	314,994	321,677	328,359	335,042	341,725
Lismore NRW	521,652	537,628	553,677	569,798	585,987	602,241	618,559	634,939	651,377
Richmond Valley NRW	61,584	64,619	68,192	69,731	70,777	72,033	73,294	74,560	75,831
Filling station sales	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399
Rous losses	364,249	390,653	410,286	424,717	437,008	448,967	460,238	471,565	482,948
Total bulk production	12,315,105	13,207,785	13,871,587	14,359,488	14,775,023	15,179,384	15,560,434	15,943,391	16,328,233

Scenario 1B: Revised forecast dry year demand (upper estimated Ballina lot yield, current NRW)	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2055**	**2060**
Ballina residential consumption (estimated lot yield)	2,641,491	2,824,492	3,013,672	3,104,976	3,169,909	3,227,807	3,261,012	3,291,319	3,323,961
Byron residential consumption	1,676,377	1,838,725	1,930,373	1,973,142	2,015,912	2,058,681	2,101,450	2,144,219	2,186,988
Lismore residential consumption	2,071,988	2,151,940	2,232,216	2,312,801	2,393,681	2,474,840	2,556,265	2,637,943	2,719,862
Richmond Valley residential consumption	412,868	433,393	457,858	467,720	474,088	482,583	491,127	499,719	508,356
Ballina non-residential consumption	647,091	774,572	902,054	1,029,535	1,157,017	1,284,498	1,411,980	1,539,461	1,666,943
Byron non-residential consumption	841,182	907,765	944,360	1,013,993	1,046,494	1,068,696	1,090,898	1,113,101	1,135,303
Lismore non-residential consumption	801,352	809,398	817,524	825,732	834,023	842,396	850,854	859,397	868,025
Richmond Valley non-residential consumption	210,049	220,229	231,902	237,606	241,819	246,031	250,243	254,455	258,667
Rous retail consumption	888,196	998,433	1,017,440	1,034,184	1,048,617	1,057,977	1,066,069	1,074,161	1,082,253
Ballina NRW	835,435	914,311	994,756	1,050,336	1,099,218	1,146,312	1,187,133	1,227,217	1,267,895
Byron NRW	258,952	282,499	295,690	307,252	314,994	321,677	328,359	335,042	341,725
Lismore NRW	521,652	537,628	553,677	569,798	585,987	602,241	618,559	634,939	651,377
Richmond Valley NRW	61,584	64,619	68,192	69,731	70,777	72,033	73,294	74,560	75,831
Filling station sales	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399
Rous losses	364,364	388,907	410,297	426,668	440,559	453,765	466,003	478,144	490,387
Total	*12,318,980*	*13,233,310*	*13,956,411*	*14,509,875*	*14,979,491*	*15,425,937*	*15,839,646*	*16,250,075*	*16,663,972*

Scenario 2A: Revised forecast dry year demand (estimated Ballina lot yield, reduced NRW)	2020	2025	2030	2035	2040	2045	2050	2055	2060
Ballina residential consumption (estimated lot yield)	2,638,492	2,802,745	2,946,040	2,986,610	3,009,693	3,035,026	3,042,959	3,052,008	3,062,168
Byron residential consumption	1,676,377	1,838,725	1,930,373	1,973,142	2,015,912	2,058,681	2,101,450	2,144,219	2,186,988
Lismore residential consumption	2,071,988	2,151,940	2,232,216	2,312,801	2,393,681	2,474,840	2,556,265	2,637,943	2,719,862
Richmond Valley residential consumption	412,868	433,393	457,858	467,720	474,088	482,583	491,127	499,719	508,356
Ballina non-residential consumption	647,091	774,572	902,054	1,029,535	1,157,017	1,284,498	1,411,980	1,539,461	1,666,943
Byron non-residential consumption	841,182	907,765	944,360	1,013,993	1,046,494	1,068,696	1,090,898	1,113,101	1,135,303
Lismore non-residential consumption	801,352	809,398	817,524	825,732	834,023	842,396	850,854	859,397	868,025
Richmond Valley non-residential consumption	210,049	220,229	231,902	237,606	241,819	246,031	250,243	254,455	258,667
Rous retail consumption	888,196	998,433	1,017,440	1,034,184	1,048,617	1,057,977	1,066,069	1,074,161	1,082,253
Ballina NRW	807,864	828,827	902,979	946,976	985,841	1,024,702	1,059,835	1,094,463	1,129,373
Byron NRW	245,752	216,499	229,690	241,252	248,994	255,677	262,359	269,042	275,725
Lismore NRW	500,052	429,628	445,677	461,798	477,987	494,241	510,559	526,939	543,377
Richmond Valley NRW	57,584	44,619	48,192	49,731	50,777	52,033	53,294	54,560	55,831
Filling station sales	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399
Rous losses	340,249	270,653	290,286	304,717	317,008	328,967	340,238	351,565	362,948
Total	*12,225,495*	*12,813,826*	*13,482,992*	*13,972,198*	*14,388,348*	*14,792,748*	*15,174,531*	*15,557,432*	*15,942,218*

Scenario 2B: Revised forecast dry year demand (upper estimated Ballina lot yield, reduced NRW)	2020	2025	2030	2035	2040	2045	2050	2055	2060
Ballina residential consumption (estimated lot yield)	2,638,492	2,802,745	2,946,040	2,986,610	3,009,693	3,035,026	3,042,959	3,052,008	3,062,168
Byron residential consumption	1,676,377	1,838,725	1,930,373	1,973,142	2,015,912	2,058,681	2,101,450	2,144,219	2,186,988
Lismore residential consumption	2,071,988	2,151,940	2,232,216	2,312,801	2,393,681	2,474,840	2,556,265	2,637,943	2,719,862
Richmond Valley residential consumption	412,868	433,393	457,858	467,720	474,088	482,583	491,127	499,719	508,356
Ballina non-residential consumption	647,091	774,572	902,054	1,029,535	1,157,017	1,284,498	1,411,980	1,539,461	1,666,943
Byron non-residential consumption	841,182	907,765	944,360	1,013,993	1,046,494	1,068,696	1,090,898	1,113,101	1,135,303
Lismore non-residential consumption	801,352	809,398	817,524	825,732	834,023	842,396	850,854	859,397	868,025
Richmond Valley non-residential consumption	210,049	220,229	231,902	237,606	241,819	246,031	250,243	254,455	258,667
Rous retail consumption	888,196	998,433	1,017,440	1,034,184	1,048,617	1,057,977	1,066,069	1,074,161	1,082,253
Ballina NRW	807,864	833,351	917,761	974,424	1,024,416	1,072,139	1,114,186	1,154,153	1,194,712
Byron NRW	245,752	216,499	229,690	241,252	248,994	255,677	262,359	269,042	275,725
Lismore NRW	500,052	429,628	445,677	461,798	477,987	494,241	510,559	526,939	543,377
Richmond Valley NRW	57,584	44,619	48,192	49,731	50,777	52,033	53,294	54,560	55,831
Filling station sales	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399
Rous losses	340,364	268,907	290,297	306,668	320,559	333,765	346,003	358,144	370,387
Total	*12,225,610*	*12,816,604*	*13,497,784*	*14,001,596*	*14,430,475*	*14,844,984*	*15,234,647*	*15,623,701*	*16,014,996*

Table 30: Forecast demand (average bulk production, kL/a)

Revised forecast average demand (estimated Ballina lot yield, current NRW)	2020	2025	2030	2035	2040	2045	2050	2055	2060
Ballina residential consumption (estimated lot yield)	2,443,150	2,598,253	2,733,564	2,771,874	2,793,671	2,817,593	2,825,083	2,833,628	2,843,222
Byron residential consumption	1,635,490	1,793,878	1,883,291	1,925,017	1,966,743	2,008,469	2,050,195	2,091,921	2,133,647
Lismore residential consumption	1,958,401	2,033,969	2,109,845	2,186,013	2,262,458	2,339,168	2,416,130	2,493,330	2,570,758
Richmond Valley residential consumption	393,208	412,756	436,055	445,448	451,512	459,603	467,740	475,922	484,149
Ballina non-residential consumption	611,039	731,419	851,798	972,177	1,092,556	1,212,935	1,333,314	1,453,693	1,574,072
Byron non-residential consumption	820,665	885,624	921,327	989,261	1,020,970	1,042,630	1,064,291	1,085,952	1,107,613
Lismore non-residential consumption	757,422	765,026	772,707	780,465	788,301	796,216	804,210	812,284	820,440
Richmond Valley non-residential consumption	200,046	209,742	220,859	226,292	230,303	234,315	238,327	242,338	246,350
Rous retail consumption	844,293	949,081	967,149	983,065	996,784	1,005,682	1,013,374	1,021,066	1,028,757
Ballina NRW	775,890	845,874	910,830	951,143	987,262	1,023,920	1,056,404	1,089,156	1,122,175
Byron NRW	252,636	275,609	288,478	299,758	307,311	313,831	320,351	326,871	333,390
Lismore NRW	493,055	508,155	523,325	538,561	553,863	569,226	584,650	600,131	615,669
Richmond Valley NRW	58,651	61,542	64,945	66,411	67,407	68,603	69,804	71,010	72,220
Filling station sales	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399	86,399
Rous losses	345,337	370,542	389,233	402,989	414,682	426,053	436,771	447,544	458,369
Total	11,675,683	12,527,869	13,159,805	13,624,872	14,020,223	14,404,643	14,767,043	15,131,245	15,497,228

Table 31: Forecast demand (local supplies, kL/a)

Local supply	2020	2025	2030	2035	2040	2045	2050	2055	2060
Wardell	175,000	187,500	200,000	212,500	225,000	237,500	250,000	262,500	275,000
Mullumbimby	462,067	499,738	546,772	588,144	638,009	684,608	733,172	785,181	840,879
Casino	2,342,465	2,344,172	2,347,954	2,353,726	2,361,404	2,370,912	2,382,176	2,395,126	2,409,696
Nimbin	69,223	71,467	73,747	76,063	78,458	80,888	83,353	85,855	88,395
All local supplies	***2,873,755***	***2,915,377***	***2,968,473***	***3,017,933***	***3,077,872***	***3,136,408***	***3,198,701***	***3,266,162***	***3,338,970***