Tweed Shire Council

Water Efficiency and Demand Management Review

Part 1: Review of Efficacy of Demand Management Strategy and Implementation Plan

25 January 2017

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PROJECT 16-049 – TWEED WATER EFFICIENCY AND DEMAND MANAGEMENT REVIEW

REV	DESCRIPTION	AUTHOR	REVIEW	APPROVAL	DATE
0	Draft for Council review	R. Campbell	M. Howland	M. Howland	24 Aug 2016
1	Final Draft	R. Campbell	M. Howland	M. Howland	12 Sep 2016
2	Additional historical data included	R. Campbell	M. Howland	M. Howland	19 Jan 2017
3	Minor edits	R. Campbell		R. Campbell	25 Jan 2017

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1. INTRODUCTION

Tweed Shire Council (TSC) has requested a review of historical demand management activities, the Tweed Demand Management Strategy (DMS) (MWH, 2009a) and the three year implementation plan to assess the efficacy of demand management and water efficiency projects implemented to date.

1.1 Scope of this Review

Part 1 of this review includes:

- A review of historical water demand data (river extraction and customer consumption), trends and influences;
- Discussion of demand management measures undertaken by Council and the NSW government;
- Analysis of the influence of the Building Sustainability Index (BASIX) on Tweed Shire demand;
- Comparison with other water utilities for the purposes of benchmarking; and
- Analysis of the efficacy of demand management actions implemented by TSC.

Part 2 of the review will include an analysis of additional demand management and water efficiency measures as suggested by a Community Reference Group.

1.2 Demand Management Initiatives

Key water efficiency and demand management measures implemented by TSC and the NSW Government are listed in Table 1 and discussed further in this review.

Table 1: Timeline of Water Saving Measures

Date	Measure	TSC/NSW Government
1965-1967	Introduction of customer water meters in Tweed Shire	TSC
1989	Water loss management program	TSC
1994 (ongoing)	Water main replacement program	TSC
1994	North Coast Regional Waterwise program	NSW Government
1 July 1996 – 1 July 2002	Free water allowance phased out	TSC
2001 (ongoing)	Regulation of bulk water usage	TSC
Oct 2002 – Feb 2003	Drought restrictions	TSC
Nov 2005	Showerhead giveaway	TSC
2006	Original Integrated Water Cycle Management (IWCM) Strategy adopted	TSC
1 July 2006	BASIX commences	NSW Government
1 July 2007	Significant increase in Step 1 usage charge	TSC
1 July 2007	NSW Home Saver Rebates program	NSW Government
1 July 2008	Stepped usage charge (inclining block tariff) introduced (450 kL/a)	TSC

Date	Measure	TSC/NSW Government
2009	DMS adopted	TSC
1 July 2010	Stepped usage charge reduced to 350 kL/a	TSC
1 July 2011	Stepped usage charge reduced to 300 kL/a	TSC
2011	DMS Implementation Plan adopted	TSC
2014	Revised IWCM Strategy adopted	TSC
2014	Long-term demand forecast prepared	TSC
June 2014	Residential water savings program adopted	TSC

The per capita residential demand since 1991 is shown in the following figure. The demand follows a generally decreasing trend although there are year-to-year fluctuations which are most likely due to climate influences as discussed in Section 3.2.2. The timing of demand management actions is also shown on the figure.

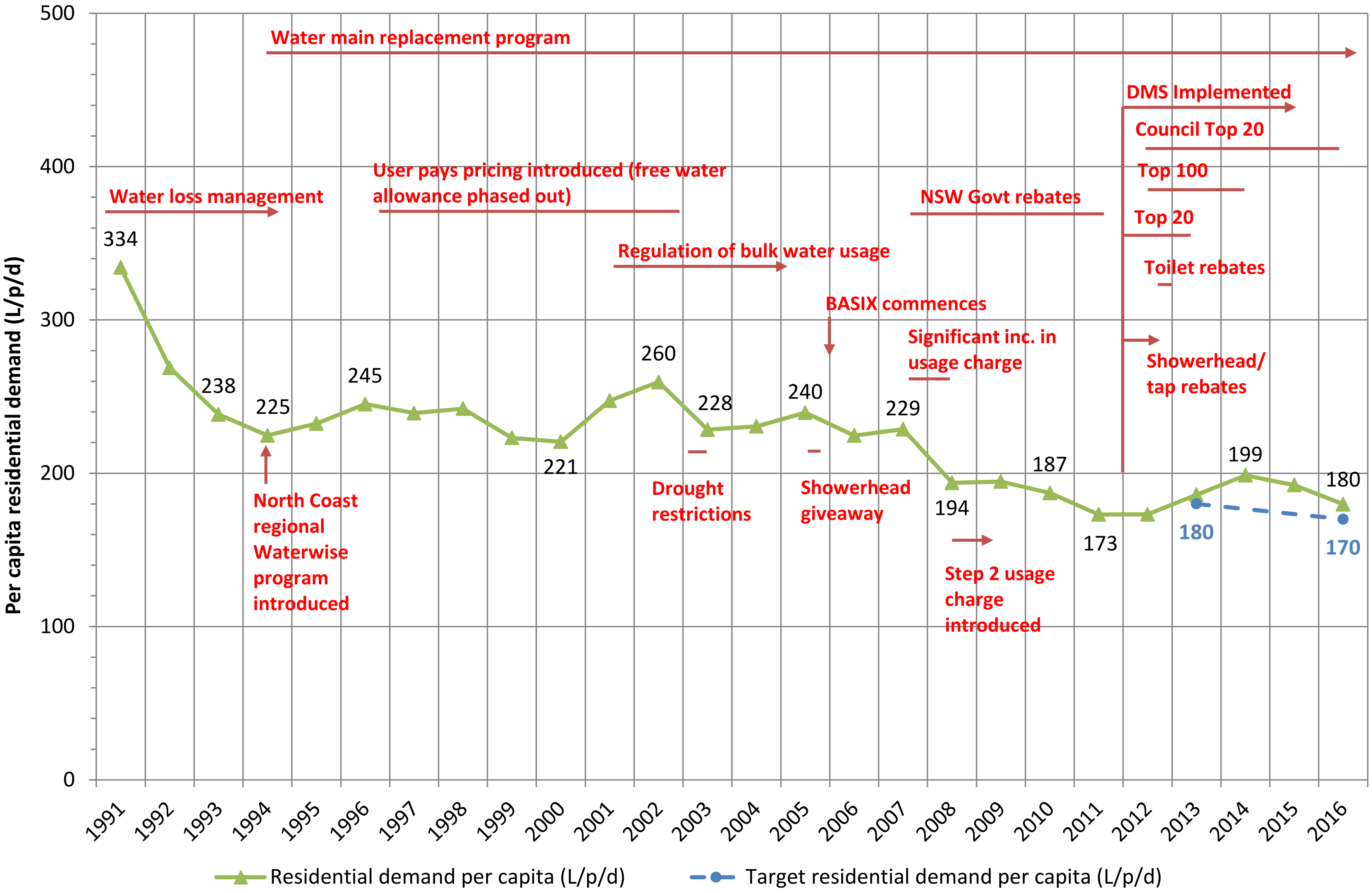

Figure 1: Per capita residential demand since 1991 and timing of demand management actions

In 1991, low rainfall was experienced after three years of high rainfall and demand in 1991 increased in response (refer Appendix 1). Climate influences on demand are discussed further in Section 3.2.2.

2. WATER EXTRACTION, PRODUCTION, CONSUMPTION AND LOSSES

Raw water is extracted from the TSC water sources (Bray Park Weir on the Tweed River and Tyalgum Weir Pool on the Upper Oxley River), transferred to the WTPs (at Bray Park, Uki and Tyalgum respectively) for treatment then distributed to the customers for consumption.

Data are presented in the following sections for raw water extraction, treated water production and customer consumption between 2008/09 (2009) and 2015/16 (2016) for each water supply system. Historical data since 1991 are presented in Appendix 1.

The recent historical data have also been used to estimate the water losses in each system. Data are presented with the same terminology as the *Tweed District, Uki and Tyalgum Water Supplies: Demand Forecast* (Hydrosphere Consulting, 2014). The water losses consist of two components:

- Raw water losses (L1): the difference between raw water extraction (A) and treated water production (B); and
- Non-Revenue Water, NRW (L2): the difference between treated water production (B) and metered customer consumption (C).

Because the losses are derived this way, it should be noted that the non-revenue water estimate may 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 Council for maintenance) and unauthorised consumption. Similarly, the raw water losses will consist of bulk meter errors and treatment losses. Interpretation of annual variations in unmetered water therefore needs to be cognisant of these components.

2.1 Tweed District

Water is extracted from Bray Park Weir on the Tweed River (A) for treatment at Bray Park WTP. Water abstraction upstream of the weir is used to supply Uki. Water is released from Clarrie Hall Dam as required for environmental flow provisions and town water supply (Uki and Tweed District) requirements.

Treated water from Bray Park WTP (B) is distributed to residential and non-residential customers in the Tweed District supply area (Figure 2).

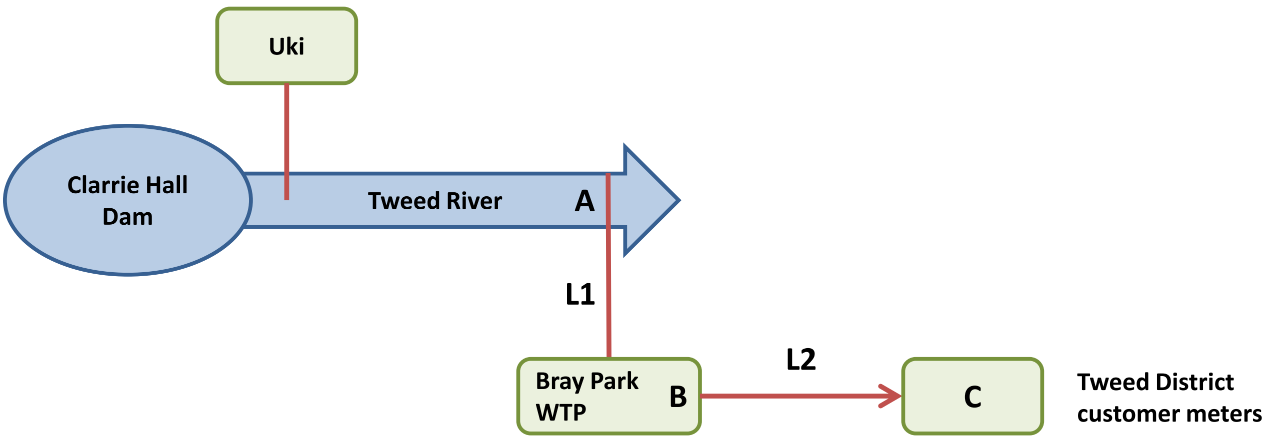

Figure 2: Components of the Tweed District water supply system

The Tweed District data for 2009 - 2016 are shown in Table 2 and Figure 3.

Table 2: Existing raw water extraction, treated water production, consumption and losses – Tweed District (ML/a)

Data	2009	2010	2011	2012	2013	2014	2015	2016
Raw Water Extraction (A)	9,489	10,472	8,843	8,751	9,213	9,713	9,208	8,998
Treated Water Production (B)	8,577	9,610	8,432	8,221	8,626	9,134	8,610	8,358
Raw Water Losses (L1)	912	862	412	531	587	579	599	641
Total Consumption (C)	7,439	8,104	7,062	7,006	7,481	7,957	7,592	7,336
NRW (L2)	1,138	1,506	1,370	1,215	1,145	1,177	1,017	1,022
NRW (%)	13%	16%	16%	15%	13%	13%	12%	12%

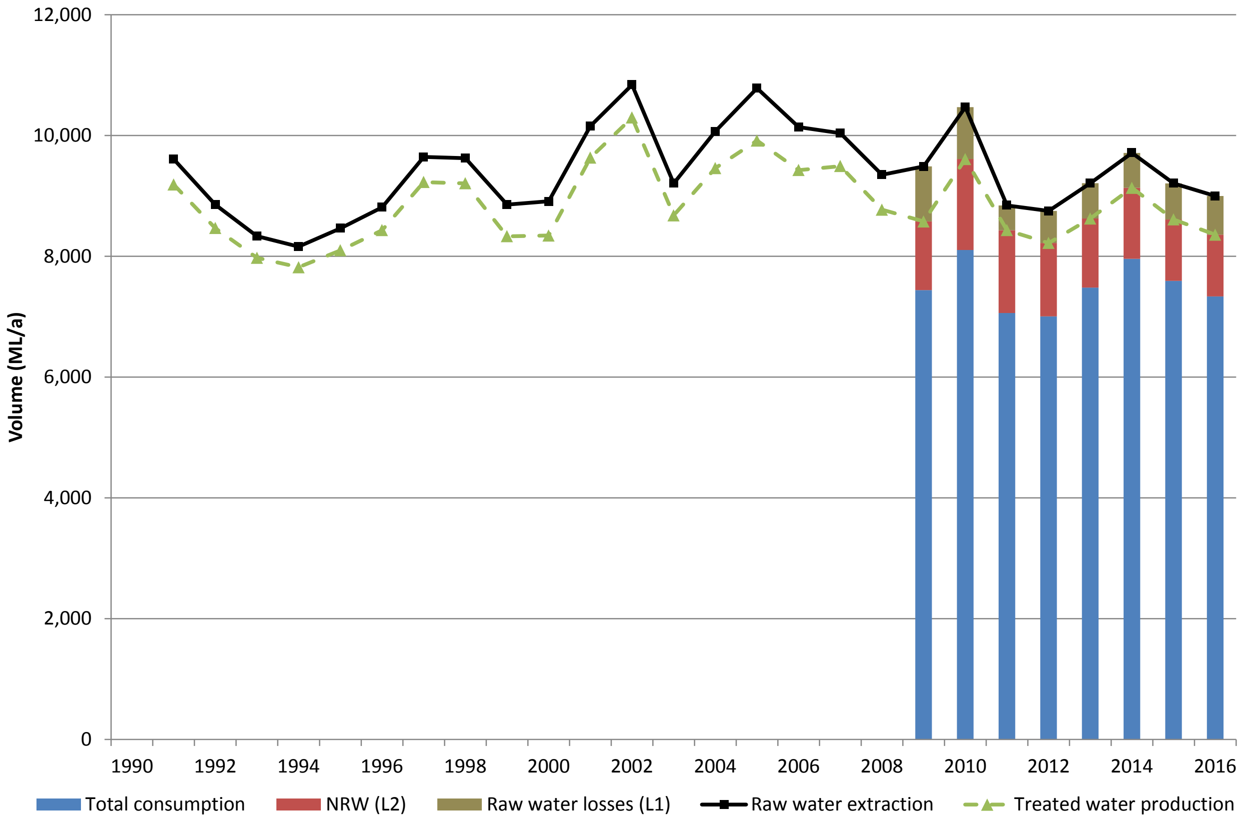

Figure 3: Raw water extraction, consumption and losses: Tweed District 1991 – 2016

Separate consumption data for each water supply system is not available prior to 2009

A comparison of recent demand with the Tweed District demand forecast (Hydrosphere Consulting, 2014) is given in Figure 4. The total demand (raw water extraction) in 2015 and 2016 were lower than predicted by the demand forecast for an average year (when average consumption and losses are experienced) which is equivalent to 9,727 ML/a in 2015. Climate data are presented in Appendix 2 and discussed in relation to water demand in Section 3.2.2. The volume of NRW in 2015 and 2016 was lower than pre-2015 values.

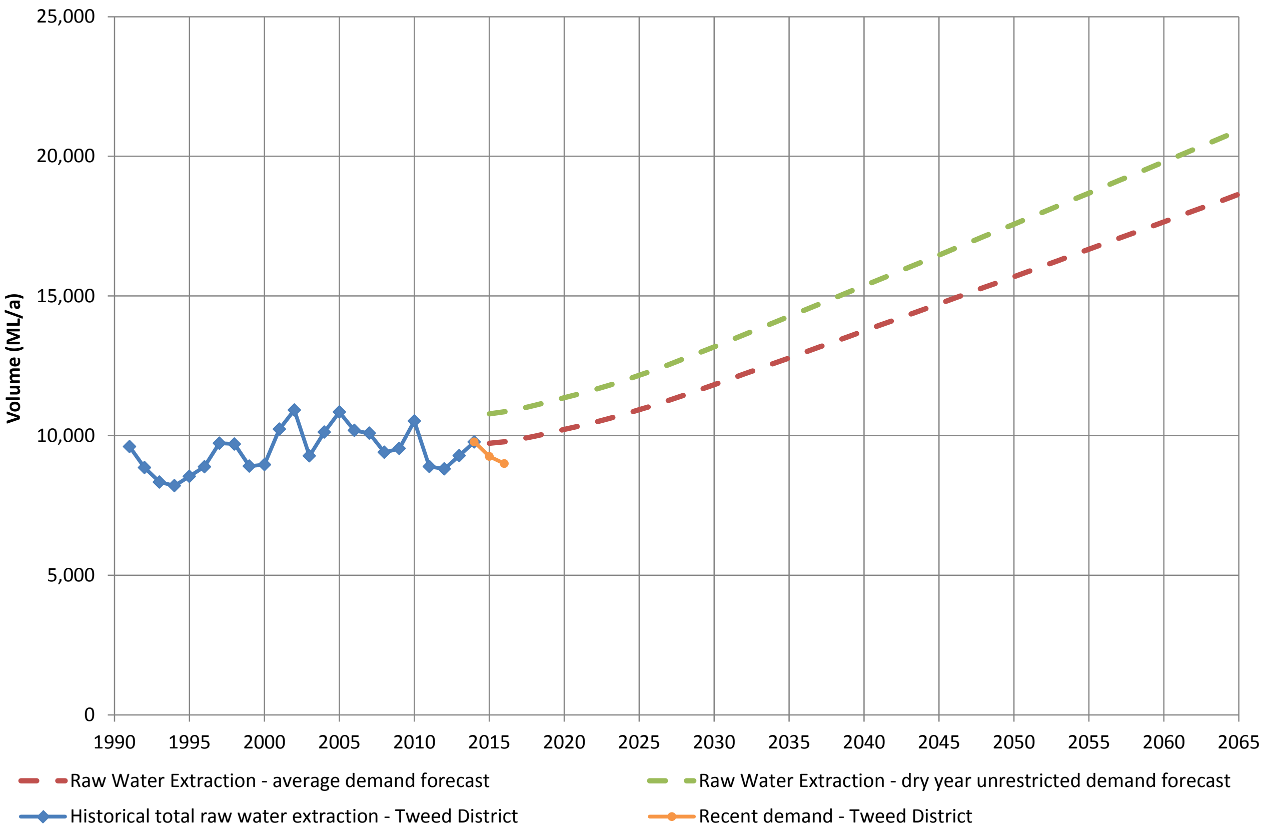

Figure 4: Comparison between recent demand and the demand forecast: Tweed District

2.2 Uki

Water is abstracted from the Tweed River (A) for treatment at Uki WTP. Treated water from Uki WTP (B) is distributed to residential and non-residential customers in the Uki supply area (Figure 5).

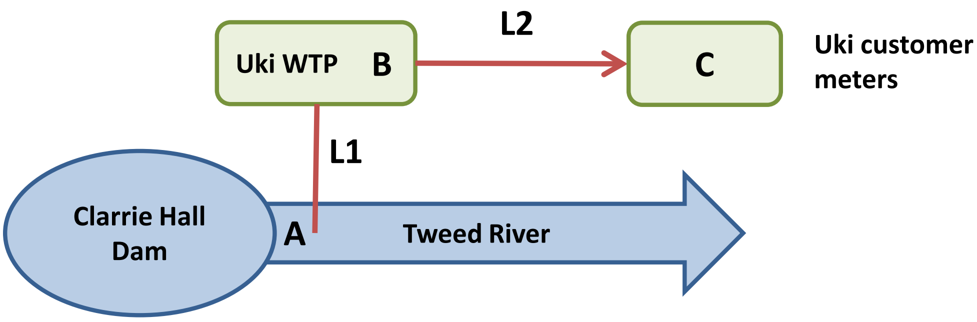

Figure 5: Components of the Uki water supply system

The Uki data for 2009 - 2016 are shown in Table 3. There appears to be some anomalies in the data with consumption being greater than production for some years. In addition, raw water losses are very high. These data indicate that the treated water production may be higher than reported here or there are other errors leading to this discrepancy. TSC has advised that there are ongoing inaccuracies in these data as daily volumes are calculated using flow estimates based on pump flow and run times for raw and treated water rather than meter readings.

Figure 6 shows the raw water extraction, total losses and total consumption for Uki.

Table 3: Existing raw water extraction, treated water production, consumption and losses – Uki (ML/a)

Data	2009	2010	2011	2012	2013	2014	2015	2016
Raw Water Extraction (A)	49.42	49.62	49.45	57.03	64.56	58.38	47.92	53.25
Treated Water Production (B)	43.24	43.21	38.06	36.59	42.63	39.44	30.85	44.61
Raw Water Losses (L1)	6.18	6.42	11.39	20.44	21.93	18.95	17.07	8.63
Total Consumption (C)	43.26	40.53	38.22	42.31	36.01	36.18	32.24	32.34
NRW (L2)	-0.02	2.67	-0.17	-5.72	6.62	3.25	-1.39	12.28
Total Losses (L1+L2)	6.16	9.09	11.23	14.72	28.55	22.20	15.68	20.91

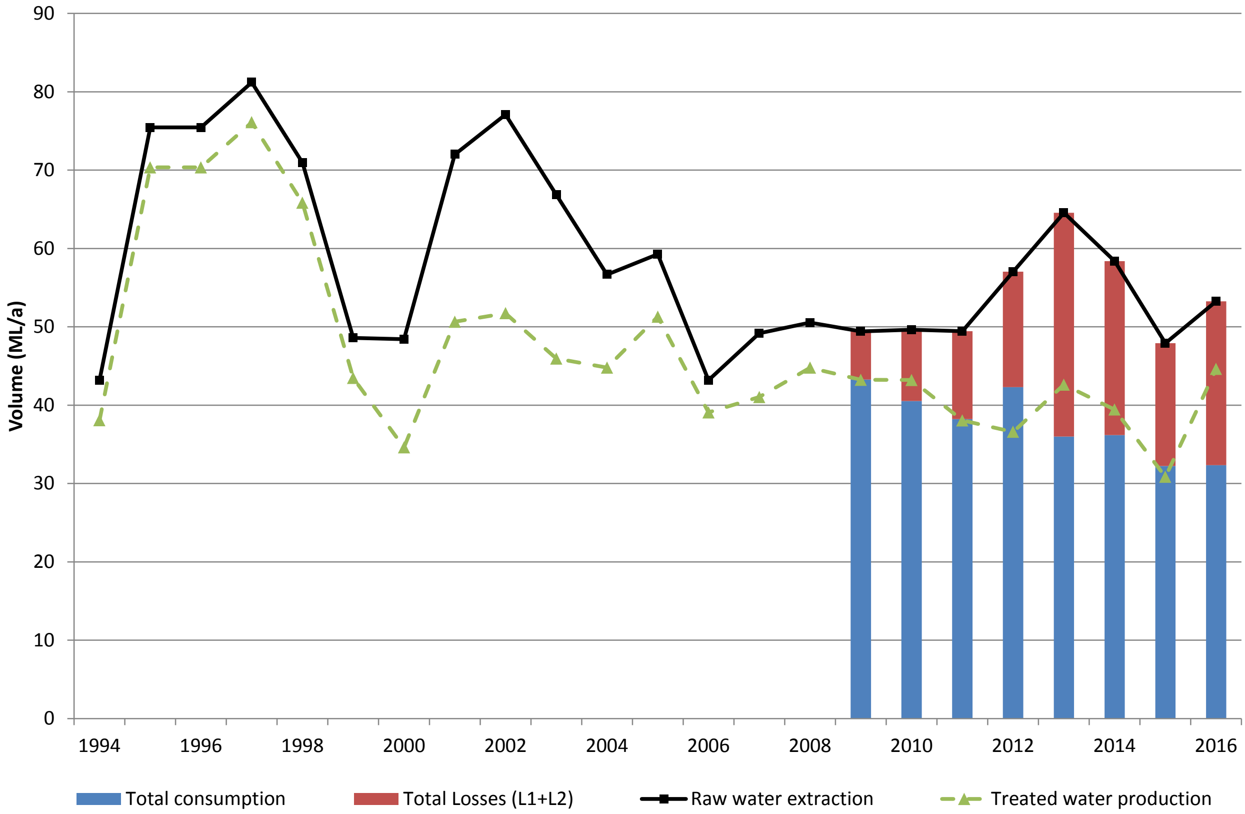

Figure 6: Raw water extraction, consumption and total losses: Uki 2009 - 2016

Separate consumption data for each water supply system is not available prior to 2009

A comparison of recent demand data with the Uki demand forecast (Hydrosphere Consulting, 2014) is given in Figure 7. The total demand (raw water extraction) in 2015 was lower than predicted by the demand forecast for an average year (when average consumption and losses are experienced) equivalent to 53.6 ML/a in 2015. The total demand (raw water extraction) in 2016 was similar to the demand forecast for an average year.

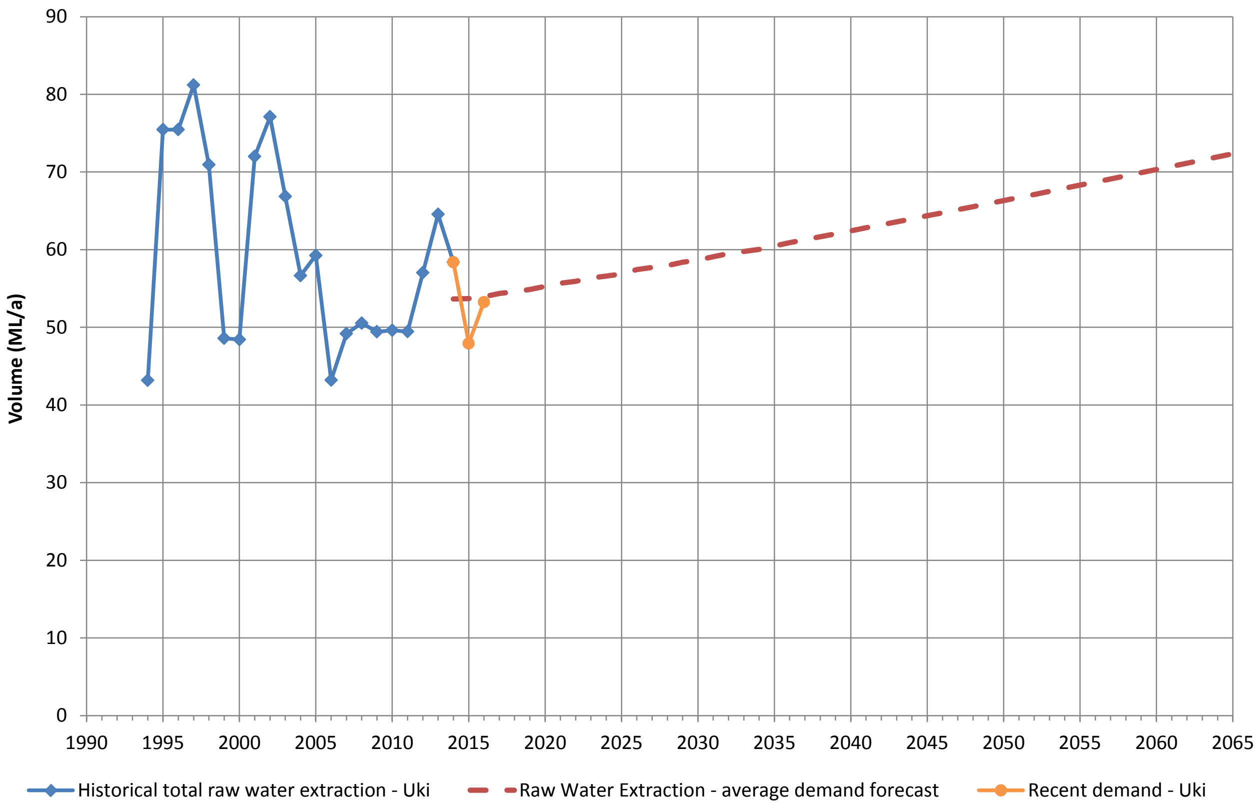

Figure 7: Comparison between recent demand and the demand forecast: Uki

2.3 Tyalgum

Water is extracted from the Tyalgum weir pool on the Upper Oxley River (A) for treatment at Tyalgum WTP. Treated water from Tyalgum WTP (B) is distributed to residential and non-residential customers (C) in the Tyalgum supply area (Figure 8). Prior to the upgrade of the Tyalgum WTP in late 2012, treated water was also carted from Bray Park WTP (D) to Tyalgum reservoir at times of poor water quality in the Tyalgum weir pool.

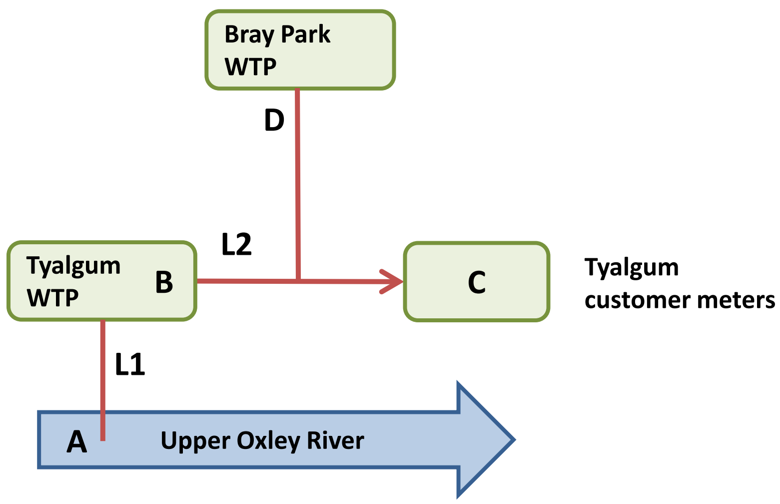

Figure 8: Components of the Tyalgum water supply system

The Tyalgum data for 2009 - 2016 are shown in Table 4. As with Uki data, there appears to be some anomalies in the data with consumption greater than production for some years and raw water losses are very high. Prior to the Tyalgum WTP upgrade, daily volumes were calculated using flow estimates based on pump run times for raw and treated water. For a short time after the WTP upgrade, the new meters were either overstating treated volumes or understating raw water volumes.

The total demand for Tyalgum is assumed to be the raw water extraction plus carted water. Figure 9 shows the raw water extraction, total losses and total consumption for Tyalgum.

Table 4: Existing raw water extraction, treated water production, consumption and losses – Tyalgum (ML/a)

Data	2009	2010	2011	2012	2013	2014	2015	2016
Raw Water Extraction (A)	26.1	33.8	34.1	21.8	40.2	31.1	27.5	30.4
Carted Water (D)			11.0	10.0	1.0			
Treated Water Production (B)	18.8	20.8	17.3	17.5	32.8	30.4	26.8	29.1
Raw Water Losses (L1)	7.4	12.9	16.8	4.4	7.4	0.7	0.7	1.3
Total Consumption (C)	21.0	20.7	19.0	21.0	21.8	21.8	22.1	21.1
NRW (L2)	N/A	0.1	9.3	6.4	12.0	8.6	4.8	8.0
NRW (%)	N/A	1%	54%	37%	37%	28%	18%	27%
Total Losses (L1+L2)	5.1	13.1	26.1	10.8	19.4	9.3	5.5	9.3

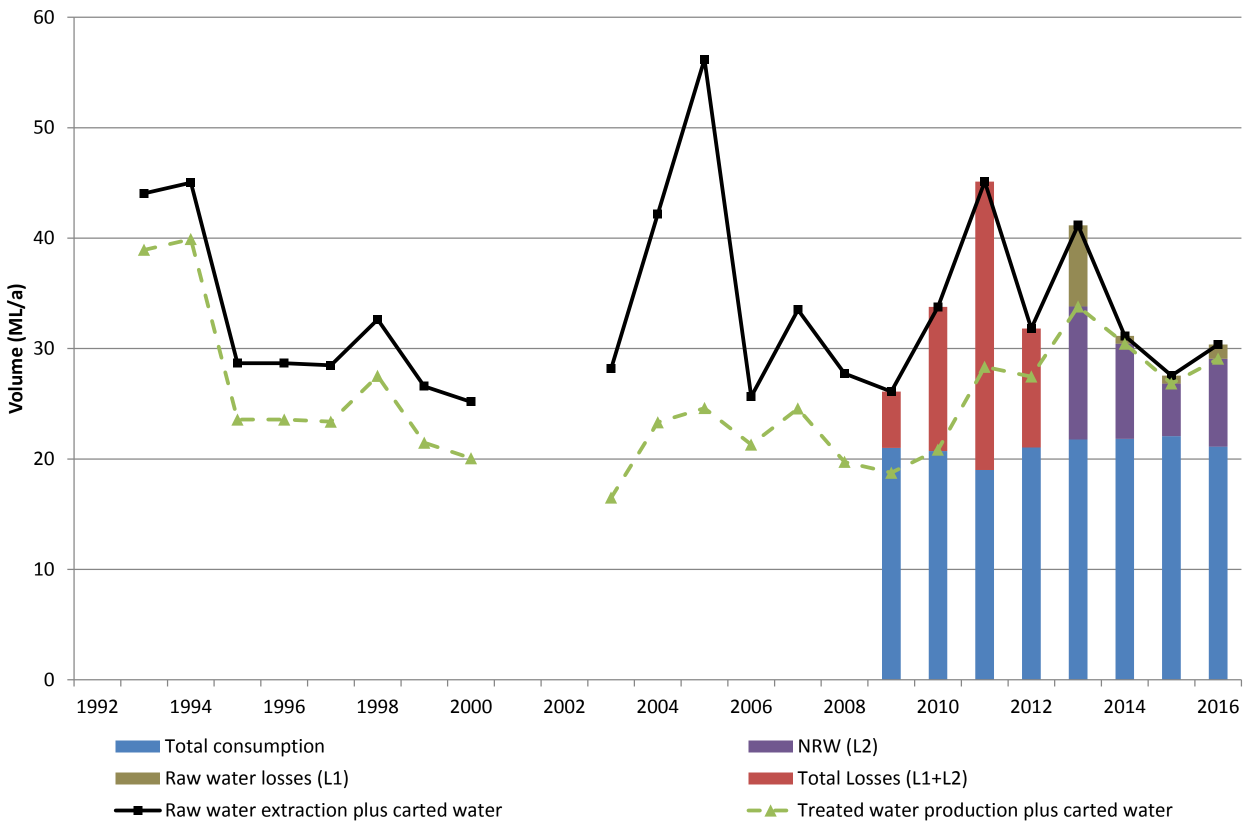

Figure 9: Raw water extraction plus carted water, consumption and total losses: Tyalgum 2009 - 2016

Separate consumption data for each water supply system is not available prior to 2009. Data are not available for 2001 and 2002.

A comparison of recent demand data with the Tyalgum demand forecast (Hydrosphere Consulting, 2014) is given in Figure 10. The total demand (raw water extraction) in 2015 and 2016 was lower than predicted by the demand forecast for an average year (when average consumption and losses are experienced) equivalent to 34.7 ML/a in 2015.

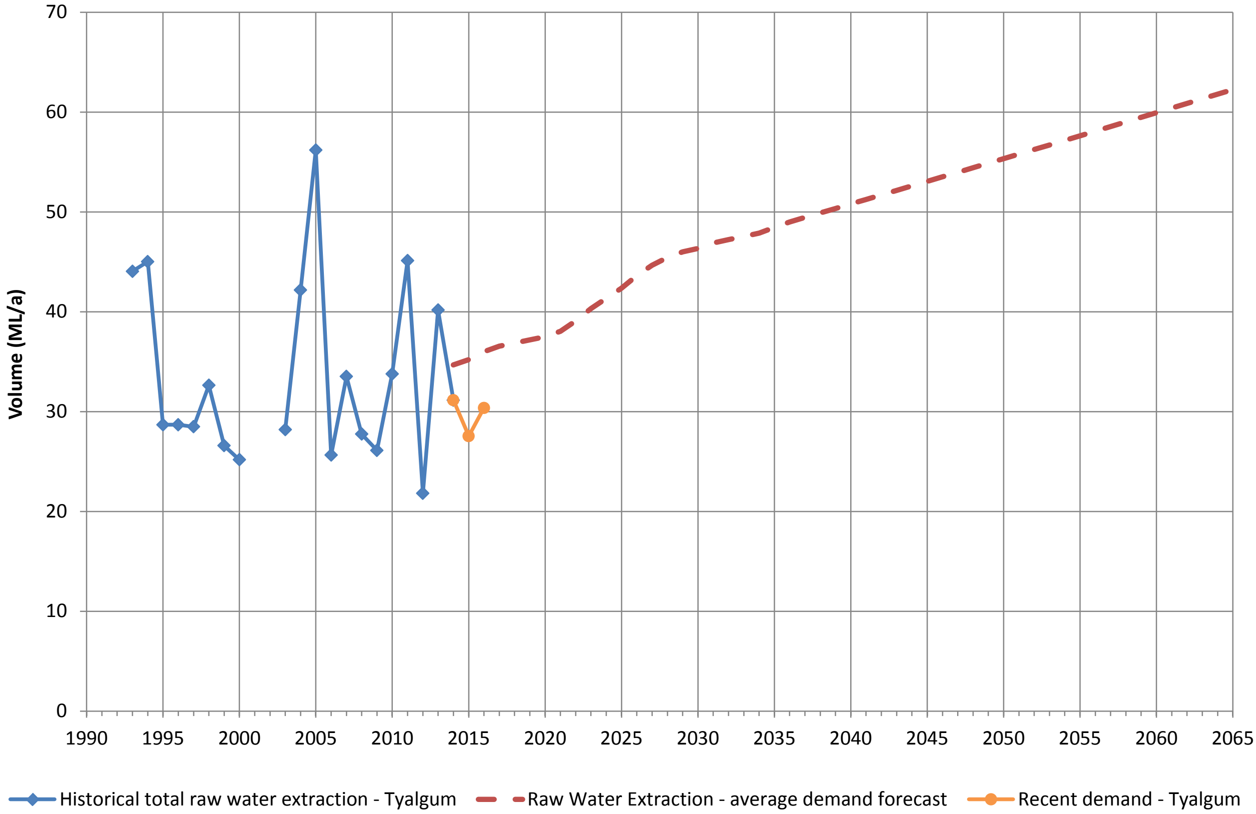

Figure 10: Comparison between recent demand and the demand forecast: Tyalgum

Data are not available for 2001 and 2002.

3. DEMAND VARIABILITY

3.1 Water Losses

Based on the data provided in Section 2, the variation in year to year total demand does not appear to be influenced by the amount of water losses. The volume and percentage of NRW appear to be decreasing, particularly since 2012 in the Tweed District. The NRW KPI is discussed further in Section 6.3.

3.2 Customer Consumption

Comparison of annual Tweed District total consumption (Figure 3) between 2011 and 2016 shows that total consumption is variable, with approximately 14% difference between the minimum in 2012 and maximum in 2014 but there is no trend (increasing or decreasing with time) evident.

3.2.1 Customer Numbers

Data on the number of water supply assessments in each year are given in Figure 11. Changes in customer demand from year to year do not appear to correlate with the change in number of water supply customers.

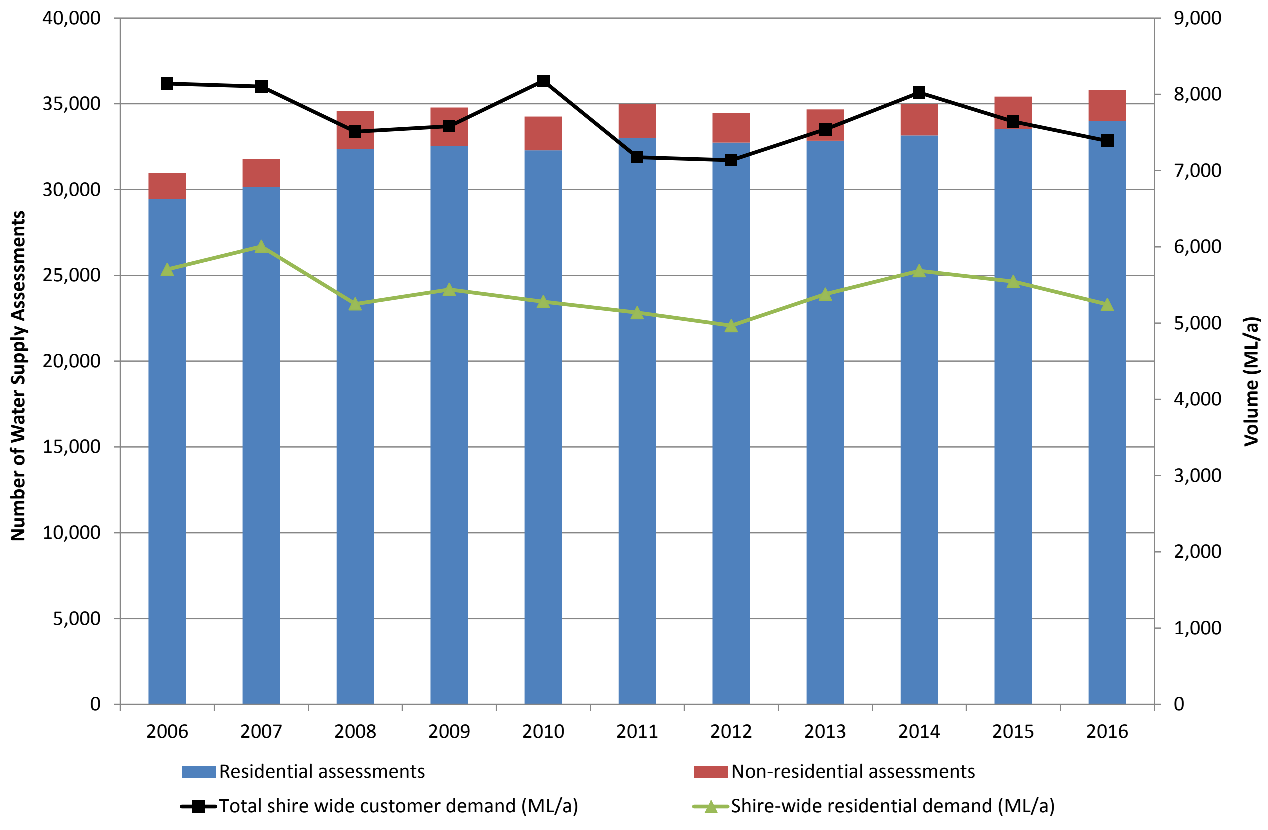

Figure 11: Shire-wide consumption compared to number of water supply customers

Note: Data has been sourced from Council's performance reporting. Adjustments in population figures have resulted in fluctuations in number of assessments.

3.2.2 Climate

Variations in climate are often suspected as being a major driver for consumption variability as there are intuitive linkages between water use and the weather with outdoor consumption generally more sensitive to rainfall and temperature. Data on rainfall and temperature in the major Tweed District population centres (Pottsville, Banora Point and Murwillumbah), Tyalgum and Uki are provided in Appendix 2.

For the Tweed District:

- 2011 and 2012 were wet years throughout the water supply area, 2016 was a dry year and 2014 was a very dry year. Rainfall in 2013 and 2015 was similar to the long-term average in Pottsville but higher than average in Banora Point and Murwillumbah;
- Rainfall in summer and autumn of 2014 and 2016 throughout the water supply area was low compared to the seasonal average rainfall;
- Rainfall in winter 2011 and 2014 throughout the water supply area was low compared to the seasonal average rainfall;
- Rainfall in spring of 2013 and 2015 throughout the water supply area was low compared to the seasonal average rainfall;
- 2011, 2012, 2013 and 2016 throughout the water supply area were generally colder years than average; and
- 2014 and 2015 were generally hotter years than average.

For Uki:

- 2011, 2012 and 2013 were wet years, 2015 and 2016 were dry years and 2014 was a very dry year;
- Rainfall in summer of 2014 and 2016 was low compared to the seasonal average rainfall and high in 2011, 2012, 2013 and 2015;
- Rainfall in autumn was low in all years apart from 2015 compared to the seasonal average rainfall;
- Rainfall in winter 2011, 2013 and 2014 was low compared to the seasonal average rainfall and very high in 2012 and 2016;
- Rainfall in spring of 2012, 2013 and 2015 was low compared to the seasonal average rainfall and high in 2011;
- 2011, 2012 and 2016 were generally colder years than average; and
- 2014 was generally hotter than average.

For Tyalgum:

- 2011, 2012 and 2013 were wet years, 2015 was a dry year and 2014 was a very dry year;
- Rainfall in summer of 2014 and 2016 was low compared to the seasonal average rainfall and high in 2011, 2012 and 2013;
- Rainfall in autumn was low in all years apart from 2015 compared to the seasonal average rainfall;
- Rainfall in winter 2011, 2013 and 2014 was low compared to the seasonal average rainfall and very high in 2012 and 2016;
- Rainfall in spring of 2013 and 2015 was low compared to the seasonal average rainfall and high in 2011 and 2016;
- 2011, 2012 and 2016 were generally colder years than average; and
- 2014 and 2015 were generally hotter years than average.

The Tweed Shire generally experienced very low rainfall and high temperatures in 2014. Conversely, 2011, 2012, 2013 and 2015 were wetter than average. These years were also cooler than average particularly in the coastal areas.

The climate data have been compared to customer demand for each customer type with the following conclusions.

High temperature is a key driver of high demand in the Tweed District, particularly for the residential sector and public parks. Figure 12 and Figure 13show a strong correlation between higher temperatures and increases in residential and municipal public parks consumption respectively. A similar trend is not evident for Tyalgum and Uki residential demand.

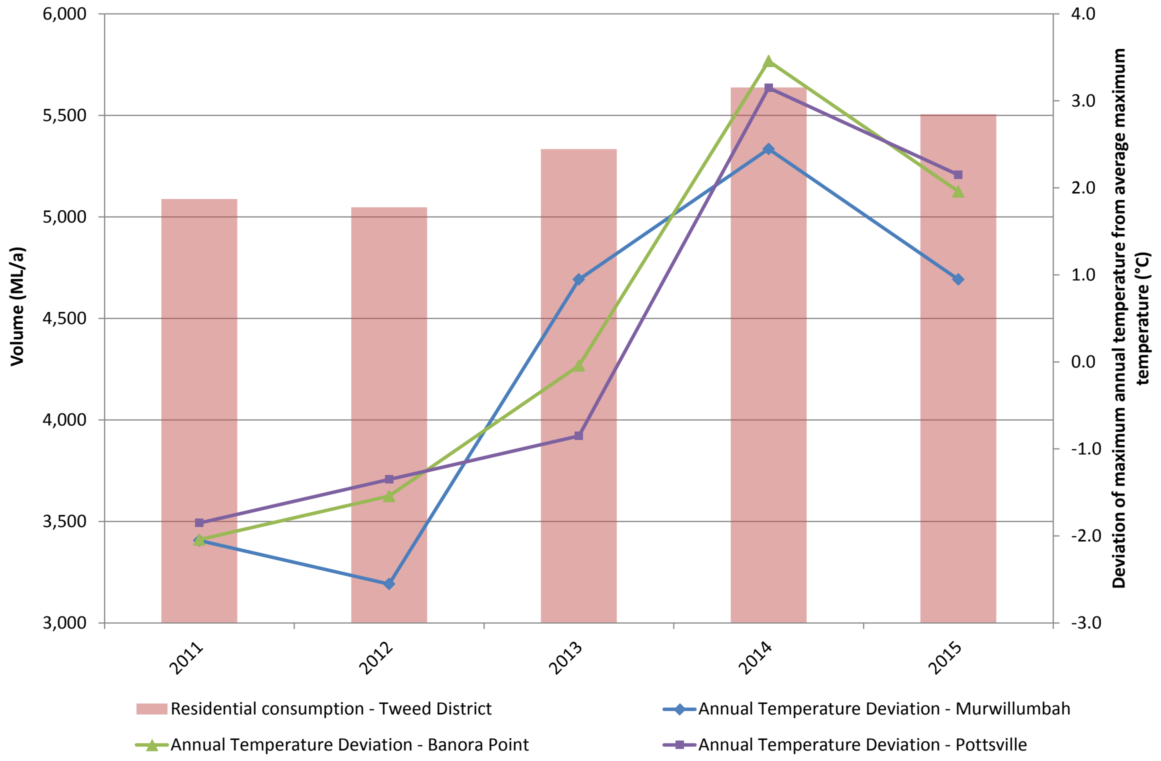

Figure 12: Tweed District residential consumption compared to annual temperature deviation

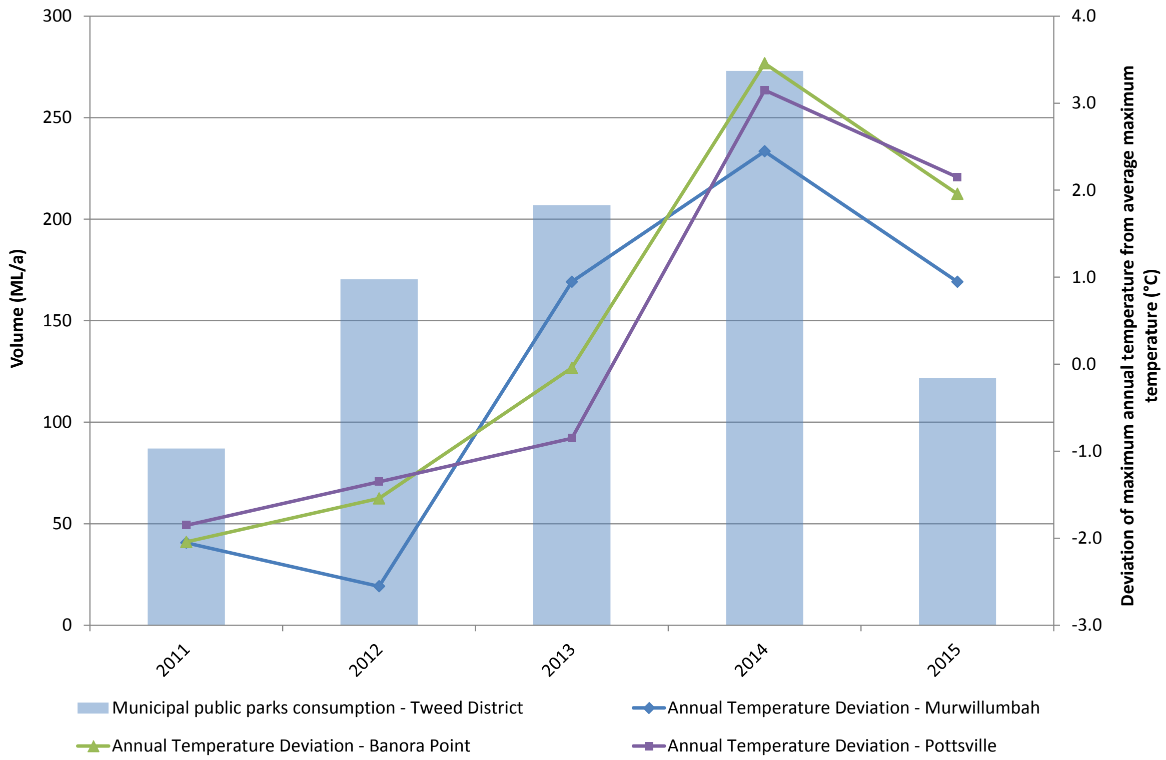

Figure 13: Tweed District public parks consumption compared to annual temperature deviation

Residential, Commercial and Municipal – Public Parks demand in the Tweed District increases with low rainfall. Figure 14, Figure 15 and Figure 16 show a strong correlation between lower rainfall and increases in residential, municipal public parks and commercial consumption respectively. A similar trend is evident for Tyalgum rural demand.

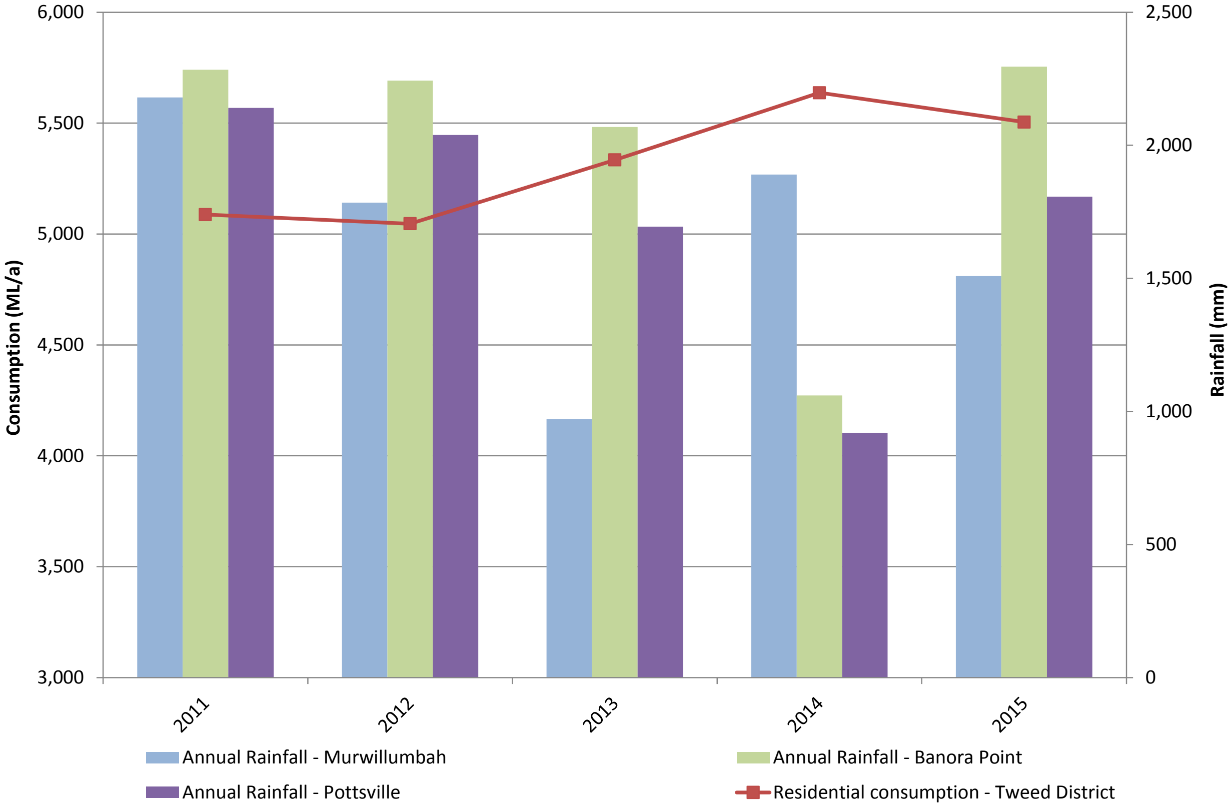

Figure 14: Tweed District residential consumption compared to rainfall

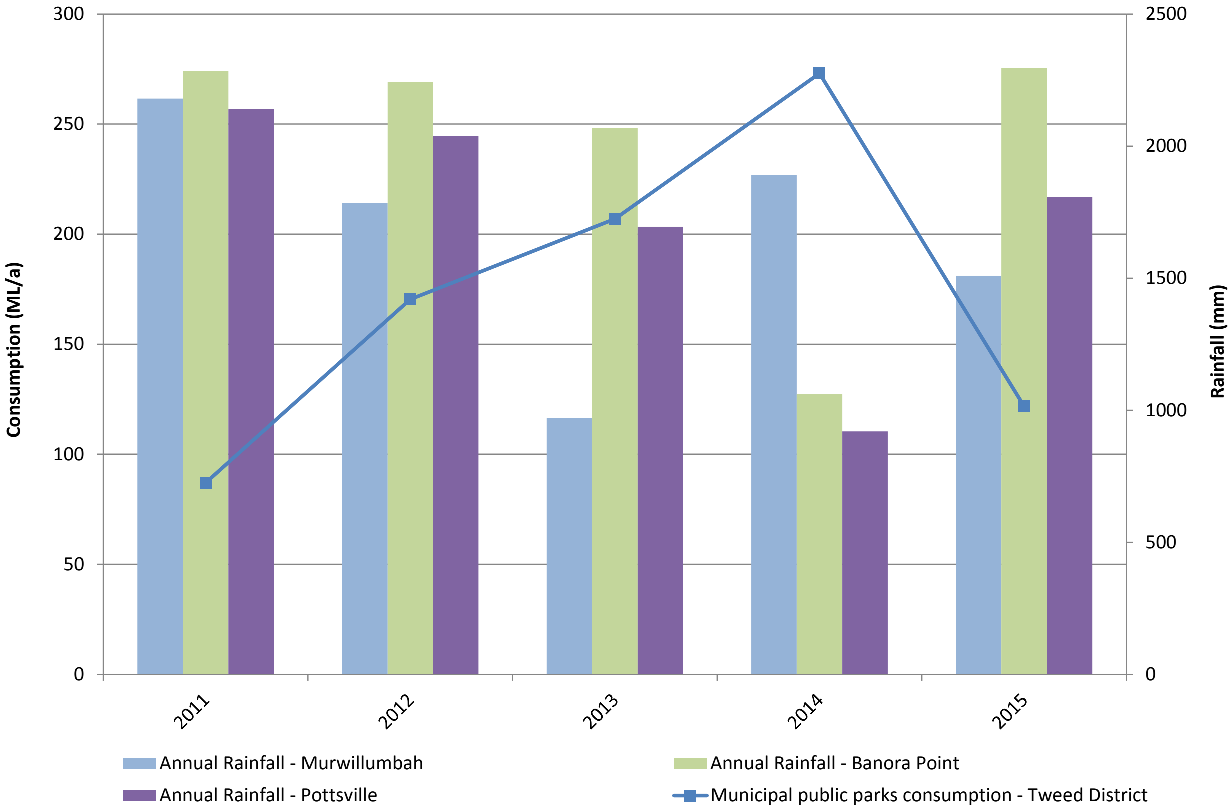

Figure 15: Tweed District municipal-public parks consumption compared to rainfall

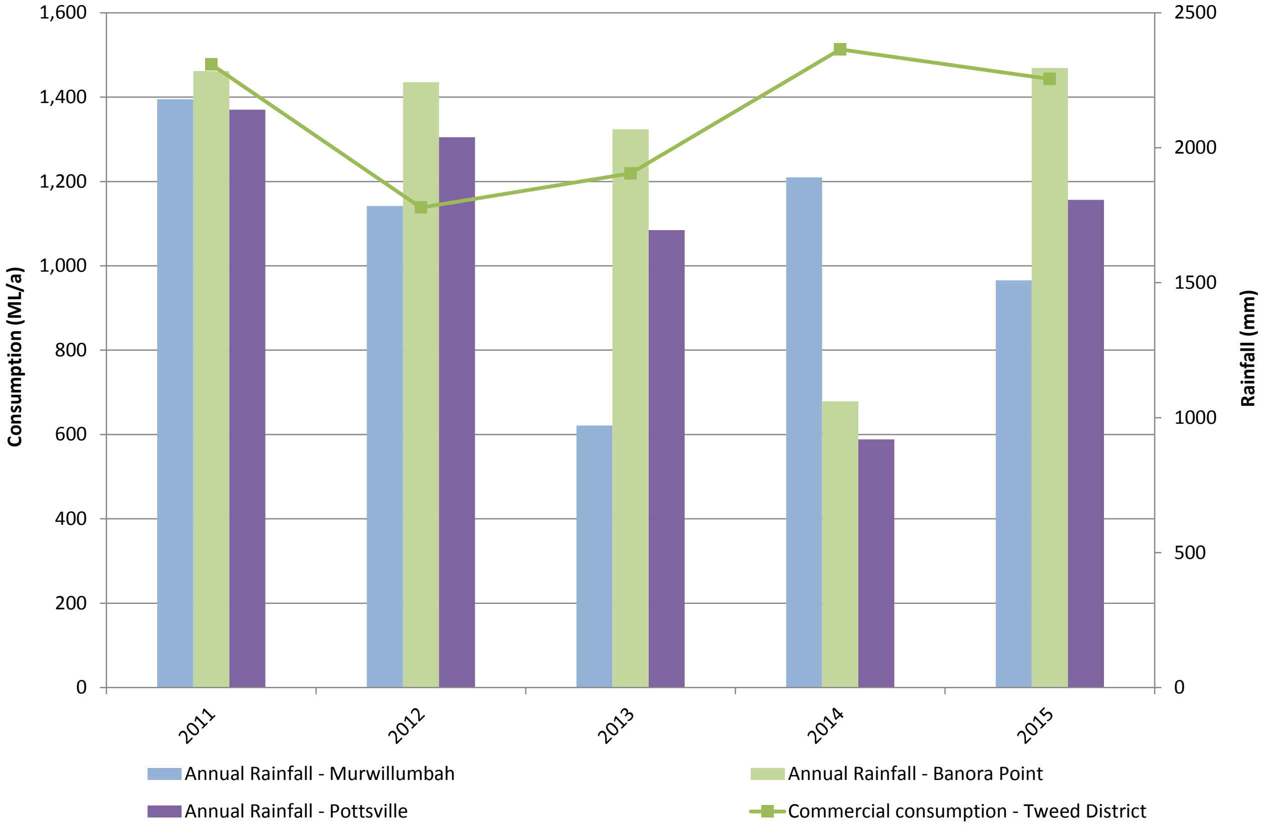

Figure 16: Tweed District commercial consumption compared to rainfall

4. BASIX

All new residential development must comply with the State Government's Building Sustainability Index (BASIX) which requires a reduction in potable water use per household through a combination of rainwater tanks, water efficient appliances, garden design or recycled water reuse. BASIX is the NSW Government's online sustainability tool that has mandated water and energy savings for residential development in NSW regional areas since July 2006.

In Tweed Shire, the BASIX water score must be a minimum of 40. This requires a minimum 40% reduction in mains-supplied potable water consumption, compared to the average 'pre BASIX' home. The average water use benchmark for a pre-BASIX home is 90,337 L/person/year or 247.5 L/person/day. This means that a water score of 40 is equivalent to a per capita water consumption of 148.5 L/person/day.

BASIX certificate information including information on building location, details and proposed water saving compliance measures for residential properties within the Tweed Shire was provided by the Department of Planning for use in the development of Tweed's Demand Forecast (Hydrosphere Consulting, 2014).

Rous Water also commissioned a study (Hydrosphere Consulting, 2013) to:

1. Determine the likely future water consumption from single residential dwellings constructed under BASIX legislation including per capita and per connection consumption;
2. Determine whether BASIX has achieved its primary water saving objective (40% less water than the average pre-BASIX household) and;
3. Compare the actual metered savings for the dwellings with the predicted savings from BASIX in the Rous Water service area.

Data on the predicted consumption of non-BASIX and BASIX-compliant residential properties and estimated water savings due to BASIX for a range of dwelling types are shown in Table 5.

Assuming the average occupancy in single residential properties in Tweed water supply areas is 2.8 (estimated), the average per capita consumption of a BASIX compliant single residential property is approximately 151 L/person/day during an average year. Similarly, the average per capita consumption of a BASIX compliant multi-residential property is approximately 88 L/person/day during an average year.

BASIX certificate data are also available for 2013/14 and 2014/15 for the Tweed. The total savings due to BASIX represents the approximate additional demand that would have been experienced if BASIX was not mandatory in the Tweed Shire. The analysis undertaken for the Tweed Demand Forecast has been extended to 2015 to estimate the total water savings due to BASIX in the Tweed Shire (Table 6). At the end of 2014/15, the estimated savings due to BASIX was approximately 300 ML/a.

Table 5: Comparison of data on BASIX consumption

Area	Data Source	Property Type	Actual average water savings	Average consumption (kL/dwelling/a)	Average consumption (L/person/day)
NSW	Pre-BASIX water benchmark	Single residential	0%	271*	248
Sydney	Sydney Water (2012)	Single residential	39%	203	N/R
NSW	BASIX Target	Single residential	40%	163*	149
Ballina	Hydrosphere Consulting (2013)	Single residential	43%	146	162
Byron			37%	146	167
Lismore			48%	152	142
Richmond Valley **			30%	199	173
Rous Water bulk supply area			42%	150	153
Tweed	Hydrosphere Consulting (2014)	Single residential (non-BASIX)	0%	265	N/R
		Multi- residential (non-BASIX)	0%	155	N/R
		Single residential BASIX (average year)	42%***	153	N/R
		Single residential BASIX (dry year)	39%***	161	N/R
		Multi-residential BASIX (average year)	43%***	89	N/R
		Multi-residential BASIX (dry year)	39%***	94	N/R

* Based on occupancy = 3.0

** Based on limited data and unlikely to provide a true reflection of consumption

*** Compared to the non-BASIX single/multi-residential water data reported in Hydrosphere Consulting (2014)

N/R = not reported.

Table 6: Water savings due to BASIX

Data	2007	2008	2009	2010	2011	2012	2013	2014	2015
BASIX single residential connections*	538	691	905	1,010	1,187	1,272	1,374	1,612	2,087
BASIX multi-residential connections*	174	338	697	881	939	1,025	1,080	1,096	1,119
Non-BASIX single residential consumption (kL/a/connection)**	295	258	267	259	252	250	264	279	265
BASIX single residential consumption (kL/a/connection)**	170	149	154	150	146	141	152	161	157
Non-BASIX multi-residential consumption (kL/a/connection)**	172	150	156	151	147	146	154	163	155
BASIX multi-residential consumption (kL/a/connection)**	99	87	90	87	85	82	89	94	92
Total Savings due to BASIX (ML/a)	79.6	96.7	147.9	166.8	184.7	204.3	224.0	266.0	296.8

* Estimated from BASIX certificate data and new connections.

** Year to year variation is due to prevailing climate.

5. DEVELOPMENT OF THE CURRENT DEMAND MANAGEMENT STRATEGY

Since the late 1980s, Council has implemented various demand management actions which are discussed in Section 6. The IWCM Strategy adopted by TSC in 2006 guided and prioritised actions regarding Council's management of the urban water supply systems in more recent times. The IWCM Strategy was reviewed and updated in 2014.

The 2006 IWCM Strategy recommended the development of a demand management program. Demand scenarios comprising a range of water efficiency measures, source substitution and water loss management were modelled and assessed in the DMS (MWH, 2009a). A summary of demand management measures included in the Shire-wide scenarios considered in the DMS is given in Table 7. Managed demand scenarios for greenfield developments were also considered in the DMS.

A cost assessment was undertaken for each of the scenarios considering Council capital costs, customer capital costs, Council operational costs and customer operational costs. The DMS provided the following observations:

- The majority of savings are due to the installation of rainwater tanks in new residential developments (as part of BASIX);
- The requirement for water efficient fixtures in new developments under BASIX and the influence of WELS (Water Efficiency Labelling Scheme) also result in major potable water savings in the Shire;
- The pressure and leakage management program would result in major savings for the Shire; and
- For the non-residential sector, the most significant savings were expected to come from the major user and commercial auditing programs, the requirement for water efficient fittings in all new developments and the requirement for a water management plan for all new high water users.

The 2009 DMS provided a baseline demand forecast (without the impact of WELS or BASIX) and also considered a demand management scenario (Scenario 1) with only BASIX/WELS demand management measures. The baseline Shire forecast was developed using a population of 163,714 in 2041 (population was estimated to more than double in the next 30 years and of this growth, 66,000 people would be housed in greenfield areas) without the impact of WELS or BASIX. The reduced demand with Scenario 1 (including BASIX/WELS) was predicted to be 423 ML/a in 2012 (more than twice the savings reported due to BASIX in Table 6).

The DMS recommended the adoption of Scenario 4 (refer Table 7) comprising the implementation of BASIX with 5,000 L rainwater tanks, a pressure and leakage management program and demand management measures for both the residential and non-residential sectors (rainwater tank education program, inclining block pricing structure, auditing of high water users including TSC parks and gardens, regulations to control non-residential internal plumbing fixtures, water management plans for new non-residential developments, education programs, water efficiency programs for the non-residential sector and a performance tracking system). Greenfield residential development scenarios comprising BASIX with rainwater tanks were recommended rather than recycled water use. The DMS recommended that recycled water be made available to future industrial land use areas in West Kingscliff where demand is identified.

The total demand forecast for each scenario in the 2009 DMS is given in Figure 17. As shown in Figure 17, Scenario 4 recommended in the DMS was predicted to provide the greatest reduction in demand.

The "climate corrected" historical demand is also shown on Figure 17. The aim of climate correction is to adjust or normalise the observed consumption on the basis of the climate factors experienced in that period.

Table 7: Demand management measures included in the 2009 DMS scenarios

	SCENARIO			
SECTOR	1	2	3	4
Residential				
BASIX Fixtures and WELS	✓	✓	✓	✓
BASIX - Internal/External Rainwater Tank (5kL)	✓	✓	✓	✓
Inclining Block Tariff			✓	✓
Residential Education Program			✓	✓
Landscape Use Efficiency Awards			✓	✓
Residential Rebate Program - Showerheads			✓	✓
Residential Retrofit			✓	✓
NRW				
Pressure and Leakage Management Program		✓	✓	✓
Non-residential				
Major Users Audit				✓
Commercial Business Water Audit Program				✓
Aged Care Audit				✓
TSC Open Space Irrigation Audit				✓
Waterwise Non-residential Education				✓
Training Landscape Managers				✓
Non-res Efficient Fittings Regulation and Management				✓

Source: MWH (2009)

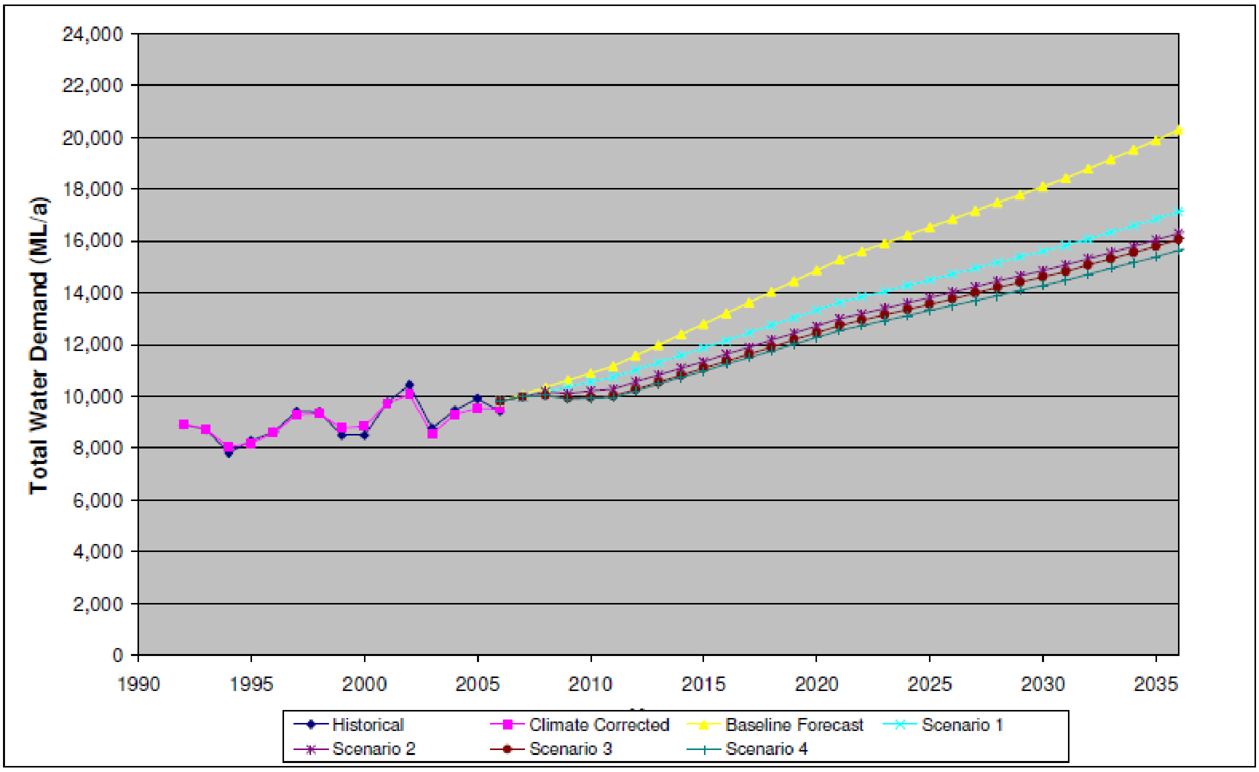

Figure 17: Forecast total annual demand – 2009 demand management scenarios

Source: MWH (2009)

Stage 1 of the Tweed DMS was adopted by TSC in January 2009 and focussed predominantly on the residential sector. Stage 2 addressed water demand management measures for the non-residential sector.

The adopted DMS includes the following demand management programs:

- Ongoing communication and education;
- Residential consumption targets (Target 180/170/160 L/p/d);
- Assistance to top non-residential water users to reduce consumption;
- Reduction in water losses (and non-revenue water target);
- Effluent reuse schemes (and recycled water target);
- Residential retrofits and rebates; and
- Rainwater tank policy.

A three year (2011/12 – 2013/14) DMS implementation plan was adopted by Council in May 2011. Key performance indicators (KPIs) were developed for the DMS implementation.

At the June 2014 Council meeting, a residential water saving program for 2014/15 was adopted including:

- Continue the existing residential rebate for showers and tapware;
- Continue ongoing links with Council's 'Target 170' campaign;
- Introduce a web-based register for residential rainwater tanks;
- Improve water consumption bills further to cater for quarterly billing and pro-rating of charges;
- Explore the cost and feasibility of a residential rainwater tank rebate;
- Continue to build community awareness and reward/encourage positive behaviour change; and
- Continue to monitor and evaluate the cost and effectiveness of the program.

6. DMS IMPLEMENTATION PROGRESS

6.1 Historical Expenditure

Historical TSC expenditure on demand management actions since 2012 is given in Table 8 and Figure 18. The majority of the expenditure was for residential rebates and the Tweed Top 20/100 (refer Section 6.4.1). Other expenditure related to TSC engineering staff and recycled water projects is not included here.

Table 8: Historical TSC expenditure on demand management since 2012

Component	2012	2013	2014	2015	2016
Resources and Equipment	$58,480	$53,592	$30,579	-	-
Publicity/Promotion	$4,308	$9,261	$3,144	$3,852	$416
Education & Awareness	$39,698	$22,889	$259	-	-
Training	$14,585	$11,109	-	-	-
Water Loss Management	$13,542	$17,340	$1,035	$5,028	$568
Rebates*	$22,876	$517,164	-	$5,291	$5,454
Non-Residential Funding Top 20	$10,000	$83,288	$4,938	-	-
Non-Residential Funding Top 100	-	$10,125	$17,162	-	-
Council's Top 20	-	-	-	$135	$40,303
Totals	*$163,489*	*$724,766*	*$57,117*	*$14,305*	*$46,741*

* The expenditure in 2013 includes over $500,000 for the dual flush toilet rebate.

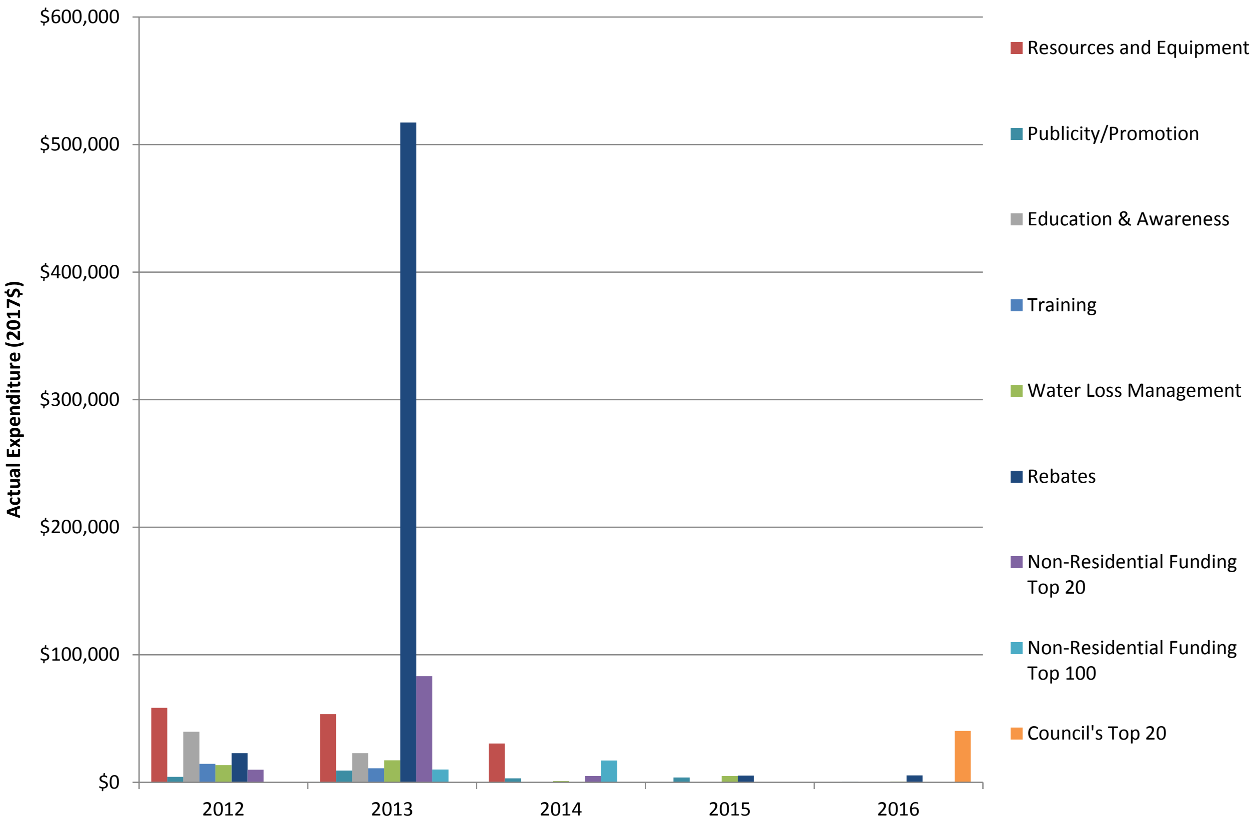

Figure 18: Historical TSC expenditure on demand management since 2012

6.2 Status of DMS Actions

Progress of the actions in the 2012 - 2014 implementation plan and the KPIs is provided below.

Table 9: Demand Management Strategy Implementation Status

Item	Action	Current (2016) Status
DMS Program Planning	Review of the DMS findings and recommendations	The DMS was reviewed in 2011 and for the IWCM review (2014). Implementation actions are reviewed on an annual basis.
Performance Tracking Framework	For average residential water use, targets have been adopted: • 180 L/person/day by 2013; • 170 L/person/day by 2016; and • 160 L/person/day by 2020.	Demand KPIs are shown in Table 10 and Figure 19.
	For average total water demand, a target of 300L/person/day by 2013 has been adopted.	Demand KPIs are shown in Table 10 and Figure 19.
	A non-revenue water target of 10% of water produced by 2013 has been adopted.	NRW KPIs are shown in Table 10 and Figure 20.
	A recycled water target of 15% of treated effluent reused by 2013 has been adopted.	Recycled water KPIs are shown in Table 10 and Figure 21. Discussion of recycled water use is provided in Section 6.4.1.
	Performance will be reported to Council annually. Reporting on the various demand management projects will also be incorporated in Council's quarterly reporting.	Complete.
	Ongoing communication and education programs	Ongoing (refer Section 6.4.3)
Water Billing Process	To be reviewed.	A new water bill format was introduced with more information to customers to increase awareness of water use and encourage customers to take water saving actions.
	The inclining block tariff structure will be maintained and enhanced to provide a price signal for high residential water users. It is proposed to continue to reduce the consumption limit which triggers the second step (+50%) residential volumetric charge.	Historical water tariffs are discussed in Section 6.4.3. Consumption limit for second step volumetric charge remains at 300 kL/a.

Item	Action	Current (2016) Status
Residential Retrofits and Rebates	A new residential home retrofit and rebate scheme for water efficient showerheads will be developed and implemented. Rebates for other water saving products will also be assessed.	The residential rebate program for water efficient showers and tapware has been running since 1 July 2011 (refer Section 6.4.1).
	A target of 2,400 residential rebate participants by 2013 has been adopted	795 participants (441 showers, 384 spouts/mixers, 737 aerators, 51 flow controllers)
	A cumulative water saving target of 36 ML/a for residential rebates by 2013 has been adopted	7.5 ML/a
Rainwater Tank Program	Council's existing Rainwater Tank Policy will be reviewed and amended as necessary to match the requirements of the DMS.	Complete (refer Section 6.4.3).
	Liaison with the Department of Planning to resolve any differences between TSC's rainwater tank policy and the State Government's BASIX requirements for Development.	Complete. The Policy is complimentary to BASIX and aims to go a step further to reduce water demand in the Tweed Shire.
	% of new dwellings with tank volume ≥ 5,000 L	53% due to BASIX (refer Section 6.4.3).
	The take-up of rainwater tanks in response to Council's Policy will be monitored with a view to offering a rebate if it is warranted.	A web-based register for rainwater tanks was proposed in 2012/13 but not implemented on the basis that the register would be voluntary and that additional information is available from BASIX data. A community survey conducted in May 2012 indicated that a Council rebate for tanks would be well received and supported. Introduction of a rainwater tank rebate was investigated by Council in 2015 with the conclusion that other demand management measures are more cost-effective.
Top 20 Water Users – Non-Residential Program	The top 20 non-residential water users will be audited to determine where their water use can be reduced.	Complete (refer Section 6.4.1).
TSC Audits	Key TSC properties will be identified and audited.	Complete (refer Section 6.4.1).
Open Space Irrigation Guidelines – Water Efficient Garden Policy	TSC will develop Open Space Irrigation Guidelines and a Water Efficient (Friendly) Garden Policy.	Council's irrigation practices have been reviewed and a new irrigation system has been installed at the nursery as part of the Council's Top 20 program (Section 6.4.1) A Water Efficient (Friendly) Garden Policy has not been implemented due to lack of resources. Water Smart gardening advice is available on the TSC website.
	100% of TSC field staff trained	Complete

Item	Action	Current (2016) Status
	15% reduction in metered water use – TSC parks and gardens	All TSC parks and gardens consumption is metered. The average metered water use was 224 ML/a between 1991 and 2011. In 2013 the consumption was 168 ML/a (25% reduction). The average consumption between 2014 and 2016 was 175 ML/a.
Other Major Water Users – Top 100	The balance of the top 100 water users will be identified and audited.	Complete (refer Section 6.4.1).
	A non-residential education program will be developed and delivered to participating businesses.	Not yet commenced. Some education is undertaken as part of the Top 20 and Top 100 programs.
Permanent Water Restrictions	Permanent restrictions in place elsewhere in NSW will be reviewed and a list of measures, suitable for the Tweed district will be prepared.	Permanent restrictions were considered as part of the review of the TSC drought restrictions policy in 2015 but were not included as they are unenforceable and at the time were considered unnecessary due to the prevailing climate. Water conservation messages are included in the Target 170/180 campaign.
Recycled Water Projects	TSC will continue to pursue opportunities for water recycling as they arise. Specific projects that have been identified will be investigated in more detail.	Discussion of recycled water projects is provided in Section 6.4.1.
Unaccounted for Water	TSC will continue to implement leakage reduction works.	In progress (refer Section 6.4.1).
	TSC's policy on standpipe use will be reviewed and alternative metering/access options will be investigated. TSC will consult widely with water carters and other stakeholders during this review process.	Complete (refer Section 6.4.3).
Water Sensitive Urban Design/ESD	Further opportunities for implementing WSUD/ESD principles in new development, specifically for reducing potable water usage, will be pursued. A review of the potable water design standards will be undertaken.	This is addressed through BASIX (refer Section 4)
	Opportunities for sewer mining, recycling of water and other integrated water solutions for greenfield areas will be assessed on a case by case basis.	Assessed on a case-by-case basis. Refer Section 6.4.1.

6.3 TSC Demand Management Performance Indicators

6.3.1 Residential and Total Demand

Demand KPIs are reported in Table 10 and Figure 19. The 2016 demand KPIs have been estimated using the forecast population.

Over the long-term, there has been a downward trend in the demand KPIs. Prior to the implementation of BASIX, the demand KPIs decreased by 20% (1.4% p.a. between 1992 and 2006) with the reduction attributed to increasing awareness of the value of water. Since 2006, the demand KPIs have decreased by a further 23% (2.3% p.a. between 2006 and 2016), attributed to BASIX, government rebates and TSC demand management measures (including pricing).

The indicators are influenced by climatic conditions as discussed in Section 3.2.2. The 180 L/p/day residential demand KPI and 300 L/p/d whole of Shire demand KPI were achieved in 2011, 2012 and 2013 (generally wetter and cooler years). Demand significantly increased in 2014 with the hot dry conditions as discussed in Section 3.2.2, which affected achievement of the demand KPIs. The demand KPIs improved in 2016 (generally a colder, drier than average year), although the residential demand KPI of 170 L/p/d has not yet been achieved.

Table 10: Demand KPIs

Measure	Measure	KPI	2015 Status	2016 Status
Whole of Shire residential demand	Average daily residential demand per capita	• 180 L/person/day by 2013; • 170 L/person/day by 2016; • 160 L/person/day by 2020.	192	177
Whole of Shire total demand	Average daily total demand per capita	300 L/person/day by 2013	301	285

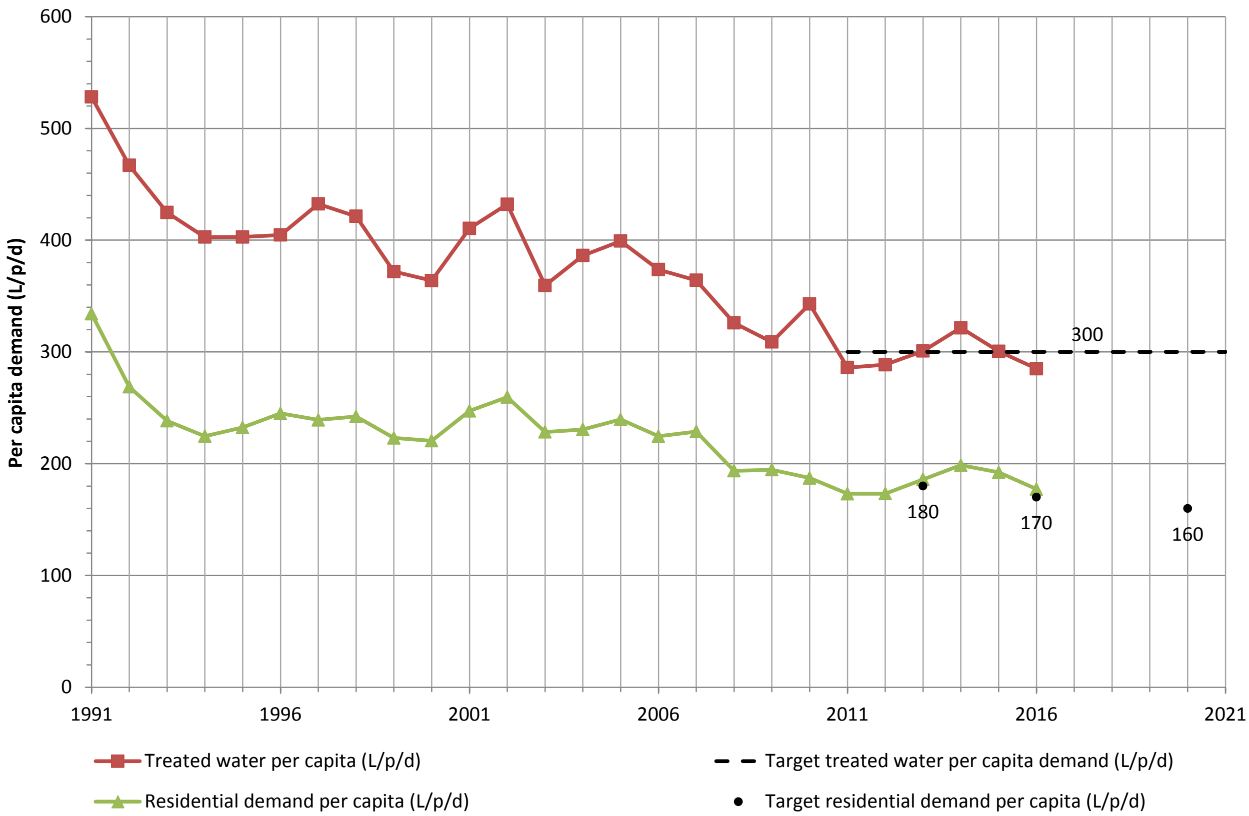

Figure 19: Residential demand and whole of shire demand KPIs

6.3.2 Non-Revenue Water

TSC introduced customer water meters between 1965 and 1967. All water supply usage is now metered.

The NRW KPI is reported in Table 11 and Figure 20. The percentage of NRW has generally decreased since 2010 and the volume of NRW has generally decreased since 2010 although the KPI of 10% has not yet been achieved. As the KPI is measured as a percentage of total water produced, if water production decreases and water losses remain static, the percentage NRW will still increase.

Table 11: NRW KPI

Measure	Measure	KPI	2015 Status	2016 Status
NRW	Unbilled water as a % of total water produced	10% by 2013	11.8% (1,025 ML)	12.4% (1,042 ML)

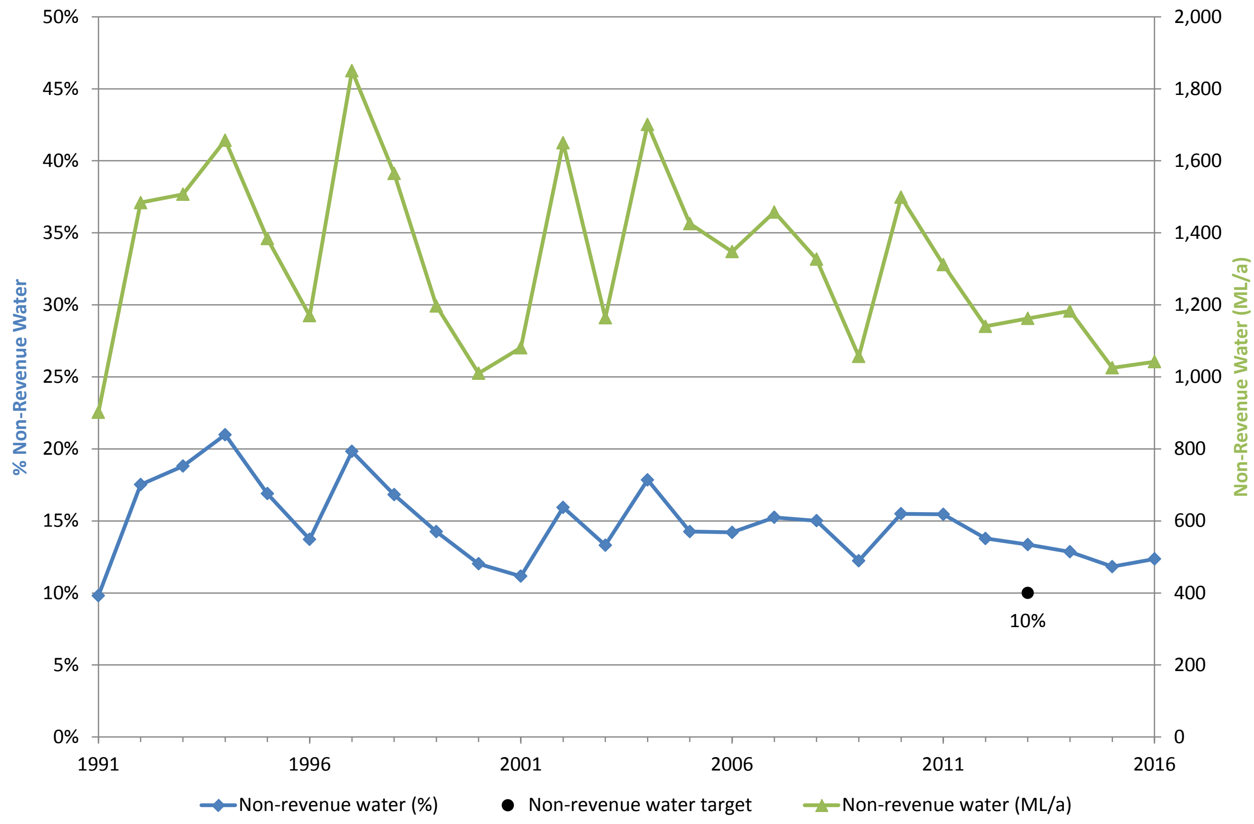

Figure 20: Non-revenue water KPI

6.3.3 Recycled Water

The Recycled Water KPI is reported in Table 12 and Figure 21. The volume of water recycled is influenced by climatic conditions and generally follows a similar trend to residential and public parks consumption which has increased in drier and hotter years (2010 and 2014). This is because a large proportion of the recycled water is used for open space irrigation (refer Section 6.4.1). The volume of effluent recycled at the Condong Sugar Mill was also lower after 2010 due to a change in operation at the mill.

Table 12: Recycled Water KPI

Measure	Measure	KPI	2015 Status	2016 Status
Recycled water	% of treated effluent that is reused	15% by 2013	6.8%	N/A

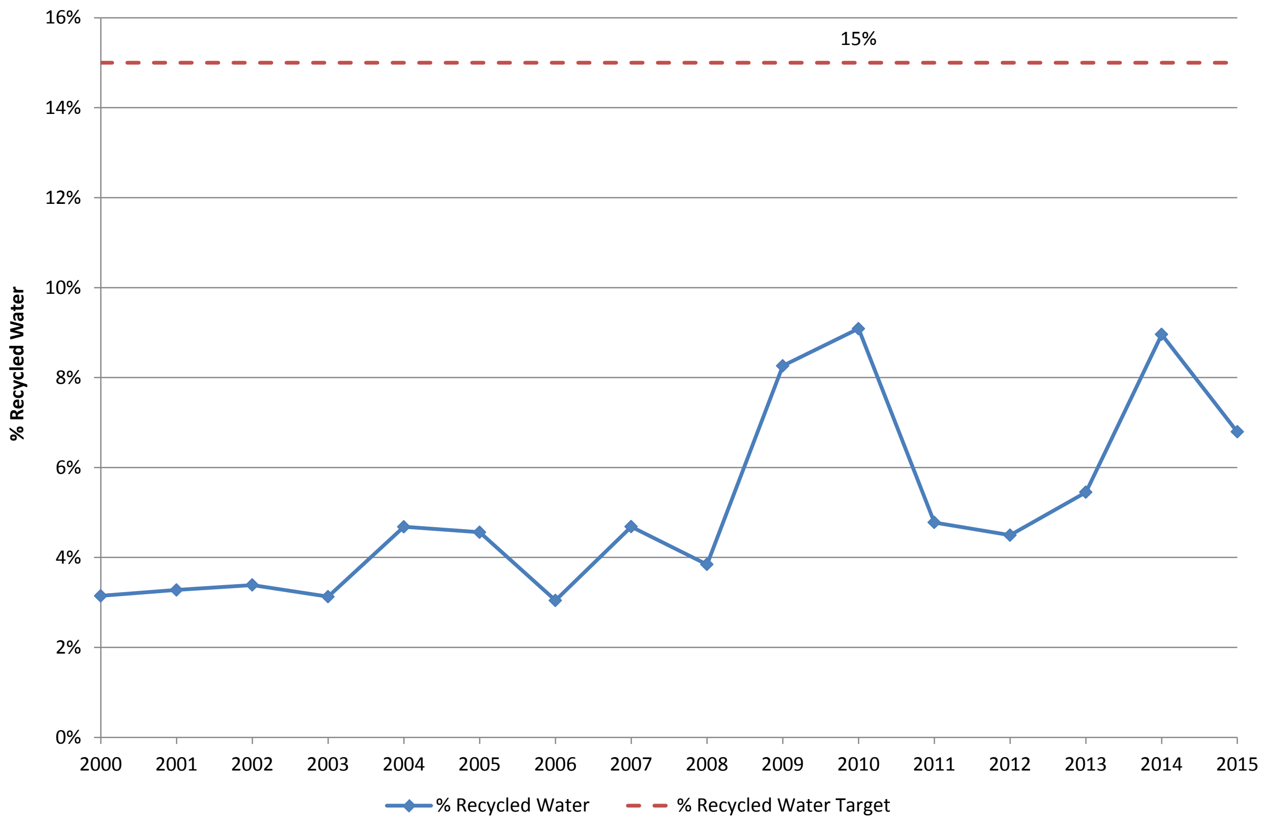

Figure 21: Recycled water KPI

6.4 Discussion of TSC Demand Management Actions

6.4.1 Pricing

Increasing the price of water is seen as an effective tool in demand management. Pay-for-use pricing provides appropriate incentives to conserve water by empowering consumers to influence their bills through the amount they consume and their water consumption habits (investment in water-efficient devices, garden composition, leakage reduction etc.).

Full user pays pricing was introduced by TSC in 2002. Prior to this, the water supply tariff included an annual access charge, water usage charge and a free water allowance (371 kL/a between 1991 and 1995, progressively reduced to 250 kL/a in 2002).

Data on water supply pricing are shown in the following figures. Council has been progressively increasing the price of water over the last ten years. Significant increases in usage charge were adopted in 2007 and 2008 with a real increase (not including inflation) in step 1 usage charge between 7% and 10% over the last eight years.

The step 2 usage charge was introduced in 2009/10 with applicable consumption 450 kL/a in 2009/10, 350 kL/a in 2010/11 and 300 kL/a thereafter. The step 2 usage charge is 50% higher than the step 1 usage charge. The step 2 usage charge aims to encourage water conservation for high water consuming residential customers.

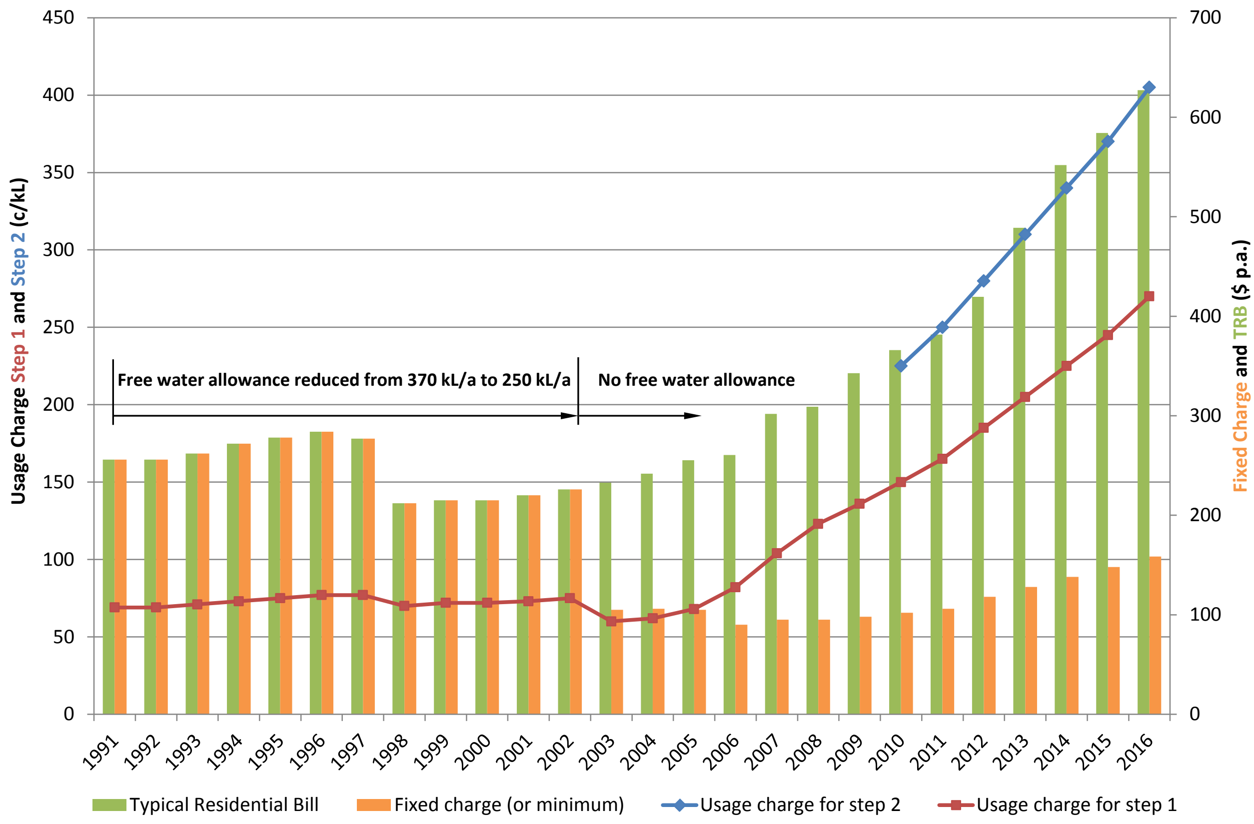

Figure 22: Historical residential water supply tariffs: 1991 – 2016

Note: Average annual consumption 1991 – 2003 is assumed to be 200 kL/a

Figure 23: Real increase in residential water supply tariffs: 1992 – 2016

As shown in Figure 24, a significant decrease in residential consumption was observed with the increases in usage charge in 2007 and 2008. Although climate will also influence consumption, a similar relationship between increased usage charge and consumption is not evident since 2009, potentially because the larger tariff increases already implemented were most effective (refer below). Data on average annual residential water consumption are not available prior to 2003.

Figure 24: Real increase in residential water supply tariffs compared to residential consumption

Price elasticity measures the change in water use in response to changes in prices. Price elasticity is negative reflecting the reduction in water use in response to increase in prices (i.e., negative relationship between water price and use). The Price Elasticity of Demand (PED) relationship between the increase in price and the reduction in water demand is illustrated in Figure 25. The PED recommended for non-metropolitan NSW water utilities is a mid-range value of -0.2. For example, a 10% increase in usage charge would result in a 2% reduction in demand and a 30% increase in price would result in a 5.4% reduction in demand (NSW Office of Water, 2011). Based on the real increase in usage charge (step 1) and the average annual residential consumption for Tweed residents between 2006 and 2016, an 11% p.a. increase in usage charge has resulted in a 2% p.a. reduction in demand (on average). Over the 11 year period, the usage charge has increased by 136% and the demand has reduced by 17%. Therefore a PED of -0.2 appears to be appropriate for Tweed Shire.

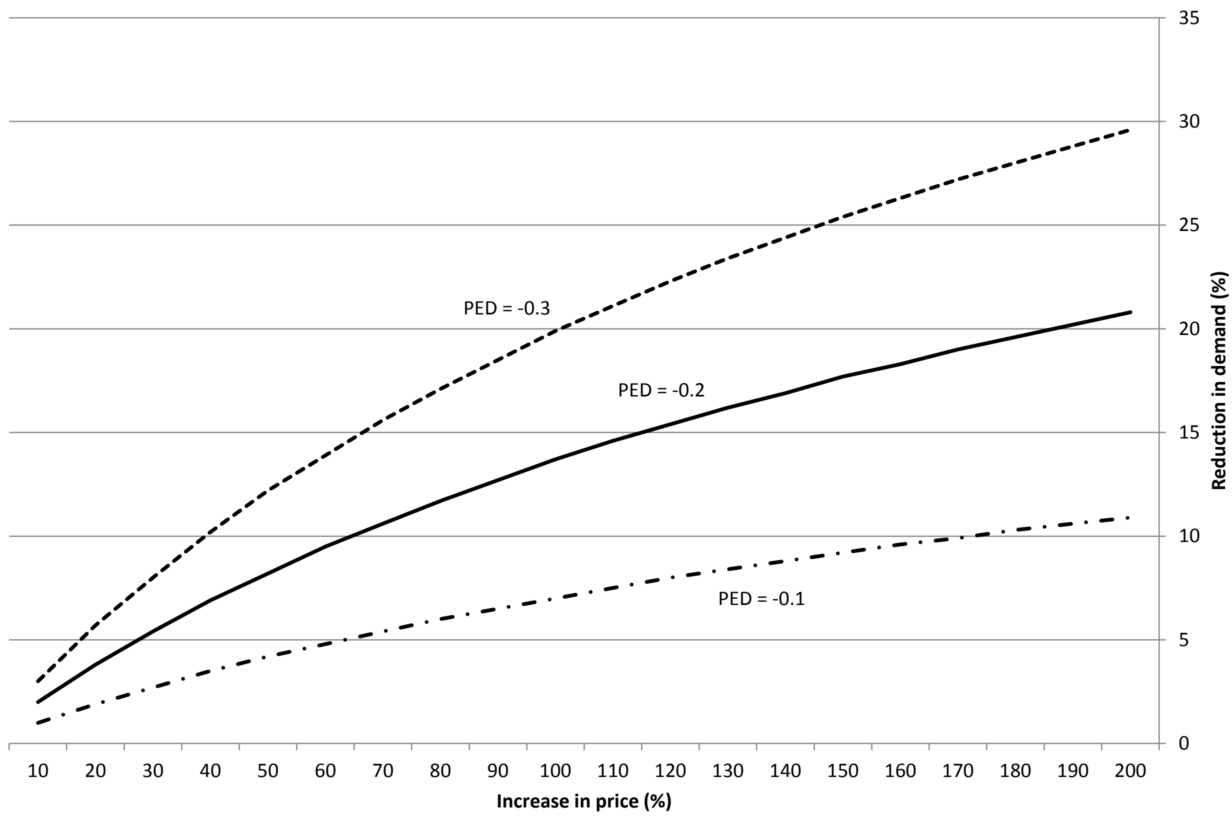

Figure 25: Price elasticity of water demand

Source: NSW Office of Water, 2011

6.4.2 TSC Investment Actions

Demand management actions with an investment by TSC are discussed in the following sections. The annualised costs per kL of water saved by Council and the customer have been calculated based on the net present value (NPV) of the net expenditure and the predicted water savings. This calculation provides an indication of the relative investment of each water savings measure as a function of water saved (kL) to enable comparison between the measures on a cost basis. The TSC cost represents the net investment made by Council (expenditure less the reduced cost of water production) and the customer cost represents the net investment made by the customer (expenditure less the reduction in water bill). A positive value indicates that the costs are higher than the monetary savings and a negative cost indicates that monetary savings are higher than costs (over the life of the product). The calculations include the following assumptions (refer Appendix 3):

- Water savings for rebate items have been estimated by Council and are consistent with values previously reported;
- Water savings for the Top 20/100 programs are based on predicted water savings for each project;
- Council savings due to reduced water production have been estimated using the marginal cost of potable water (variable operating cost components estimated as the additional cost to TSC of producing each kL of potable water = 60c/kL);
- Customer savings due to reduced water bills have been estimated on the basis of the 2014/15 step 1 usage charge (245 c/kL);
- Customer savings due to reduced hot water costs have not been estimated as this is dependent on the hot water system in place;
- The lost revenue from sale of potable water has not been included in the analysis; and

- The annualised cost of the project is estimated for the life of the product at a discount rate of 5%.

The predicted water savings, TSC cost and customer cost for each demand management measure are discussed in the following sections. The investment actions with the lowest (or negative) TSC cost are considered to be the most cost-effective. Any customer savings (negative customer costs) are an indirect benefit of the demand management measure that may encourage take-up of the demand management measure (e.g. rebate) but should not be used to identify cost-effective investment actions.

Residential Rebates – Showerheads and Tapware

TSC offers a water saving rebate to households connected to the town water supply for water saving products and devices including showers (at least 3-star WELS rated), basin/sink spouts and mixers (at least 4-star WELS rated), aerators (at least 4-star WELS rated) and flow control valves (at least 4-star WELS rated) plus the associated installation costs. The rebate is 50% of the combined cost of eligible products and installation costs up to a maximum rebate of $100 per customer.

Participating households have installed water efficient showerheads and a combination of other water saving devices. An audit of participating households is conducted every six months to ensure that products are being installed correctly and performing as expected. This information is used to improve the efficiency of the rebate program. The program is tracking well short of the 2,400 participants targeted by 2013, despite regular promotion.

Table 13: Residential showerhead and tapware rebate annualised costs

Implementation Dates	*TSC Expenditure*	*Average rebate per customer*
July 2011 – ongoing	$49,472	$62

Performance Indicator	*2013 Target*	*Actual Performance (to date)*
Number of participants	2,400 (10% of all residential connections)	795 participants (448 for tapware and 347 with 1 or 2 showerheads) (441 showers, 384 spouts/mixers, 737 aerators, 51 flow controllers)
Cumulative water saving	36 ML/a	7.5 ML/a (savings assumed: 15 kL/a for showerhead participants and 5 kL/a for tapware participants)

Rebate Item	*Approximate Item Cost*	*Rebate*	*Estimated Life of Product (years)*	*Estimated Water Saving (kL/a)*	*TSC Cost (per kL)*	*Customer Cost (per kL)*
Showerhead	$100	$50	5	15	$0.13	-$0.58
Tapware	$100	$50	5	5	$1.60	-$4.00
Aerators/flow controllers	$50	$25	5	5	$0.50	-$0.74

Residential Rebates – Toilets

The residential toilet rebate was extremely well received and take up was much higher and more rapid than anticipated. Council's rebate budget was expended after just eight weeks and the program was closed.

Table 14: Residential toilet rebate annualised costs

Implementation Dates	*TSC Expenditure*	*Average rebate per customer*
15 October 2012 – 7 December 2012	$508,312	$313

Performance Indicator	*2013 Target*	*Actual Performance (to date)*
Number of participants	500	1,624 (2,553 toilets)
Cumulative water saving	15 ML/a	48.7

Rebate Item	*Approximate Item Cost*	*Rebate*	*Estimated Life of Product (years)*	*Estimated Water Saving (kL/a)*	*TSC Cost (per kL)*	*Customer Cost (per kL)*
Dual-flush toilet	$400	$200	15	30	$0.01	-$0.54

Top 20 Water Users (Non-Residential)

Businesses that were identified as one of the top 20 non-residential water users (increased to 21 customers) in the Shire participated in the Tweed's Top 20 program, which aimed to reduce business water use. About 35 businesses were invited to participate although many did not have the capacity or opportunities to participate. Participating businesses received assistance to implement a water saving project, including a free water assessment, support, promotion opportunities and financial assistance. A total of up to $5,000 was available to each business to design, construct and install water saving measures at their business. Any additional costs would be borne by the business.

Council has reported the combined average daily water usage by the Top 21 between 2004 and 2013 (Figure 26). The data suggest a 10-11% reduction in water consumption since 2011 and a 30% reduction since 2004. However, other factors such as climate, pricing and production rates would also affect consumption and more recent consumption may follow a similar trend to other customer types, increasing in 2014 with the hotter, drier conditions.

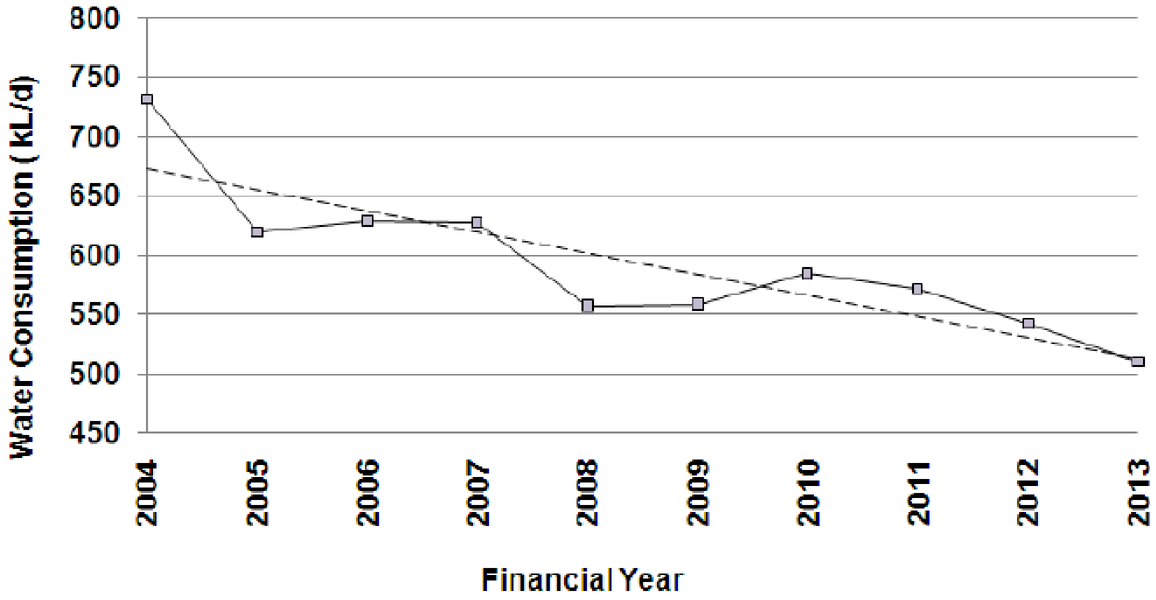

Figure 26: Top 20 combined average daily water consumption

Table 15: Top 20 program annualised costs

Implementation Dates	*TSC Expenditure*	*Average rebate per customer*
October 2011 – mid-2013	$97,296	$4,633

Performance Indicator	*2013 Target*	*Actual Performance (to date)*
Completed water audits	20	21
Individual water saving targets	50 ML/a (10% of water use)	34.7 ML/a
Commenced projects	20	21
Completed projects	20	21

Rebate Item	*Average Cost*	*Average Rebate*	*Life of Product (years)*	*Average Estimated Water Saving (kL/a)*	*Average TSC Cost (per kL)*	*Average Customer Cost (per kL)*
Various	$6,217	$4,633	Various (assume 10)	1,650	-$0.25	-$2.33

Top 100 Water Users (Non-Residential)

Businesses that were identified as one of the next top 80 non-residential water users in the shire were invited to participate in the Tweed's Top 100 program.

Participating businesses received assistance to implement a water saving project, including a free water assessment, support, promotion opportunities and financial assistance. A total of up to $1,000 was available to each business to design, construct and install water saving changes at their business. Any additional costs would be borne by the business.

Table 16: Top 100 program annualised costs

Implementation Dates	*TSC Expenditure*	*Average rebate per customer*
July 2012 – June 2014	$27,287	$1,000

Performance Indicator	*2013 Target*	*Actual Performance (to date)*
Completed water audits	40	34
Individual water saving targets	40 ML/a (5% of water use)	13.5 ML/a
Commenced projects	40	27
Completed projects	40	27

Rebate Item	*Average Cost*	*Average Rebate*	*Life of Product (years)*	*Average Estimated Water Saving (kL/a)*	*Average TSC Cost (per kL)*	*Average Customer Cost (per kL)*
Various	$1,000*	$1,000	Various (assume 10)	350	-$0.25	-$2.10

* Most customers spent only the total rebate as part of the water saving project.

Council's Top 20 Water Users

Council's Top 20 (now 21) water using properties/sites have been audited and water efficiency projects have been identified. Some improvements have been implemented with zero or minimal expenditure. Major projects have included repair of a leak at Murwillumbah pool, a new automated irrigation system for Council's nursery and modification to the water sampling regime at Bray Park WTP.

Table 17: Council's Top 20 program annualised costs

Implementation Dates	*TSC Expenditure*	*Average rebate per customer*
2012 - 2016	$50,438	$10,000 – Murwillumbah pool leak repair $40,438 – Nursery irrigation system

Performance Indicator	*2013 Target*	*Actual Performance (to date)*
Completed water audits	10	21
% of TSC field staff trained	100%	10%
% water savings	29 ML/a (15% of total water use)	10.5 (estimated)

Rebate Item	*Capital Cost*	*Life of Product (years)*	*Average Estimated Water Saving (kL/a)*	*Average TSC Cost (per kL)*
Murwillumbah pool leak repair	$10,000	Assume 20	1,825 (5 kL/d)	-$0.18
Nursery irrigation system	$40,438	Assume 10	Unknown	Unknown

Recycled Water

Recycled water is reused at the following sites:

- The Coolangatta-Tweed Heads Golf Club has been using treated effluent from Banora Point WWTP for irrigation since 1987 (160 ML in 2015);
- Council operates a koala feed tree eucalyptus plantation at Uki (since 2004);
- Irrigation of pasture at Tyalgum (since 1987);
- Cooling at Condong Sugar Mill (recycling from Murwillumbah WWTP since 2007, approximately 420 ML/a);
- Chinderah Golf Course (supply 40 ML/a from Kingscliff WWTP);
- Irrigation of Les Burger Field (Bogangar Rugby League grounds), recycling up to 38 kL/d from Hastings Point WWTP; and
- Burringbar/Mooball – riparian regeneration.

Other projects being investigated by TSC include:

- Irrigation of Arkinstall Park and Memorial Gardens, Tweed Heads;
- Barry Sheppard Oval and Round Mountain Pony Club;
- Chinderah Ti Tree plantation;
- Tweed River Jockey Club;
- West Kingscliff; and
- Tyalgum Eucalyptus plantation (Currumbin Wildlife Sanctuary).

The development of recycling schemes has been hampered by the increasing regulations, treatment requirements and costs and community perceptions of the use of recycled water. The increasing regulation has the effect of reduced risks to the public and the environment but at high cost to Council and the consumer, which is often prohibitive and affects the viability of the scheme.

TSC has received a proposal from a private developer to provide water and sewerage services to the Cobaki development by a private water utility. The proposed scheme includes a recycled water reticulation network for domestic reuse suitable for toilet flushing, cold water connection to washing machines, garden watering, car washing, wash down and open space irrigation areas. Recycled water use generation is predicted to be 2.4 ML/day with 1.15 ML/d to be reused within the development and 1.2 ML/d to be reused off-site. TSC's drinking water supply network is proposed to be used to provide the drinking water into the proposed development (WGM, 2016).

Developers of the Dunloe Park (West Pottsville) site have proposed a similar scheme with dual reticulation to be operated by a private water utility. The Dunloe Park and Cobaki developments are in the planning and development assessment stages and may not proceed as dual reticulated private utility developments.

The annualised costs of the Les Burger fields recycling scheme has been used to represent the cost of recycled water to TSC. Other schemes will have different capital and operating costs, types of water use and water savings, although this provides an indication of the annualised cost of a recent scheme.

Table 18: Les Burger fields recycling scheme annualised costs

Project	*Capital Cost*	*Recurrent Cost*	*Life (years)*	*Average Estimated Water Saving (kL/a)*	*Average TSC Cost (per kL)*
Les Burger fields recycling scheme	$320,575 (2008 – 2016)	$5,000 p.a.	Assume 20	13,850 (38 kL/d)	$1.53

Customer Meter Replacement

Customer water meters were first introduced in 1965.

A meter replacement program between 1996 and 2002 included the replacement of all meters greater than 20 years old.

Council has been replacing about 1,000 customer water meters each year for over ten years. While this has no impact on the customer demand, it allows more accurate measurement of customer consumption (and reduced NRW).

Education and Awareness

Education activities have included:

- Information sessions and displays featuring information about Council's water saving rebate, rainwater tanks, water efficient products, general water management and a water quiz;
- Launch of the water saving programs;
- Surveys regarding modifications to water bills; and
- Water awareness television advertisements.

The Meet Your Meter campaign in November/December 2012 supported the residential water saving program. A competition was run to raise awareness of household water use by encouraging residents to monitor their own meter readings on an ongoing basis. Residents were encouraged to meet Target 180, Council's household target of 180 L/p/day. The competition included links to online information about how to locate and read the water meter, calculate the daily water use and work out the water use per person per day.

More recently, staff members have promoted water conservation/efficiency and rebates by attending community events such as the “Living for the Future” home expo, Tweed River Festival, Seniors Expo, World Environment Day and Local Government Information Day.

Articles and advertisements are published in the Tweed Link and media releases are used to announce new programs, important milestones and achievements. Direct mail to plumbers, plumbing retailers and real estate agents based in the Tweed Shire is used to keep them informed.

The Water Unit produces a newsletter called ‘Water Matters’ which is mailed with all water consumption bills. The newsletter is used as an opportunity to showcase Council’s water saving initiatives and achievements.

Information provided on Council’s website is continually being updated and expanded to support specific programs and address customer questions and needs.

Table 19: Education and awareness expenditure

Implementation Dates	*TSC Expenditure*
2012 - 2016	Publicity and promotion: $21,000 Education and awareness: $62,800

Water Loss Management

In the late 1980s water losses were estimated to be 50% of water production (refer Appendix 1) and TSC introduced a program in 1989 to reduce wastage and leakage. At that time, reservoir drop tests confirmed that significant leakage was occurring and the following actions were implemented to reduce water losses:

- Revised water service material standards were adopted to reduce pipe failure;
- A water service replacement program was implemented including replacement of galvanised iron services with new polyethylene services, replacement of road crossings with copper pipes, new road crossings were placed in conduits, services were replaced as part of main replacements and hydrants were replaced;
- A mains replacement program was implemented for failing mains. Improved water main material and fittings standards were implemented as part of this program which has expended in excess of $43 million from 1994 to 2016;
- In 1996 measures to improve responsiveness to the replacement of broken or failed meters were implemented;
- Since 2000 Council has metered fire services and improved meter reading and checks of fire services for large consumers on a monthly basis;
- Sound correlation surveys were conducted on the reticulation network in the Tweeds Heads and Tweed Heads West areas in the late 1990s. No major leaks on mains were found, but a number of leaks in consumer services and associated fittings were detected and replaced. This work confirmed that the network was in reasonable condition; and
- In 2001, Council introduced improved regulation of bulk water use including designated metered standpipes and filling points.

A comprehensive water loss management program was implemented in 2005 targeting illegal and unmetered use, continuing the meter replacement and mains replacement programs, development of a zone metering and flow analysis program and improving response to main breaks and leaks.

Recent drop tests for Council’s water reservoirs were undertaken between 2011 and 2014, however some delays have been experienced due to limited staff resources and competing operational priorities. The drop tests are being incorporated in the Water Unit’s maintenance schedules and will become a routine activity for its operational staff in future. The drop tests are used to estimate the amount of recoverable leakage (from night flows) within the reservoir supply zone. As a result of these drop tests, leaks have been detected and repaired in Fingal Head and Tweed Heads.

On-going leak detection and repair is predicted to result in continued water savings and a reduction in NRW.

Bulk flow meters are being installed throughout the water supply trunk system to enable an accurate water balance to be carried out on an ongoing basis. This will further assist with the identification and early notification of leaks to minimise water losses.

Table 20: Water loss management expenditure

Implementation Dates	*TSC Expenditure*
2012 - 2016	Water loss management: $37,500
1994 – 2016	Water main replacement program: $43 million

6.4.3 Complementary Actions

Demand management actions with minimal expenditure by TSC (apart from staff costs) are discussed below).

Rainwater Tank Policy

The TSC rainwater tank policy (Rainwater Tanks in Serviced Areas) is designed to facilitate the installation and use of rainwater tanks to provide non-potable water for outdoor uses, flushing toilets and washing machines (TSC, 2015a). The policy has been modified to include all urban and rural residential and non-residential customers.

All new residential development must comply with the BASIX requirements which often require the installation of a rainwater tank. The Council policy is complimentary to BASIX and aims to go a step further to reduce water demand in the Tweed Shire. While Council cannot override the BASIX requirements, for single dwellings this Policy recommends a minimum tank size of 5,000 L, capturing rainwater from a roof catchment area of 160 m^2 or more. For multi-dwellings, the maximum possible tank size and 80% to 90% of the roof catchment area are recommended. For non-residential tanks, it is recommended that the rainwater tank volume and roof catchment area are maximised

Connection of toilet cistern(s), the cold water supply to the washing machine and the majority of external garden taps is encouraged.

New development and subdivisions must also comply with any additional requirements of Council's Development Control Plans and Development Codes, specific to those developments and precincts.

The revised policy has been widely promoted in the Tweed Link and through regular media releases. Plumbers and builders located in the Shire were notified about the updated policy via a mail out during the public exhibition period. Information about the policy and new resources dealing with the selection, installation and maintenance of rainwater tanks has been posted on Council's website to assist the public.

Table 21: Rainwater tank KPIs

Performance Indicator	*2013 Target*	*Actual Performance (to date)*
TSC Rainwater Tank Policy revised	Updated policy consistent with DMS	Complete
% of new dwellings with tank volume ≥ 5,000 L	100% of new single family residences	Average: 6,320 L Median: 5,000 L Range: 800 – 160,000 L* 53% of tanks are ≥ 5,000 L

* Source: BASIX certificate data since 2005/06

Bulk Water Sales

Regulation of bulk water use was introduced in 2001 with the introduction of metered standpipes, signage for licensed water carters and designated filling points.

In mid-2013 Council reviewed its policies and procedures on drawing water from Council's mains as well as standpipe use by water carters, Council staff and private individuals. A revised process of regulation and monitoring water use has been implemented to more accurately account for water use (reduce the level of unaccounted for water).

Drought Water Restrictions Policy

Council's Drought Water Restrictions Policy (TSC, 2015b) sets out the water restrictions that would be implemented in the event of a drought. The policy applies to all properties connected to Council's Bray Park and Uki water supply schemes. Implementation of the water restrictions is triggered once the per-determined water levels in Clarrie Hall Dam are reached (Table 22). Water restrictions in Tyalgum are considered when the Tyalgum weir ceases to flow.

Table 22: Drought water restriction triggers and demand reduction target – Tweed District and Uki

Restriction Trigger Levels	Demand Reduction Target (%)	Restriction Level Imposed (% of Clarrie Hall Dam full capacity)
External sales banned and pre-activation activities	0	90
Level 1 restrictions	15	75
Level 2 restrictions	20	60
Level 3 restrictions	25	50
Level 4 restrictions	30	40

Source: TSC (2015b)

The previous drought restriction policy allowed the dam level to fall to 50% prior to the introduction of level 1 restrictions (Figure 27). During the drought of 2001-2003, the Clarrie Hall Dam storage reduced to 35% triggering restrictions as follows:

- Dam capacity 50 % - level 1 restrictions imposed 28/10/02;
- Dam capacity 45 % - level 2 restrictions imposed 18/11/02;
- Dam capacity 35 % - level 3 restrictions imposed 5/2/03; and
- All restrictions lifted 27/2/2003.

During this drought, a reduction of 23% in demand was achieved compared to pre-drought conditions (MWH, 2009b). Restrictions have not been imposed since that time.

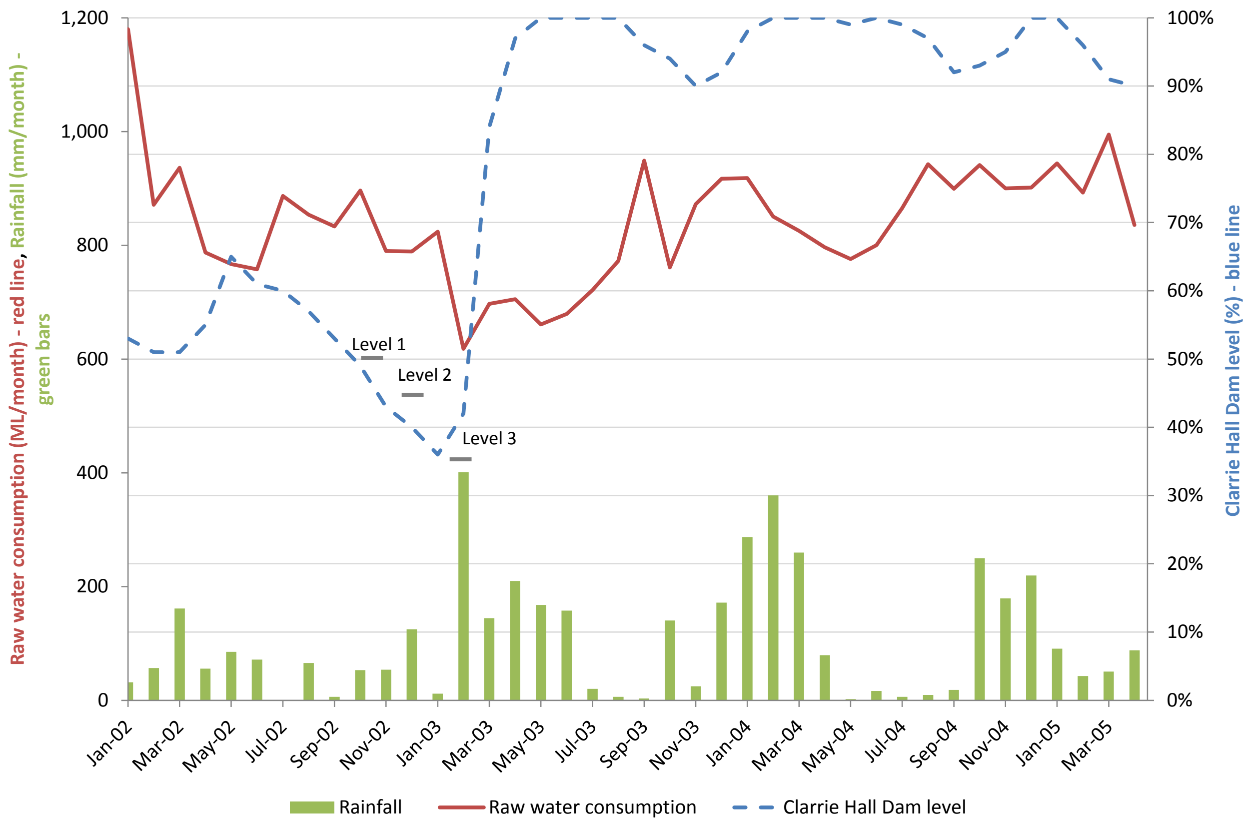

Figure 27: Clarrie Hall Dam level, consumption, rainfall and restrictions during the 2002/03 drought

Showerhead Giveaway

In June 2004, TSC conducted an education initiative aimed at motivating householders to reduce greenhouse gas emissions and water consumption. To enhance the outcomes of the project, TSC secured an agreement with NECO Hardware to give away 1,000 AAA rated showerheads at no cost to Council during November 2005. This is estimated to have reduced consumption from these householders by 15 ML/a (based on 15 kL/a savings for each showerhead assumed in Section 6.4.2).

6.4.4 NSW Government Actions

NSW Waterwise Program

The NSW Waterwise program was launched in 1993. A complementary program was introduced by TSC in 1995 including review of the water pricing structure. North Coast councils joined forces to implement a regional Waterwise campaign in 1994.

Activities undertaken in the Tweed Shire included:

- Television, newspaper and radio advertising;
- Plumbers training courses;
- School education and resource kits;
- Water conservation rating and labelling system (A to AAA depending on water efficiency); and
- National Water Week

As a result of the NSW Waterwise program, dual flush toilets became compulsory in October 1994 for all residential buildings in country NSW.

State Government Rebates

The NSW Home Saver Rebates Program (formerly the Residential Rebates Program) was funded by the NSW Government under the Climate Change Fund. One in eight NSW households received a rebate for climate-friendly hot water systems, ceiling insulation, dual flush toilets, rainwater tanks, water efficient washing machines or hot water circulators. The program commenced on 1 July 2007 and ended on 30 June 2011. The number of rebates taken up within the Tweed water supply areas have been estimated from data published by OEH (2016):

- Rainwater tanks 2,000 – 3,999L: 111
- Rainwater tanks 4,000 – 6,999L: 173
- Rainwater tanks >7,000L: 317
- Dual flush toilets: 124
- Washing machines: 985

7. TOTAL SHIRE DEMAND COMPARED TO FORECAST

Long-term demand forecasts for the TSC water supply systems were prepared in 2014 (Hydrosphere Consulting, 2014) incorporating a range of information including:

- Customer numbers;
- Water consumption;
- Regional growth predictions; and
- Demand management/water efficiency programs.

The total TSC historical demand is compared to the demand forecast for the baseline forecast and the recommended scenario from the 2009 DMS (MWH, 2009a) as well as the 2014 average year demand forecast (Hydrosphere Consulting, 2014) in Figure 28. The high rate of population growth assumed in the 2009 DMS has not been realised and demand has generally been significantly lower than predicted by the DMS apart from during 2010. Demand in 2015 and 2016 was also lower than predicted by the current (2014) demand forecast. Year-to-year climate influences are discussed in Section 3.2.2

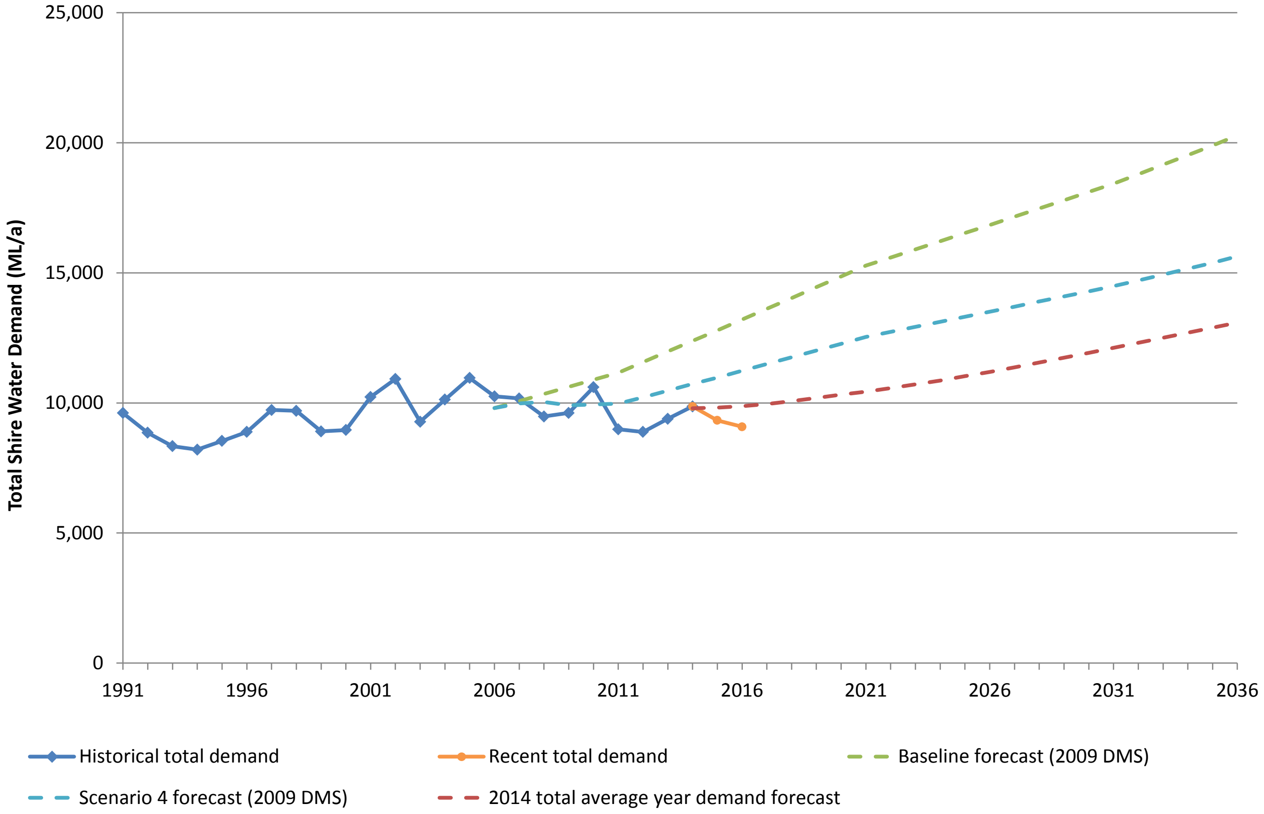

Figure 28: Comparison of Shire-wide historical demand, recent demand and the 2009 and 2014 demand forecasts

8. BENCHMARKING

The NSW Office of Water has collected and analysed performance data for water and sewerage schemes in NSW since 2002/03. The most recent data have been published for 2014/15.

8.1 Residential Demand

Residential demand data from the NSW performance monitoring reports are given in Figure 29. Since 2012, residential demand per property in Tweed Shire has been on average 7% higher than other NSW water utilities of a similar size. As shown in Figure 29, there is a wide range of demand across the State and Tweed is close to the median.

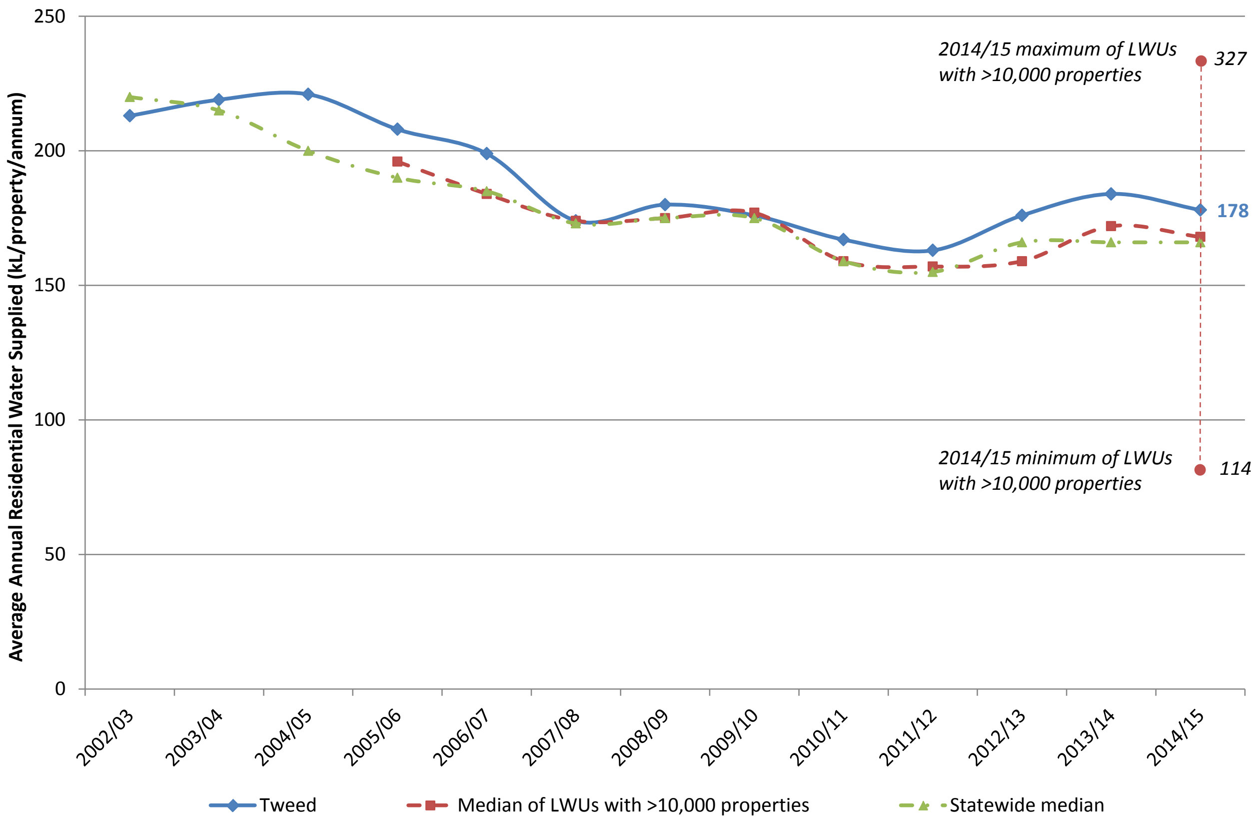

Figure 29: Residential water demand

A comparison of average residential water demand with other LWUs in the region is given in Table 23. Tweed Shire residents have similar demand compared to other customers in the region apart from Lismore residents who use significantly less water.

Table 23: Comparison of average annual residential water demand in the region (2014/15)

LWU	No. of water supply connected properties	Average annual residential water supplied (kL/property/a)
Tweed	**32,240**	**178**
Byron	11,220	180
Ballina	14,360	181
Lismore	14,320	155
Median of NSW LWUs with >10,000 properties		*170*
Richmond Valley	7,140	172
NSW State Median		*166*
Gold Coast City Council	222,000	173
Median – Regional LWUs		*176*

Source: DPI Water (2016), BOM (2016)

8.2 Pricing

Performance monitoring data on residential charges, bills and cost recovery from 2014/15 are presented in Table 24. The current (2016/17 water supply tariffs are presented in Table 25. Water supply pricing in Tweed Shire is generally higher than other water utilities in the region but significantly lower than the price of water in Lismore and the Gold Coast.

Table 24: Comparison of water supply tariffs in the region (2014/15)

LWU	No. of water supply connected properties	Fixed charge ($ p.a.)	Usage Charge Step 1 (c/kL)	TRB* ($ per assessment p.a.)	Residential revenue from usage charges (%)
Tweed	**32,240**	**148**	**245**	**584**	**75**
Byron	11,220	155	232	574	73
Ballina	14,360	189	202	555	66
Lismore	14,320	204	299	666	70
Median of NSW LWUs with >10,000 properties		*174*	*212*	*574*	*70*
Richmond Valley	7,140	127	194	460	75
Gold Coast City Council	222,000	212	380	866	N/R
Median – Regional LWUs		*172*	*239*	*579*	*73*

* Typical Residential Bill (TRB) – calculated from the average annual residential consumption

Source: DPI Water (2016), BOM (2016), City of Gold Coast (2014)

Table 25: Comparison of water supply tariffs in the region (2016/17)

LWU	Fixed charge ($ p.a.)	Usage Charge Step 1 (c/kL)
Tweed	**$166.45**	**$2.85**
Byron	$179.00	$2.47
Ballina	$200.00	$2.14
Lismore	$248.32	$3.41
Richmond Valley	$139.00	$2.12
Gold Coast City Council	$212.08	$3.83
Median – Regional LWUs	*$189.50*	*$2.66*

8.3 Water Losses

Benchmarking data on real losses (leakage) and NRW are provided in Table 26. The Infrastructure Leakage Index (ILI) is used as an indicator of how effectively real losses are being managed at the current operating pressure while accounting for other factors such as length of mains, number of service connections and customer meter location. The ILI is calculated from the ratio of the Current Annual Real Losses (CARL) to the Un-Avoidable Real Losses (UARL). CARL is the annual real losses divided by the number of service connections and percent of time the system is under pressure. UARL is a function of length of mains, number of service connections and average system pressure. An ILI of 1.0 indicates that only unavoidable losses are occurring and that optimum leakage management is in place (DPI Water, 2016).

Leakage from Tweed Shire's water supply systems is comparable to other water utilities in the region and NSW LWUs of a similar size.

Table 26: Comparison of water losses (2014/15)

LWU	Real losses (leakage) (L/connection/d)	Leakage (kL/km/d)	ILI	NRW (L/connection/d)
Tweed	**60**	**1.6**	**1.0**	**87**
Byron	50	2.2	1.2	67
Ballina	160	6.0	2.7	154
Lismore	40	1.5	1.0	78
Median of NSW LWUs with >10,000 properties	*60*	*2.0*	*1.0*	*N/R*
Richmond Valley	80	2.8	2.4	106
Gold Coast City Council	77	3.7	1.1	N/R
Median – Regional LWUs	*69*	*2.5*	*1.2*	*87*

Source: DPI Water (2016), BOM (2016)

N/R = not reported

8.4 Recycled Water

Data on volume of water recycled (as a percentage of treated sewage effluent) is given in Table 27. While the volume of water recycled is higher than other LWUs in the region apart from the Gold Coast, the percentage of treated effluent recycled in Tweed Shire is generally lower than other LWUs in the region. Recycling schemes related to other NSW LWUs in the region include open space irrigation, agricultural uses, nursery irrigation, construction and urban dual reticulation (toilet flushing at public facilities) and wetland regeneration. Class A+ recycled water is currently available to dual reticulated properties within the Pimpama-Coomera Waterfuture Master Plan region although Gold Coast City Council will be staging the closure of the scheme due to the high cost to the council and the community. Ballina Shire Council has recently commenced supply of recycled water to some urban areas.

Table 27: Water recycled

LWU	Water recycled (urban and agriculture) (ML)	
	2013/14	2014/15
Tweed	**604 (9.1%)**	**551 (6.9%)**
Byron	478 (15%)	444 (14%)
Ballina [1]	273 (9.5)	517 (9.6%)
Lismore	34 (1.0%)	5 (0.1%)
Richmond Valley	425 (22%)	420 (23%)
Gold Coast City Council [2]	8,931 (18%)	7,269 (13%)
Median – Regional LWUs	*452 (12%)*	*481 (11%)*

Source: DPI Water (2016), BOM (2016)

1. Volume of water recycled is expected to increase in Ballina with the commencement of the urban recycling scheme.
2. Volume of water recycled is expected to decrease in the Gold Coast with the closure of the Ballina urban recycling scheme.

9. CONCLUSIONS

Water efficiency has been a key component of TSC's water supply activities since the late 1980s with actions ranging from policies aimed at reducing water losses and increases in water supply pricing to significant expenditure on leak detection, water main replacement, rebates and water recycling. These earlier actions were implemented in response to data indicating high consumption and high water losses in the TSC water supply systems. Pricing has had a significant influence on demand with pay-for-use tariffs and higher costs proven to effectively encourage water savings.

Other State government initiatives such as BASIX and rebates also contribute to water savings in the Shire. The WELS program was introduced in 2005 by the Federal Government to encourage the purchase and installation of water efficient appliances and fixtures. The NSW government's BASIX program introduced in 2007 has also resulted in a significant (target 40%) reduction in water demand. The implementation of BASIX has achieved significant water savings in Tweed Shire (300 ML/a savings by 2015) through targeting discretionary outdoor water use and indoor non-potable end-uses and appears to have "picked much of the low-hanging fruit" in terms of water savings. The average per capita demand will continue to decrease with new development incorporating BASIX measures.

The more recent TSC DMS actions were implemented between 2012 and the present. During that time, water supply demand has fluctuated. The following general conclusions can be drawn from the demand data analysed:

- The dominant influence on demand appears to be climate. There is a strong correlation between high temperatures and high demand, with higher demand experienced with low rainfall and high temperatures and demand decreasing as more average conditions are experienced;
- Residential demand and municipal open space irrigation are most sensitive to climate which is expected to be related to outdoor (discretionary) uses; and
- The influences of climate appear to mask any water savings due to the implementation of demand management measures.

The estimated water savings and annualised costs of individual demand management actions are summarised in Table 28. The following general conclusions can be drawn regarding the cost-effectiveness and water efficiency of the demand management measures:

- The marginal cost of TSC's potable water supply is approximately $0.60 per kL. Of the residential rebates offered by TSC, the annualised cost data suggest that the rebates for showerheads and toilets are cost-effective as well as providing significant water savings;
- The investment in the Top 20/100 and Council top water users are very cost-effective compared to the cost of potable water, providing a cost savings to Council (saving $0.25 per kL saved);
- Many of the measures directly benefit the customer with regard to rebates and reduced water supply pricing although Council expenditure is high for low water savings. For example, the tapware rebate would be the most attractive to customers (saving $4.00 per kL of water saved) but these items provide low water savings (5 kL/a) for a relative high investment by Council (costing $1.60 per kL of water saved);
- The dual-flush toilet rebate has been the most cost-effective Council investment (costing $0.01 per kL of water saved) with high water savings (30 kL/a) and is also attractive to customers (saving $0.54 per kL of water saved). Dual-flush toilets have also been the most successful of the rebates in terms of customer take-up; and
- While recycling schemes would vary in water savings and cost-effectiveness, the Les Burger fields recycling scheme is expected to save a significant amount of water (14 ML/a) but costs more than potable water ($1.53 per kL).

Table 28: Summary of DMS expenditure and water savings

<table>
<tr><th>Measure</th><th>TSC Expenditure</th><th>Estimated Water Saving (ML/a)</th><th>Water Savings (kL/a per item)*</th><th>TSC Cost (per kL)</th></tr>
<tr><td>Top 20 water users</td><td>$98,266</td><td>34.7</td><td>1,650</td><td>-$0.25</td></tr>
<tr><td>Top 100 water users</td><td>$27,000</td><td>13.5</td><td>350</td><td>-$0.25</td></tr>
<tr><td>Murwillumbah pool leak repair</td><td>$10,000</td><td>1.825</td><td>1,825</td><td>-$0.18</td></tr>
<tr><td>BASIX</td><td>Minimal</td><td>297</td><td>N/A</td><td>0</td></tr>
<tr><td>Toilet rebate</td><td rowspan="4">$550,784</td><td>48.7</td><td>30</td><td>$0.01</td></tr>
<tr><td>Showerhead rebate</td><td rowspan="3">7.5</td><td>15</td><td>$0.13</td></tr>
<tr><td>Aerators/flow controllers rebate</td><td>5</td><td>$0.50</td></tr>
<tr><td>Tapware rebate</td><td>5</td><td>$1.60</td></tr>
<tr><td>Les Burger fields recycling scheme</td><td>$320,575</td><td>13.85</td><td>13,850</td><td>$1.53</td></tr>
<tr><td>Publicity and promotion</td><td>$21,000</td><td>Complementary action</td><td>N/R</td><td>N/R</td></tr>
<tr><td>Education and awareness</td><td>$62,800</td><td>Complementary action</td><td>N/R</td><td>N/R</td></tr>
<tr><td>Water loss management</td><td>$37,500</td><td>Flow measurement only</td><td>N/R</td><td>N/R</td></tr>
<tr><td>Staff training, resources and equipment</td><td>$168,344</td><td>Complementary action</td><td>N/R</td><td>N/R</td></tr>
<tr><td>Customer meter replacement</td><td>Not estimated</td><td>0</td><td>N/R</td><td>N/R</td></tr>
<tr><td>Pricing</td><td>Minimal</td><td>Complementary action</td><td>N/R</td><td>N/R</td></tr>
<tr><td>Policy development</td><td>Minimal</td><td>Complementary action</td><td>N/R</td><td>N/R</td></tr>
</table>

* For residential rebates, this refers to the water savings per fixture. For non-residential programs and recycling, this refers to the average water savings for each site.

N/A: data are not available

N/R: not relevant

Compared to other water utilities in the region:

- Tweed Shire residents have a similar demand apart from Lismore residents who use significantly less water:
- Tweed Shire residents pay a higher price for water apart from customers in Lismore and the Gold Coast;
- Leakage from Tweed Shire's water supply systems is similar; and
- While the volume of water recycled is higher than other LWUs in the region apart from the Gold Coast, the percentage of treated effluent recycled in Tweed Shire is generally lower than other LWUs in the region.

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APPENDIX 1: HISTORICAL DEMAND DATA

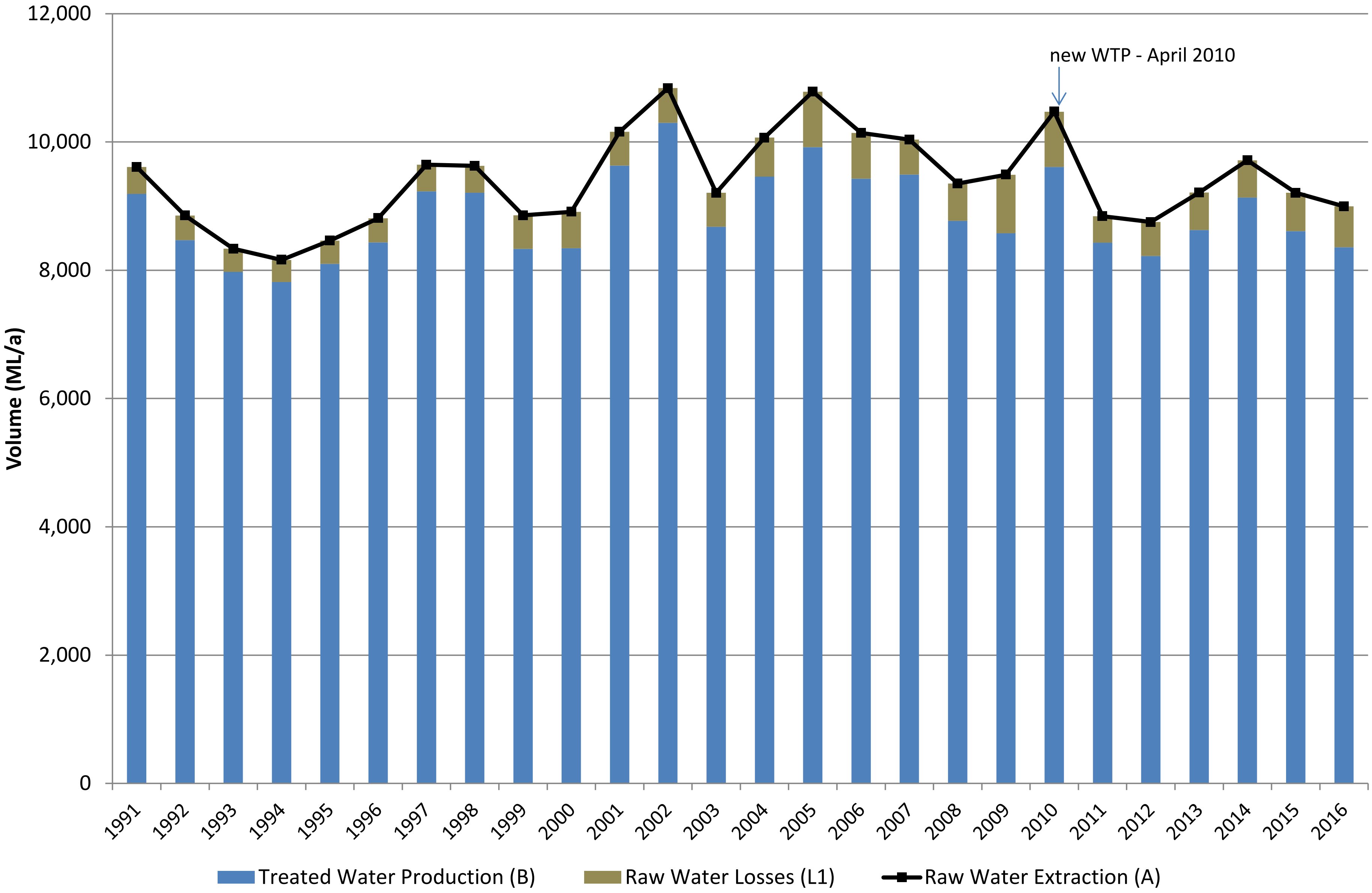

Figure 30: Raw water extraction, consumption and losses: Tweed District 1991 – 2016

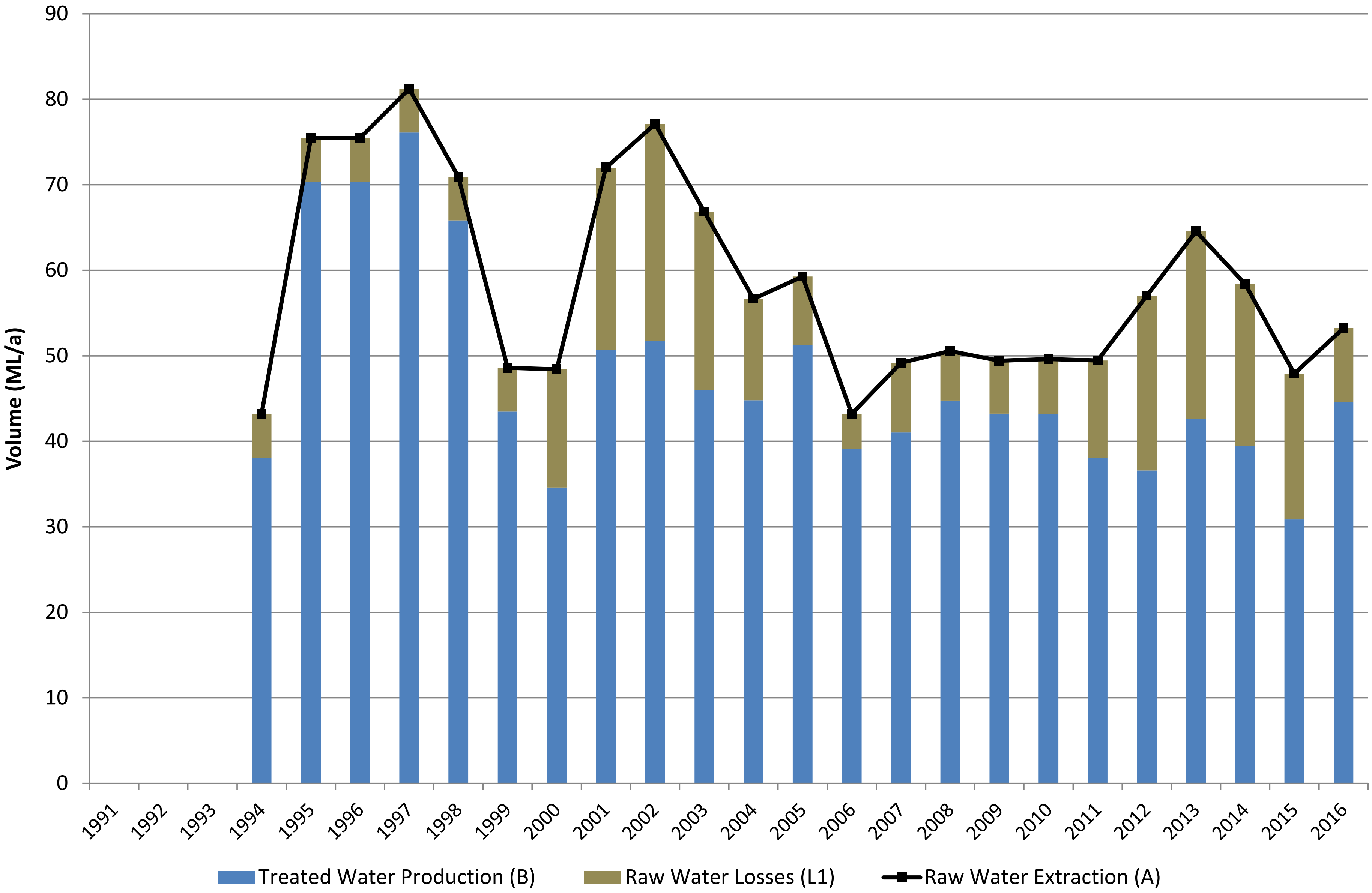

Figure 31: Raw water extraction, consumption and losses: Uki 1991 – 2016

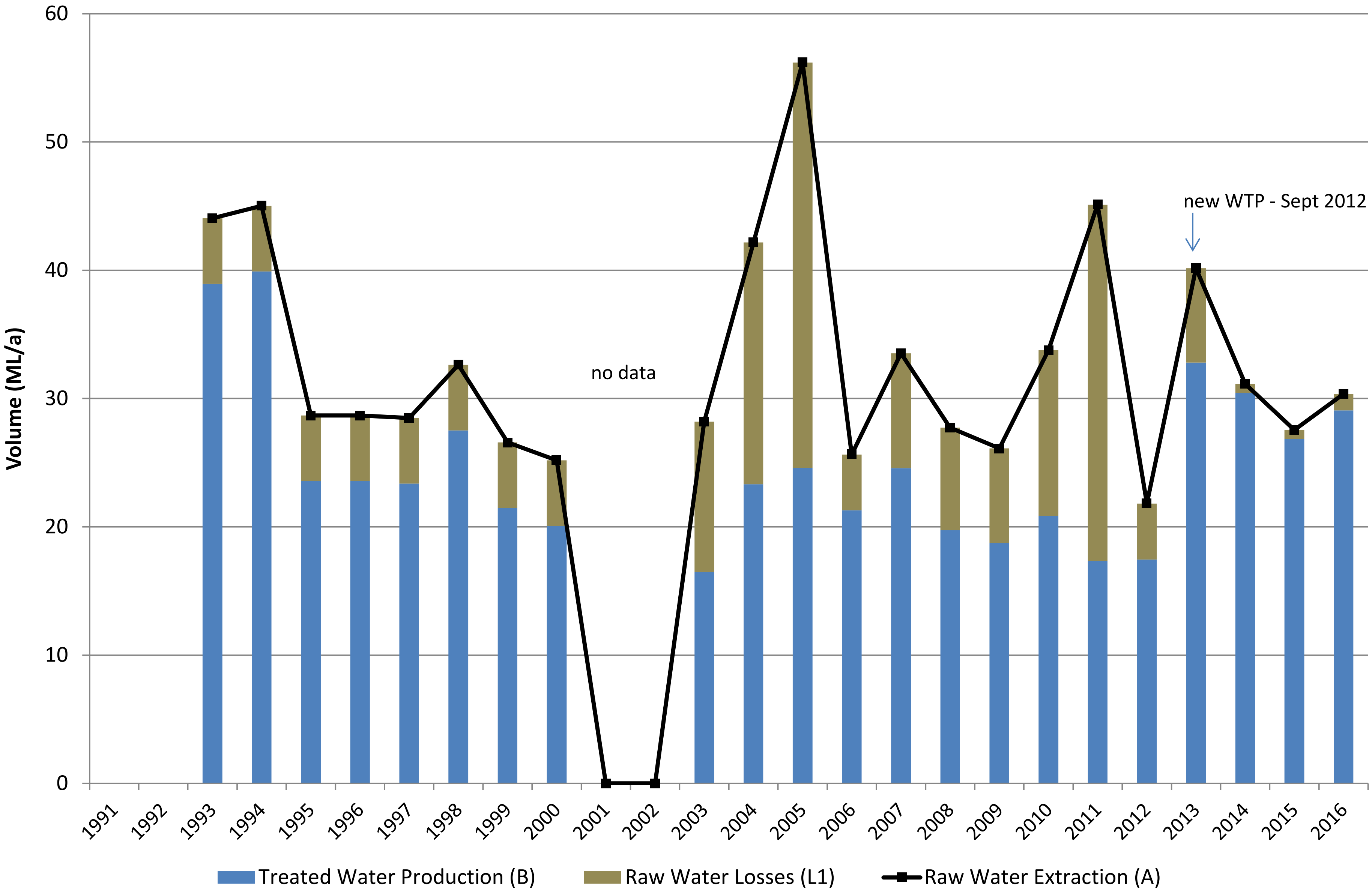

Figure 32: Raw water extraction, consumption and losses: Tyalgum 1991 – 2016

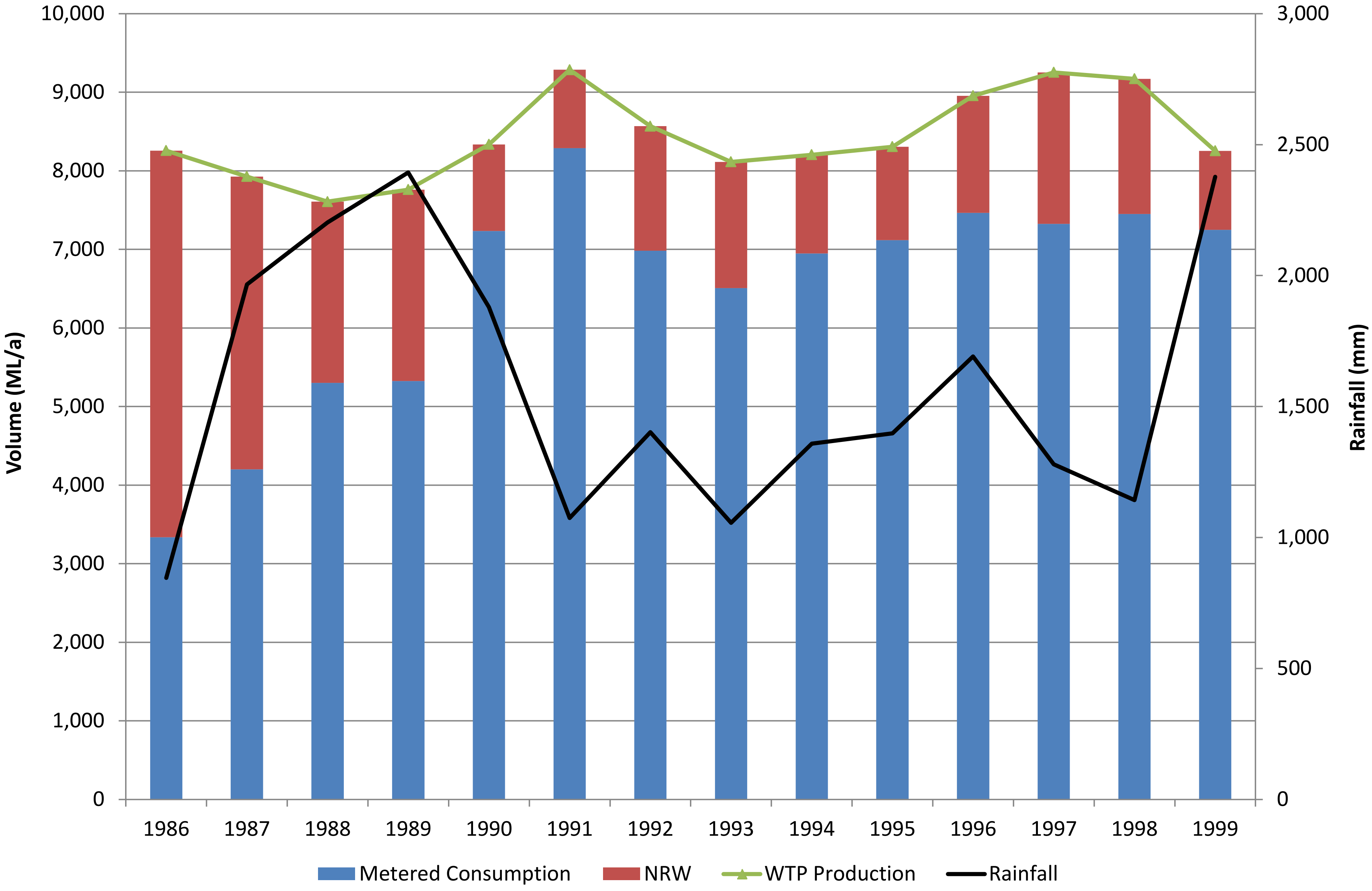

Figure 33: Treated water production, consumption and rainfall: Shire-wide 1986 - 1999

APPENDIX 2: CLIMATE DATA AND ANALYSES

Pottsville

Climate data for Pottsville (Data Drill for Lat, Long: -28.40 153.55 (decimal degrees), 28 24'S 153 33'E, elevation 14m) is presented below (SILO, 2016).

Table 29: Analysis of climate data – Pottsville

Data	2011		2012		2013		2014		2015		2016		Average 1970-2016
Annual rainfall (mm)	2,141	*125%*	2,039	*119%*	1,695	*99%*	920	*54%*	1,807	*106%*	1,478	*86%*	1,710
Rainfall comparison with average	*wetter*		*wetter*		*average*		*much drier*		*average*		*drier*		
Annual evaporation (mm)	1,378		1,478		1,579		1,740		1,702		1,736		1,540
Annual rainfall deficit (mm)	-762		-561		-116		820		-105		258		-170
Summer rainfall (mm)	803	*140%*	741	*129%*	895	*156%*	114	*20%*	893	*155%*	308	*54%*	574
Autumn rainfall (mm)	499	*89%*	517	*92%*	491	*88%*	363	*65%*	444	*79%*	360	*64%*	560
Winter rainfall (mm)	273	*98%*	504	*180%*	245	*88%*	194	*69%*	366	*131%*	548	*196%*	279
Spring rainfall (mm)	566	*191%*	277	*94%*	65	*22%*	249	*84%*	104	*35%*	262	*88%*	296
Summer max. temp (°C)	28.4	*100%*	27.6	*97%*	28.3	*99%*	28.7	*101%*	28.7	*101%*	28.5	*100%*	28.5
Temp. comparison with average	*average*		*colder*		*average*		*average*		*average*		*average*		
Autumn max. temp (°C)	25.2	*98%*	25.2	*98%*	25.2	*99%*	26.3	*103%*	26.2	*102%*	26.9	*105%*	25.6
Temp. comparison with average	*colder*		*colder*		*average*		*much hotter*		*hotter*		*much hotter*		
Winter max. temp (°C)	20.9	*98%*	20.8	*98%*	20.9	*98%*	22.2	*104%*	21.0	*99%*	21.4	*101%*	21.3
Temp. comparison with average	*colder*		*colder*		*colder*		*much hotter*		*average*		*average*		
Spring max. temp (°C)	24.6	*97%*	25.4	*100%*	25.8	*102%*	26.6	*105%*	25.9	*102%*	25.7	*101%*	25.4
Temp. comparison with average	*much colder*		*average*		*hotter*		*much hotter*		*hotter*		*average*		
Annual max. temp (°C)	33.5	*95%*	34.0	*96%*	34.5	*98%*	38.5	*109%*	37.5	*106%*	33.5	*95%*	35.4
Temp. comparison with average	*much colder*		*much colder*		*colder*		*much hotter*		*much hotter*		*much colder*		

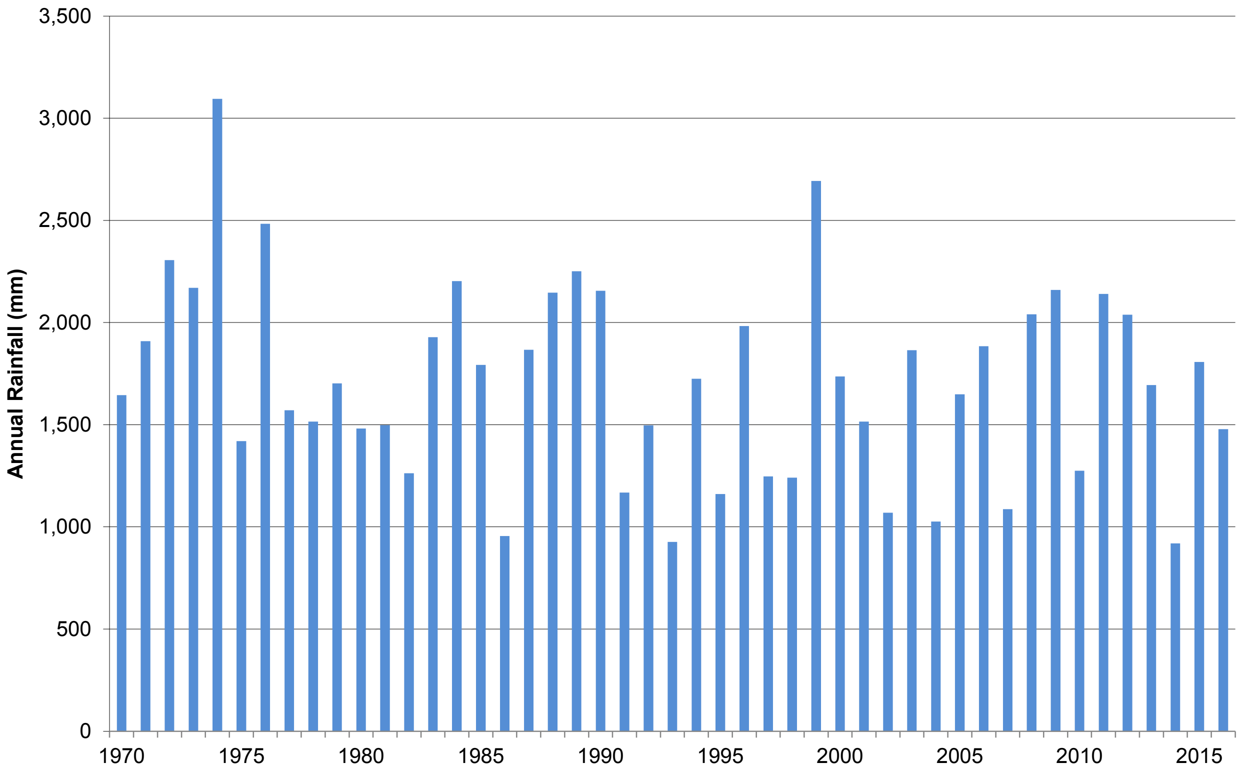

Figure 34: Annual rainfall 1970 – 2016: Pottsville

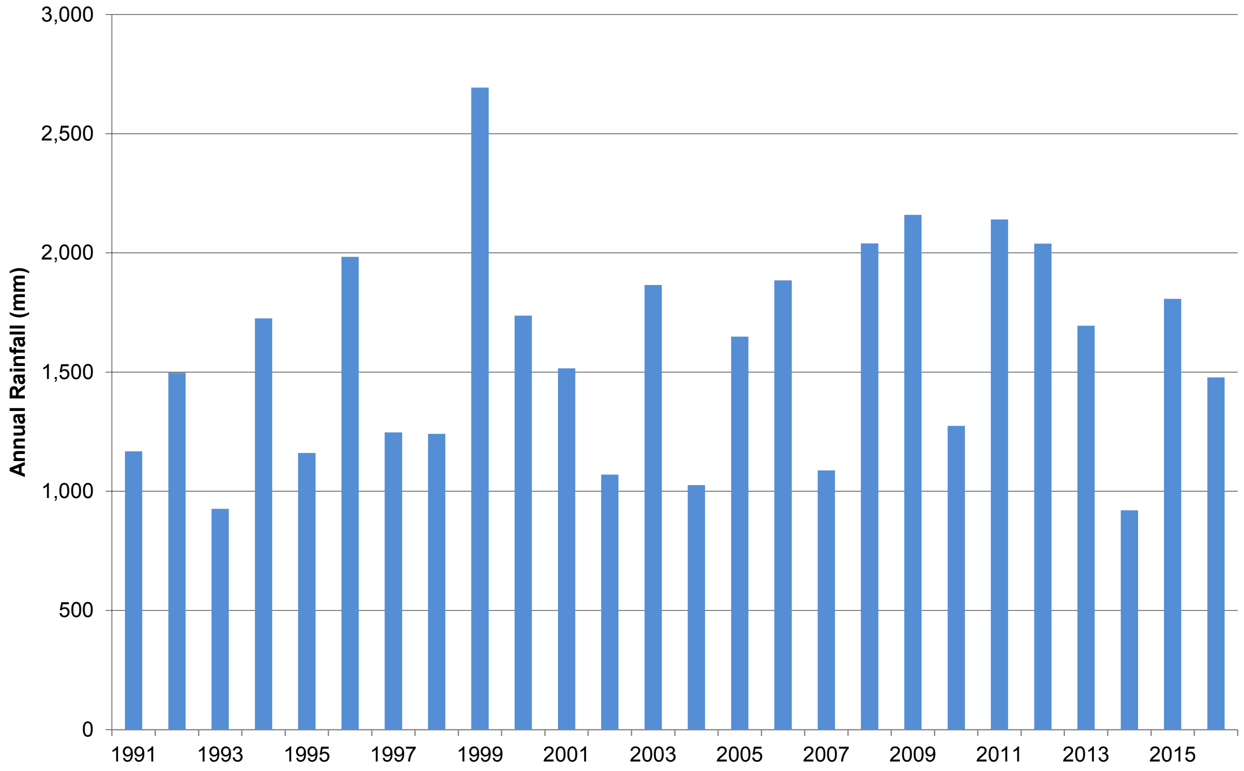

Figure 35: Annual rainfall 1991 – 2016: Pottsville

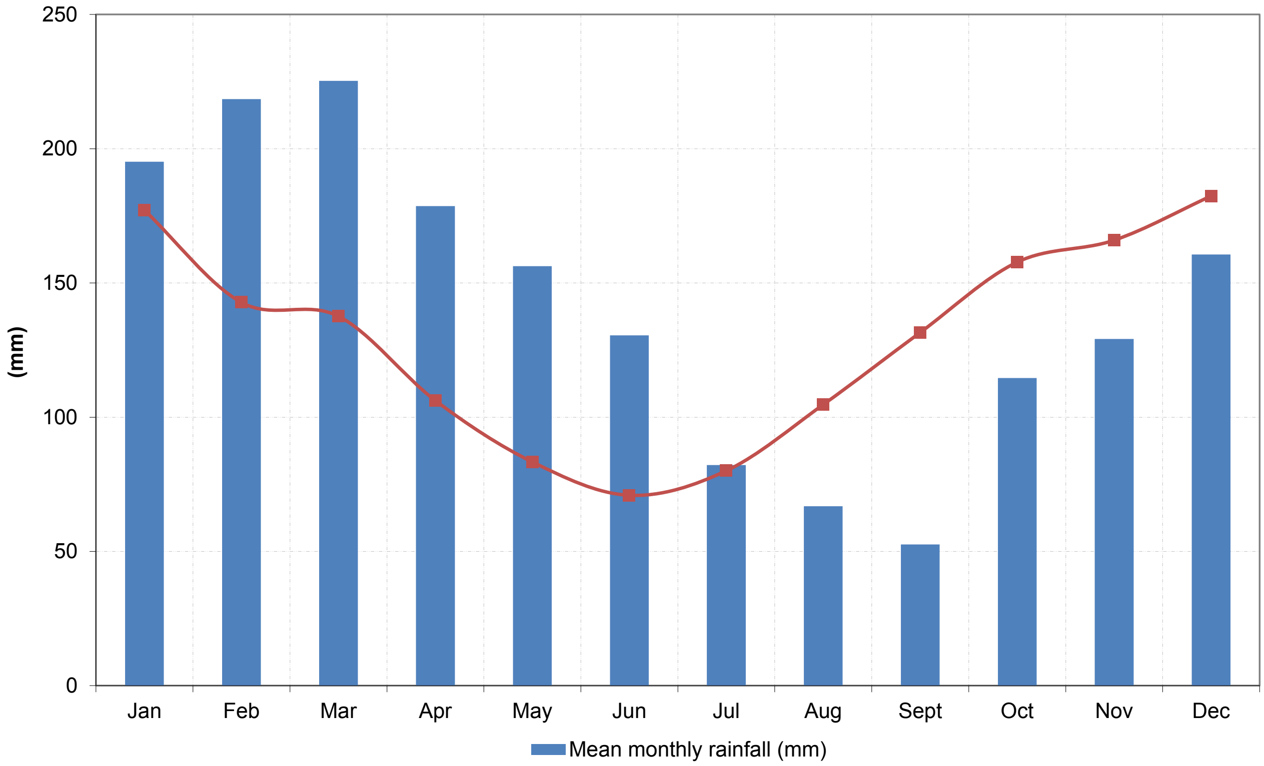

Figure 36: Monthly rainfall and evaporation 1970 - 2016: Pottsville

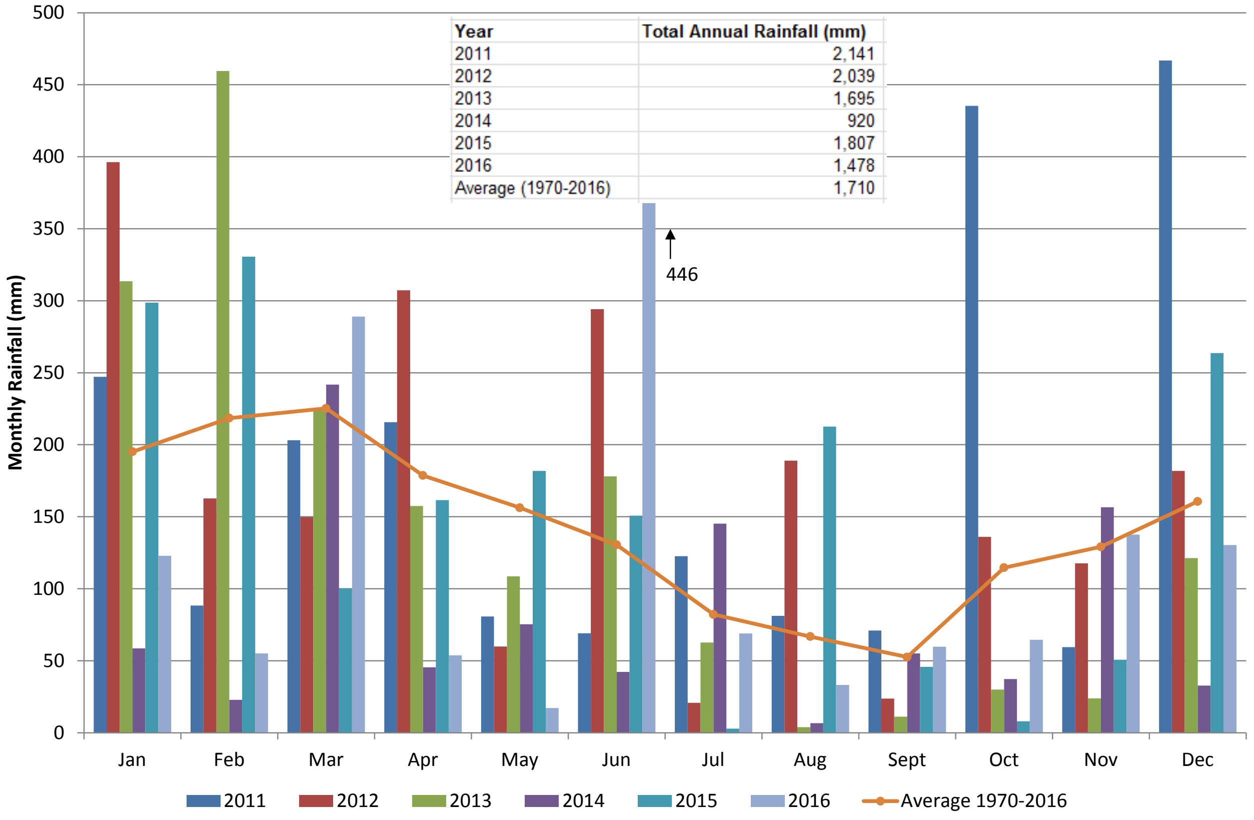

Figure 37: Monthly rainfall 2011 - 2016: Pottsville

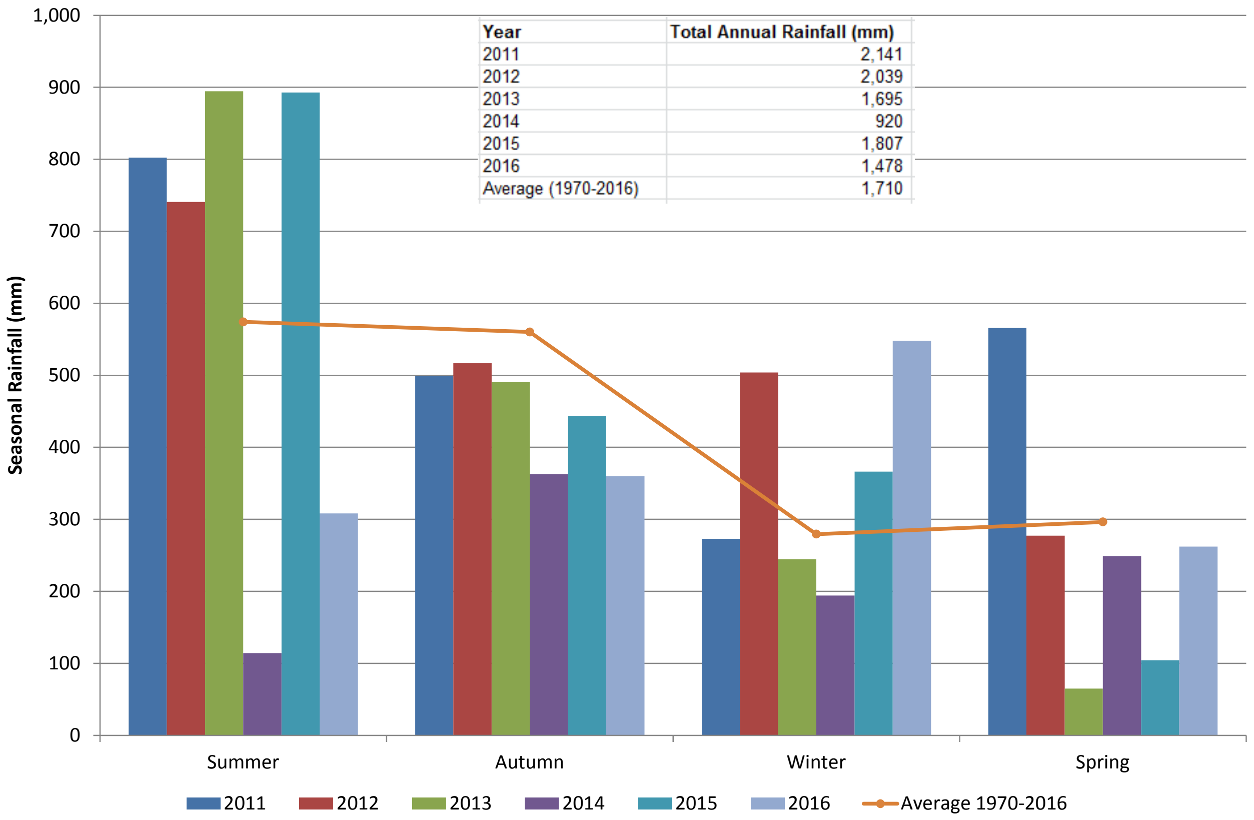

Figure 38: Seasonal rainfall 2011 - 2016: Pottsville

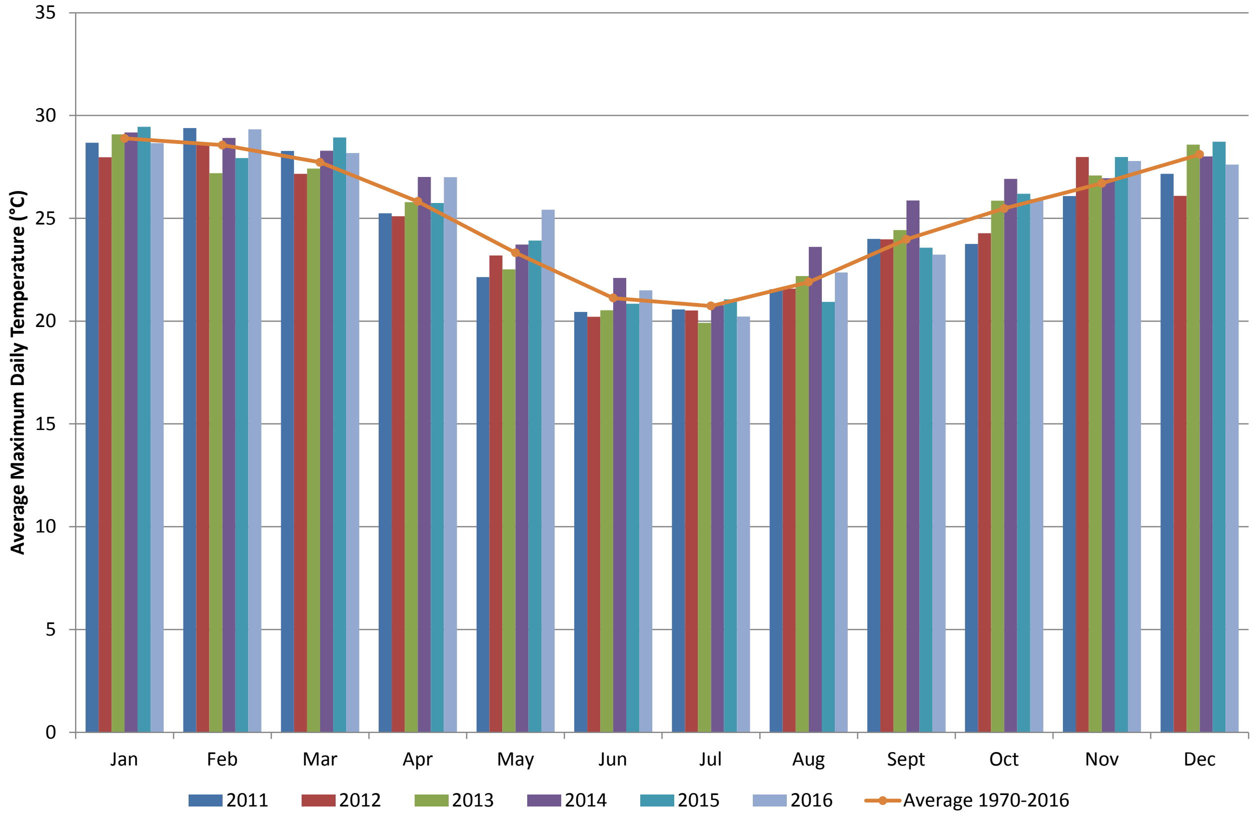

Figure 39: Monthly maximum daily temperature 2011 - 2016: Pottsville

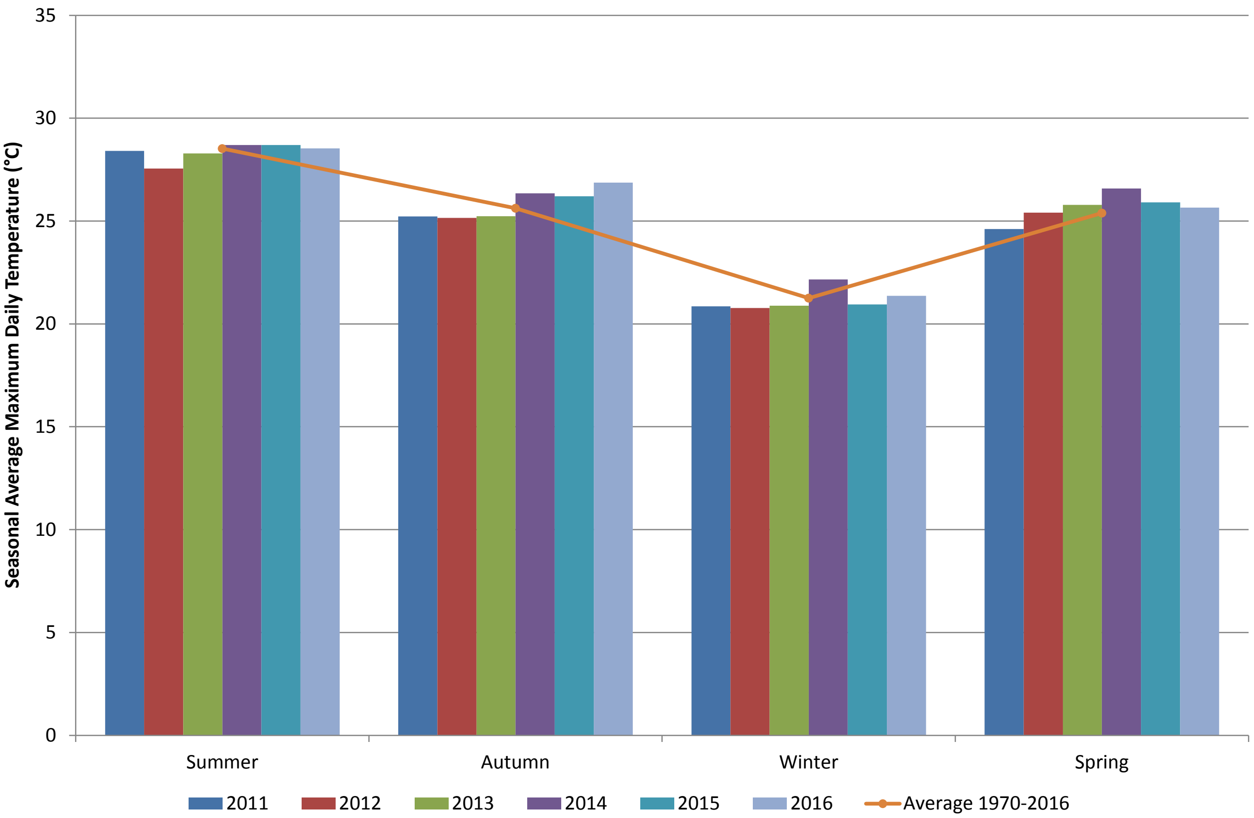

Figure 40: Seasonal maximum daily temperature 2011 - 2016: Pottsville

Banora Point

Climate data for Banora Point (Data Drill for Lat, Long: -28.20 153.55 (decimal degrees), 28 12'S 153 33'E, elevation 24m) is presented below (SILO, 2016).

Table 30: Analysis of climate data – Banora Point

Data	2011		2012		2013		2014		2015		2016		Average 1970-2016
Annual rainfall (mm)	2,284	*129%*	2,243	*127%*	2,069	*117%*	1,060	*60%*	2,296	*130%*	1,710	*97%*	1,768
Rainfall comparison with average	*much wetter*		*wetter*		*wetter*		*much drier*		*much wetter*		*average*		
Annual evaporation (mm)	1,375	*90%*	1,475	*96%*	1,579	*102%*	1,755	*112%*	1,715	*109%*	1,752	*112%*	1,548
Annual rainfall deficit (mm)	-909		-768		-489		694		-580		42		-219
Summer rainfall (mm)	768	*132%*	945	*162%*	867	*149%*	136	*23%*	1,244	*213%*	408	*70%*	583
Autumn rainfall (mm)	605	*106%*	636	*111%*	684	*120%*	384	*67%*	551	*97%*	356	*62%*	571
Winter rainfall (mm)	307	*105%*	494	*169%*	388	*133%*	237	*81%*	427	*146%*	662	*226%*	293
Spring rainfall (mm)	605	*188%*	167	*52%*	129	*40%*	303	*94%*	75	*23%*	284	*89%*	321
Summer max. temp (°C)	28.3	*100%*	27.7	*98%*	28.3	*100%*	28.7	*102%*	28.6	*101%*	28.6	*101%*	28.3
Temp. comparison with average	*average*		*colder*		*average*		*hotter*		*average*		*average*		
Autumn max. temp (°C)	25.3	*99%*	25.4	*99%*	25.4	*99%*	26.4	*103%*	26.3	*103%*	26.9	*105%*	25.6
Temp. comparison with average	*average*		*average*		*average*		*hotter*		*hotter*		*much hotter*		
Winter max. temp (°C)	21.1	*99%*	21.0	*99%*	21.2	*100%*	22.3	*105%*	21.2	*100%*	21.5	*101%*	21.3
Temp. comparison with average	*average*		*average*		*average*		*much hotter*		*average*		*average*		
Spring max. temp (°C)	24.7	*98%*	25.4	*101%*	25.5	*102%*	26.4	*105%*	25.7	*103%*	25.5	*102%*	25.1
Temp. comparison with average	*colder*		*average*		*hotter*		*much hotter*		*much hotter*		*hotter*		
Annual max. temp (°C)	33.0	*94%*	33.5	*96%*	35.0	*100%*	38.5	*110%*	37.0	*106%*	33.0	*94%*	35.0
Temp. comparison with average	*much colder*		*much colder*		*average*		*much hotter*		*much hotter*		*much colder*		

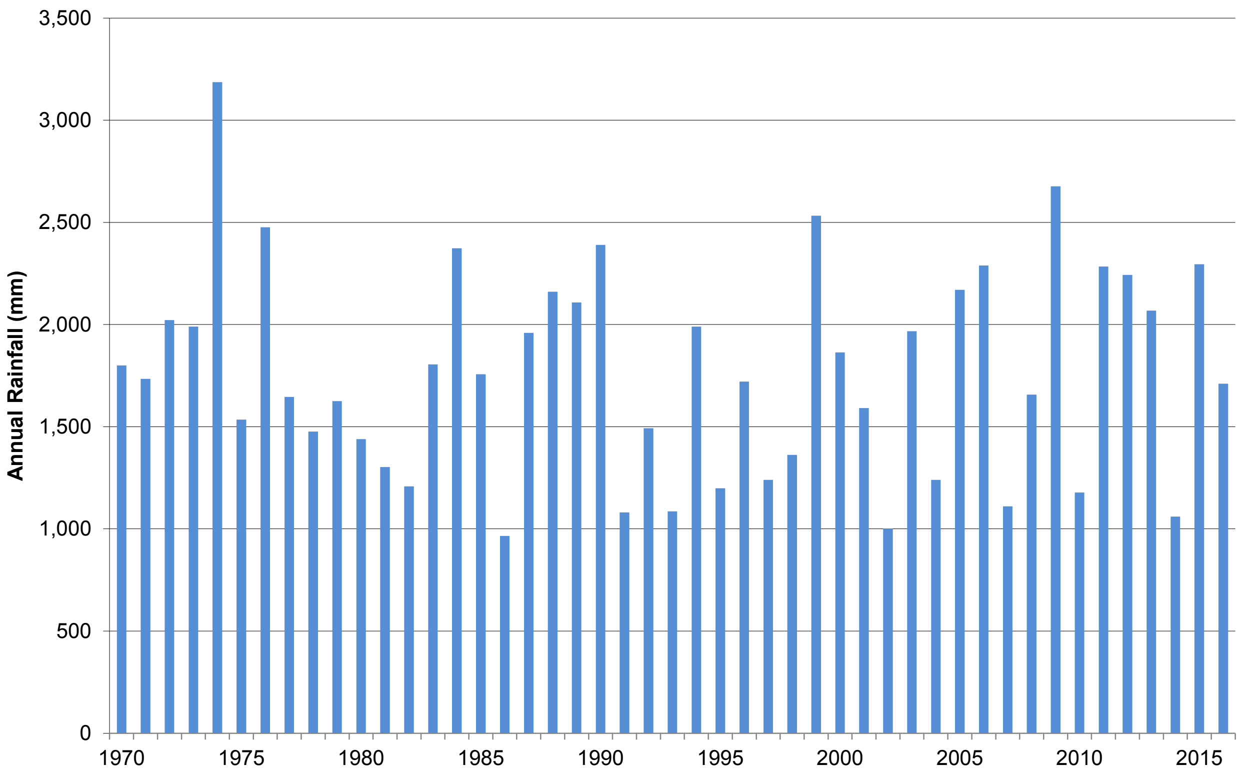

Figure 41: Annual rainfall 1970 – 2016: Banora Point

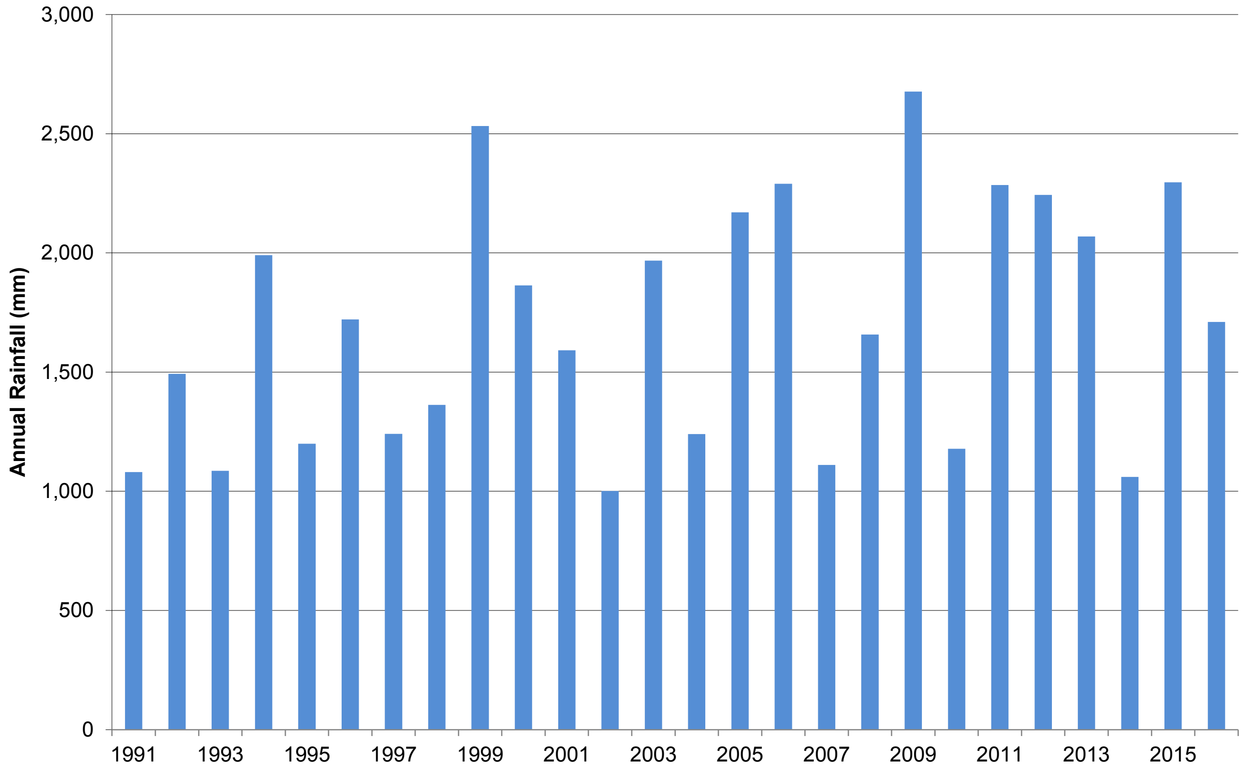

Figure 42: Annual rainfall 1991 – 2016: Banora Point

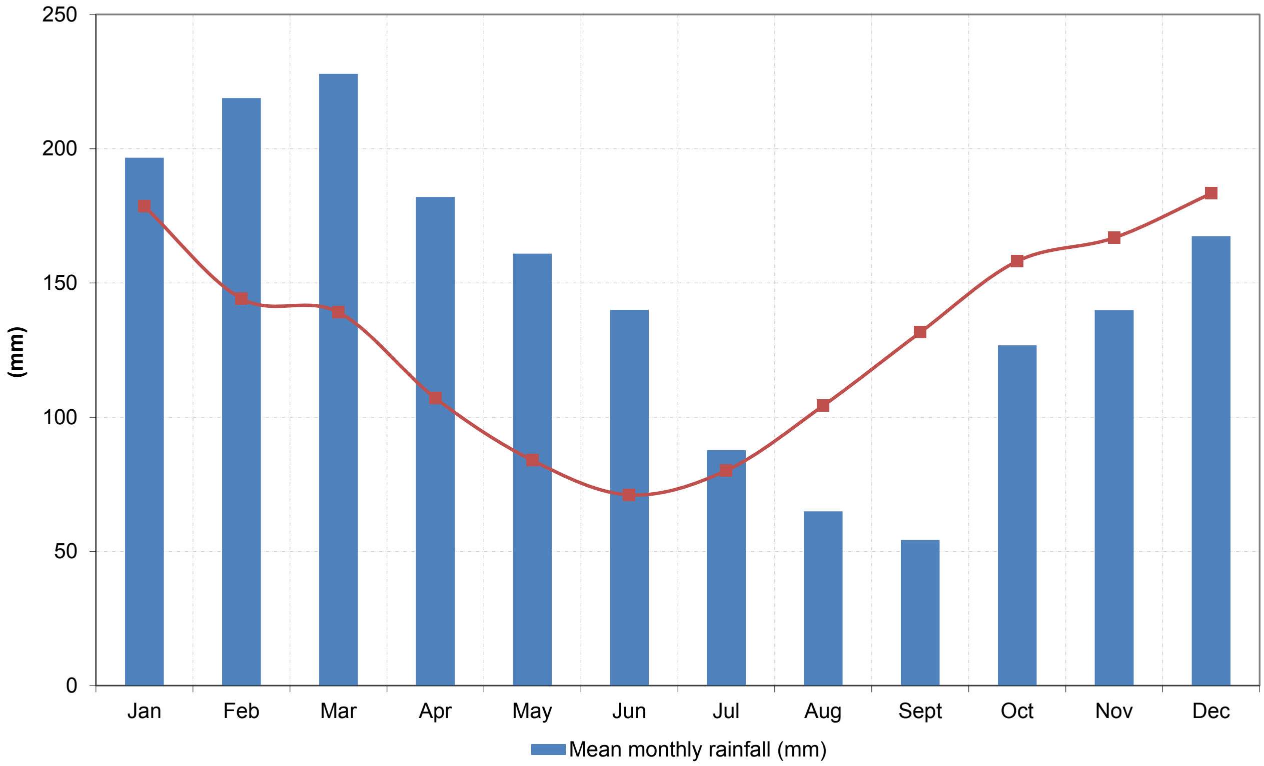

Figure 43: Monthly rainfall and evaporation 1970 - 2016: Banora Point

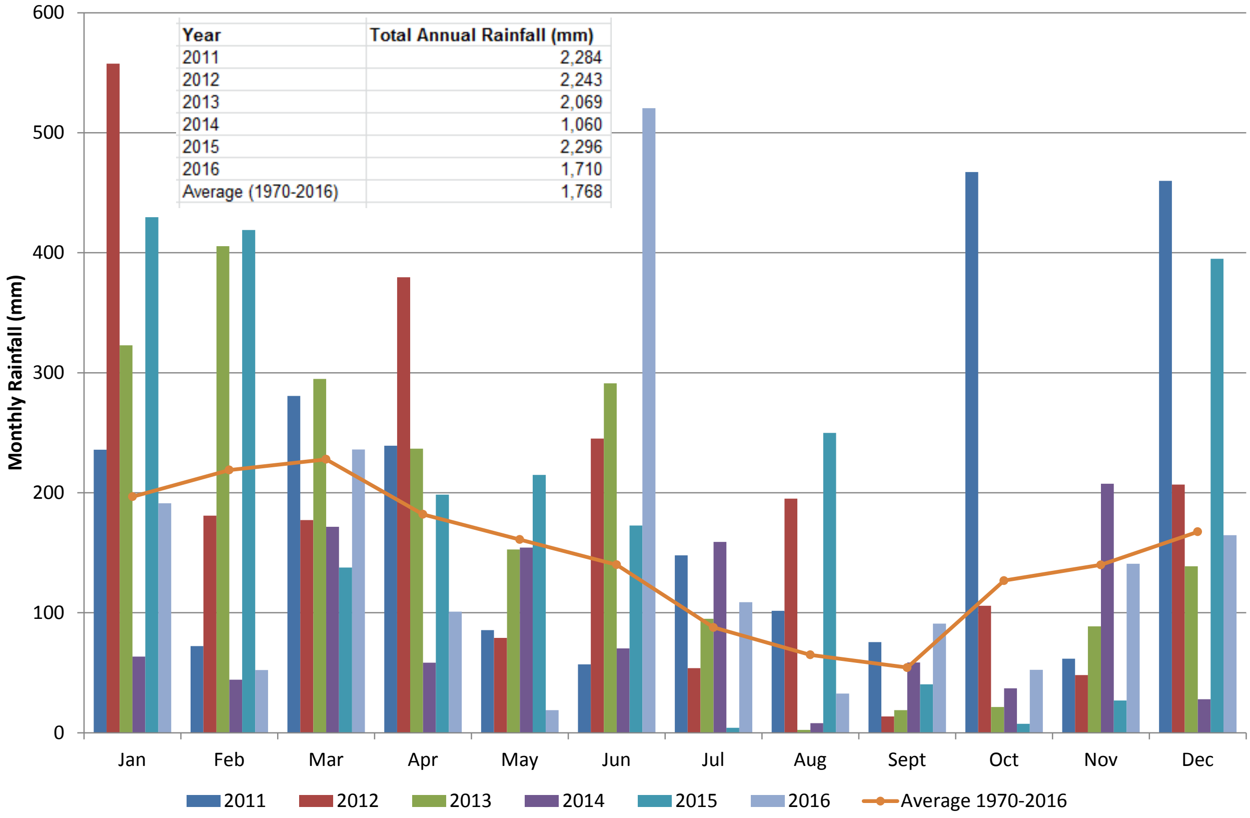

Figure 44: Monthly rainfall 2011 - 2016: Banora Point

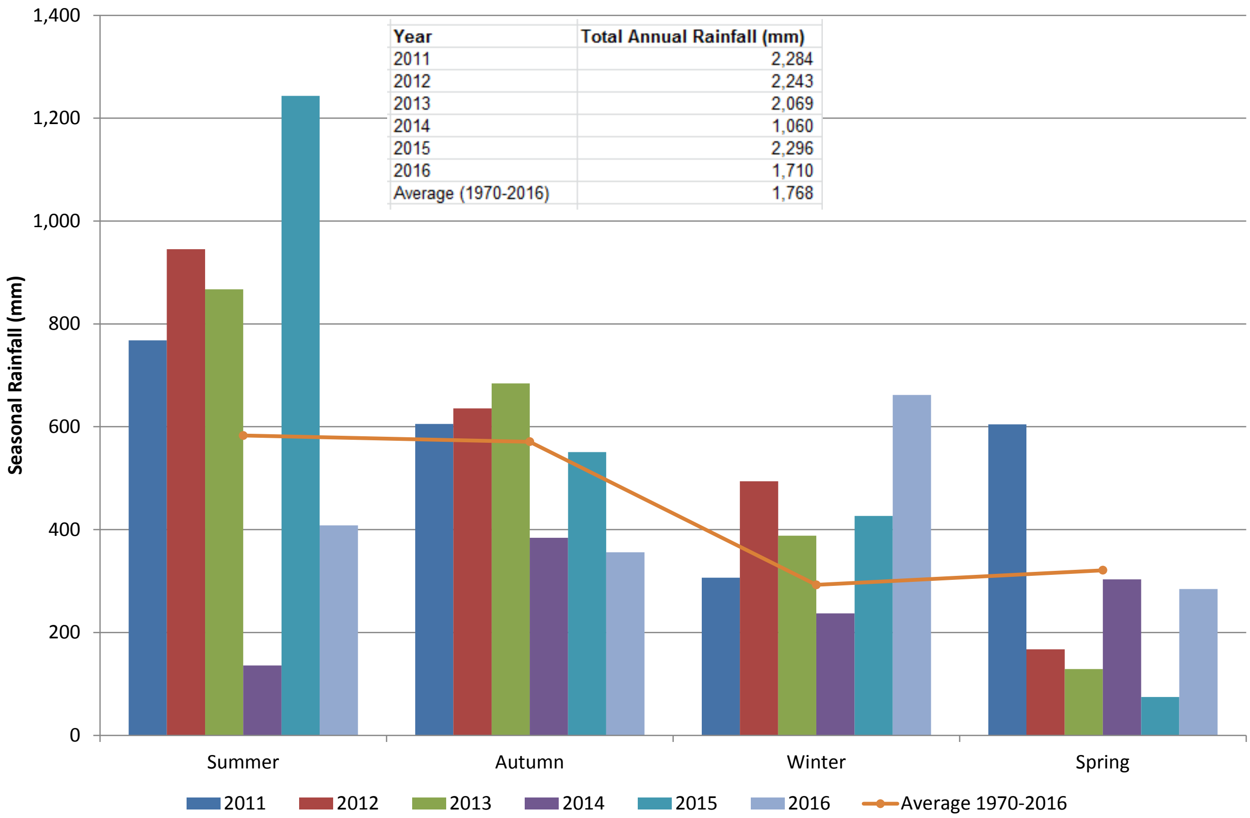

Figure 45: Seasonal rainfall 2011 - 2016: Banora Point

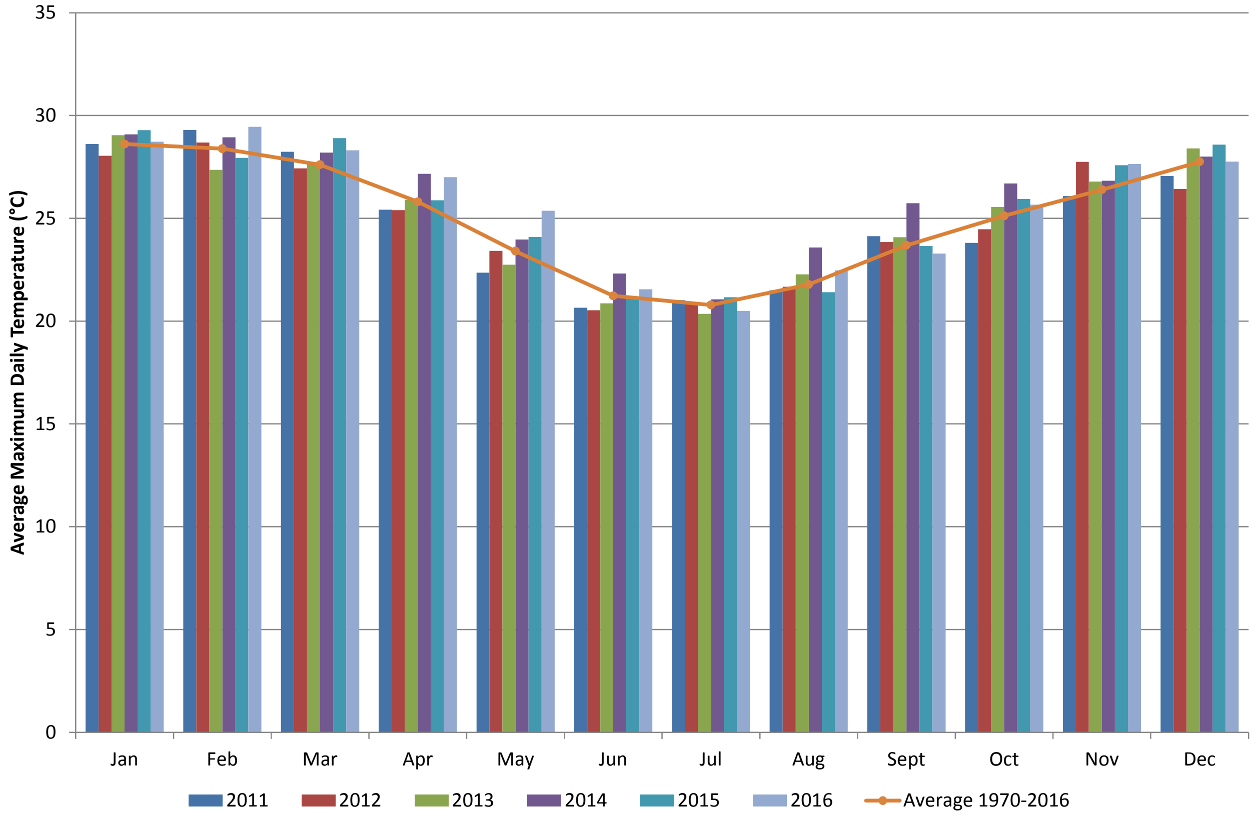

Figure 46: Monthly maximum daily temperature 2011 - 2016: Banora Point

Figure 47: Seasonal maximum daily temperature 2011 - 2016: Banora Point

Murwillumbah

Climate data for Murwillumbah (Data Drill for Lat, Long: -28.30 153.40 (decimal degrees), 28 18'S 153 24'E, elevation 55m) is presented below (SILO, 2016).

Table 31: Analysis of climate data – Murwillumbah

Data	2011		2012		2013		2014		2015		2016		Average 1970-2016
Annual rainfall (mm)	2,131	*126%*	2,180	*129%*	1,785	*106%*	971	*57%*	1,890	*112%*	1,509	*89%*	1,690
Rainfall comparison with average	*much wetter*		*much wetter*		*wetter*		*much drier*		*wetter*		*drier*		
Annual evaporation (mm)	1,365	*91%*	1,470	*97%*	1,574	*103%*	1,751	*114%*	1,713	*111%*	1,740	*113%*	1,521
Annual rainfall deficit (mm)	-766		-710		-210		780		-177		231		-169
Summer rainfall (mm)	876	*137%*	1,085	*169%*	1,050	*164%*	123	*19%*	964	*150%*	301	*47%*	640
Autumn rainfall (mm)	446	*84%*	433	*82%*	453	*85%*	426	*80%*	547	*103%*	433	*82%*	530
Winter rainfall (mm)	184	*80%*	394	*172%*	204	*89%*	154	*67%*	261	*114%*	526	*229%*	229
Spring rainfall (mm)	624	*215%*	267	*92%*	79	*27%*	269	*92%*	119	*41%*	250	*86%*	291
Summer max. temp (°C)	28.4	*98%*	27.8	*96%*	28.6	*99%*	29.1	*100%*	28.9	*100%*	29.0	*100%*	28.9
Temp. comparison with average	*colder*		*much colder*		*average*		*average*		*average*		*average*		
Autumn max. temp (°C)	25.2	*98%*	25.3	*98%*	25.2	*98%*	26.4	*102%*	26.3	*102%*	27.2	*105%*	25.8
Temp. comparison with average	*colder*		*colder*		*colder*		*hotter*		*hotter*		*much hotter*		
Winter max. temp (°C)	20.9	*97%*	20.9	*98%*	21.0	*98%*	22.3	*104%*	21.1	*99%*	21.5	*100%*	21.4
Temp. comparison with average	*much colder*		*colder*		*colder*		*much hotter*		*average*		*average*		
Spring max. temp (°C)	24.6	*95%*	25.9	*100%*	26.5	*102%*	27.2	*105%*	26.6	*102%*	26.2	*101%*	26.0
Temp. comparison with average	*much colder*		*average*		*hotter*		*much hotter*		*hotter*		*average*		
Annual max. temp (°C)	34.5	*94%*	34.0	*93%*	37.5	*103%*	39.0	*107%*	37.5	*103%*	34.0	*93%*	36.6
Temp. comparison with average	*much colder*		*much colder*		*colder*		*much hotter*		*hotter*		*much colder*		

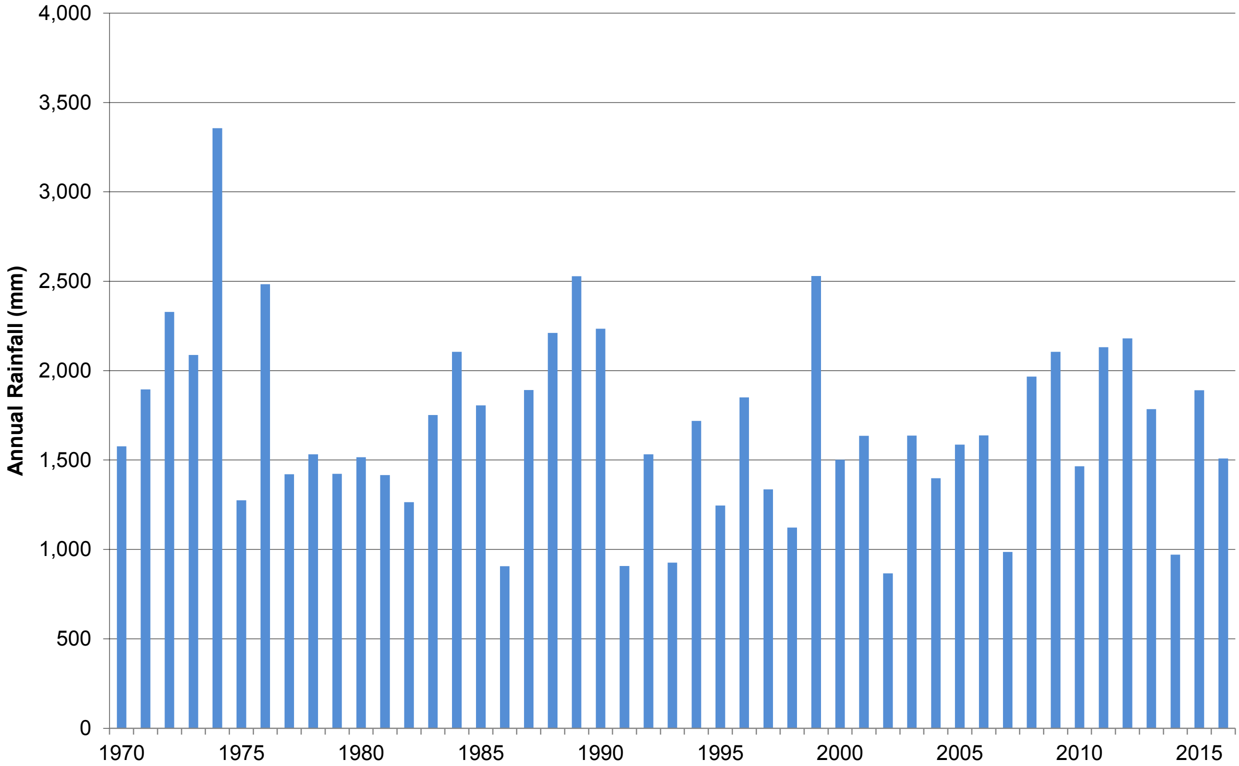

Figure 48: Annual rainfall 1970 – 2016: Murwillumbah

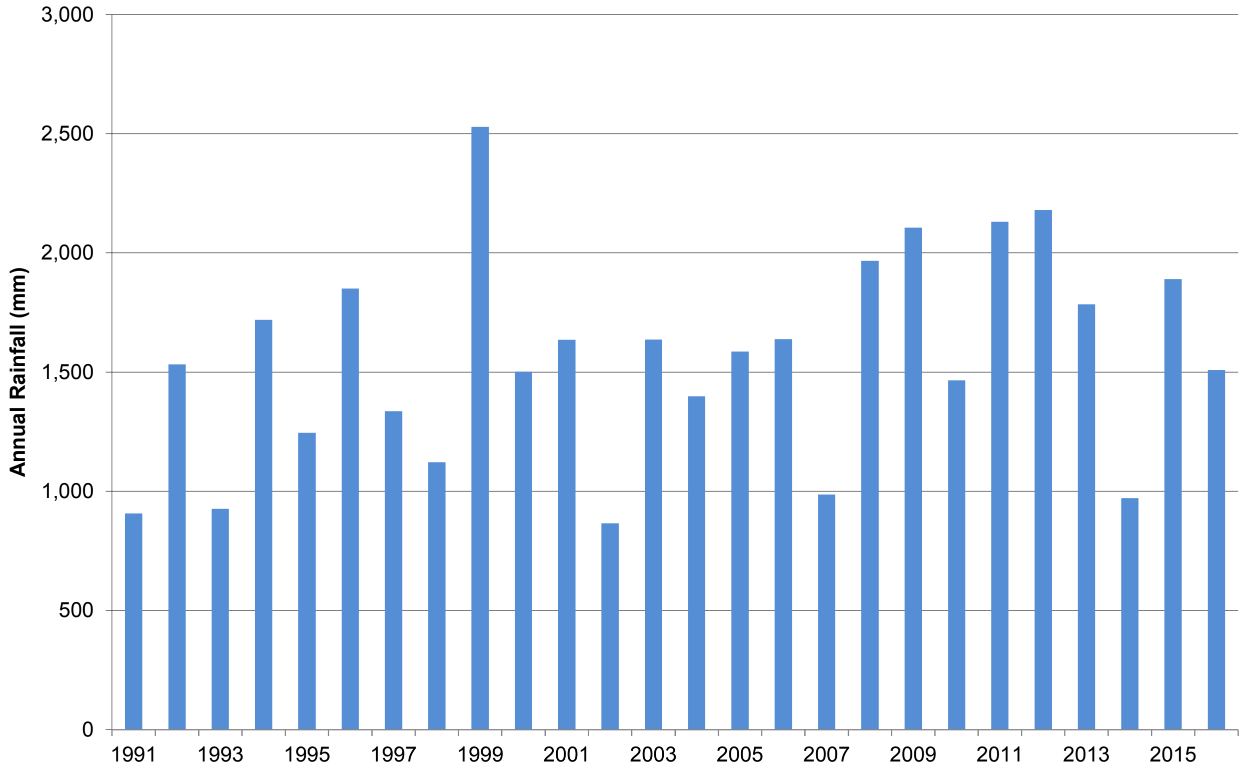

Figure 49: Annual rainfall 1991 – 2016: Murwillumbah

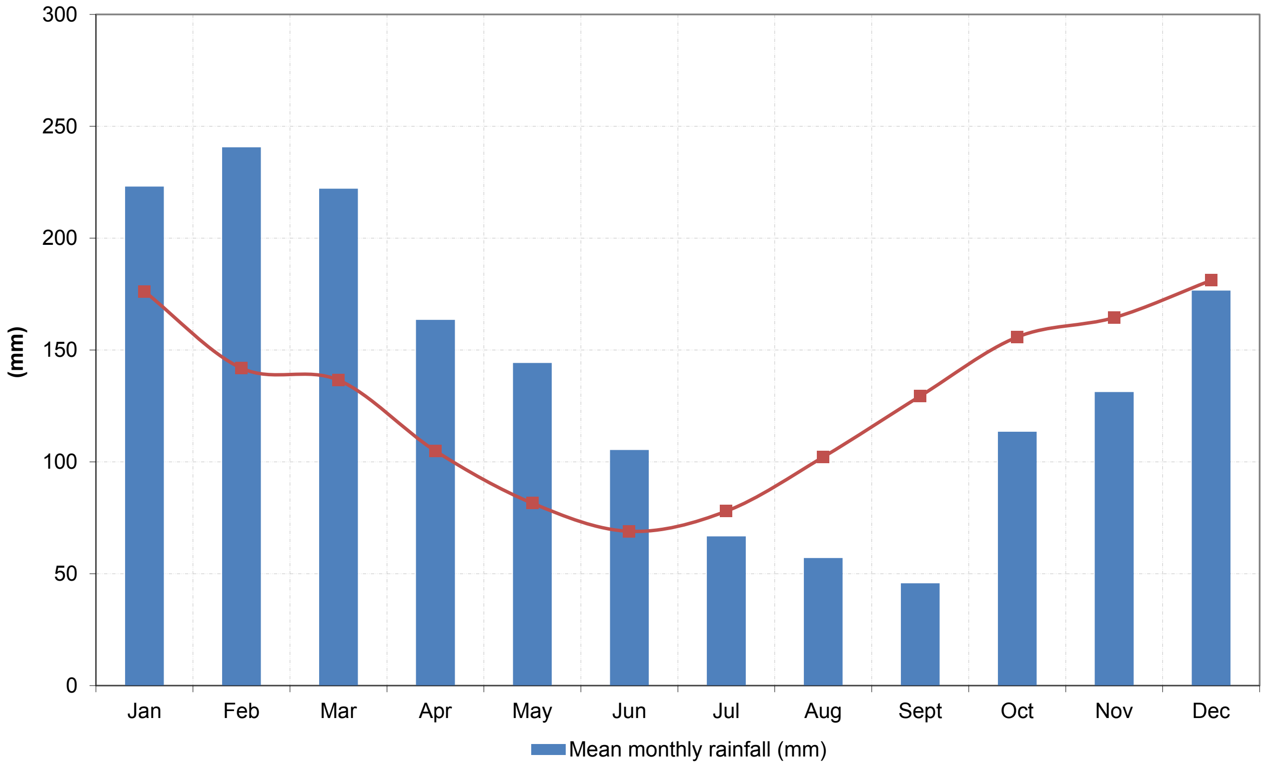

Figure 50: Monthly rainfall and evaporation 1970 - 2016: Murwillumbah

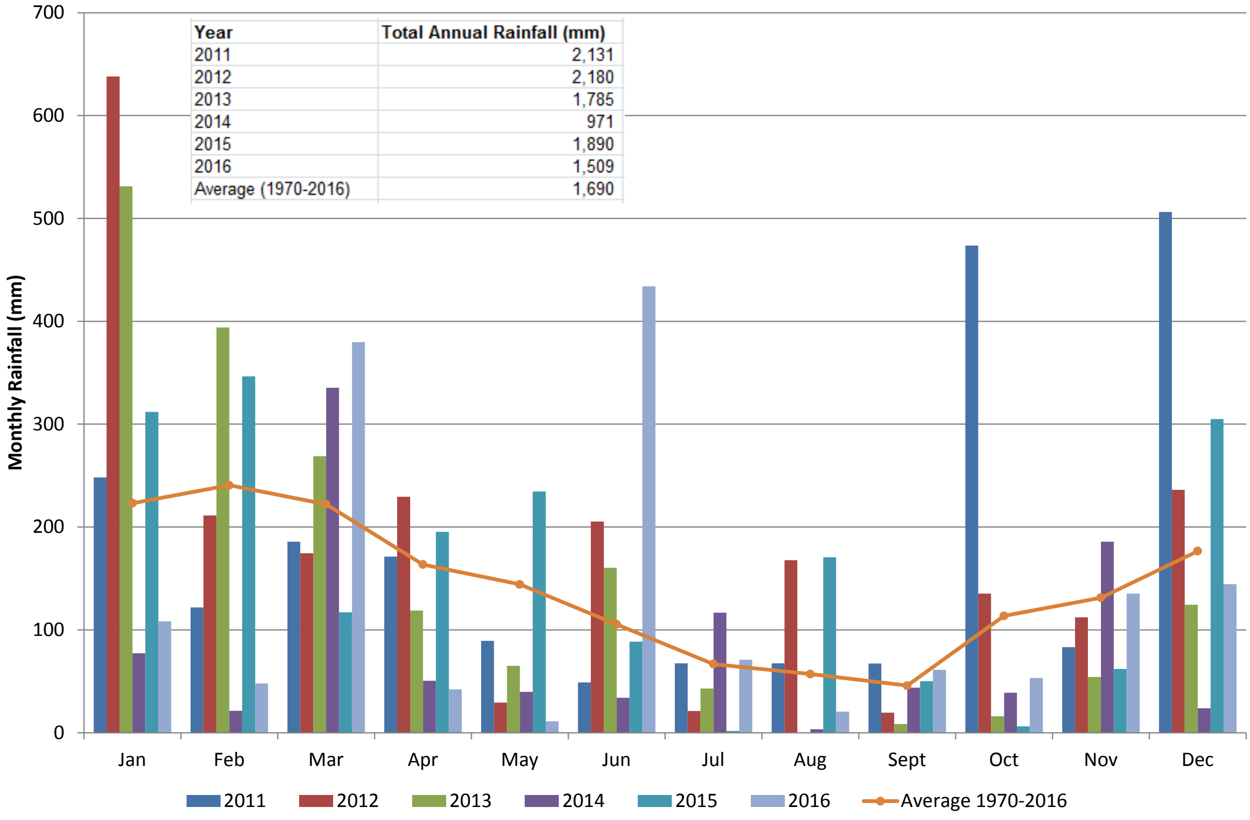

Figure 51: Monthly rainfall 2011 - 2016: Murwillumbah

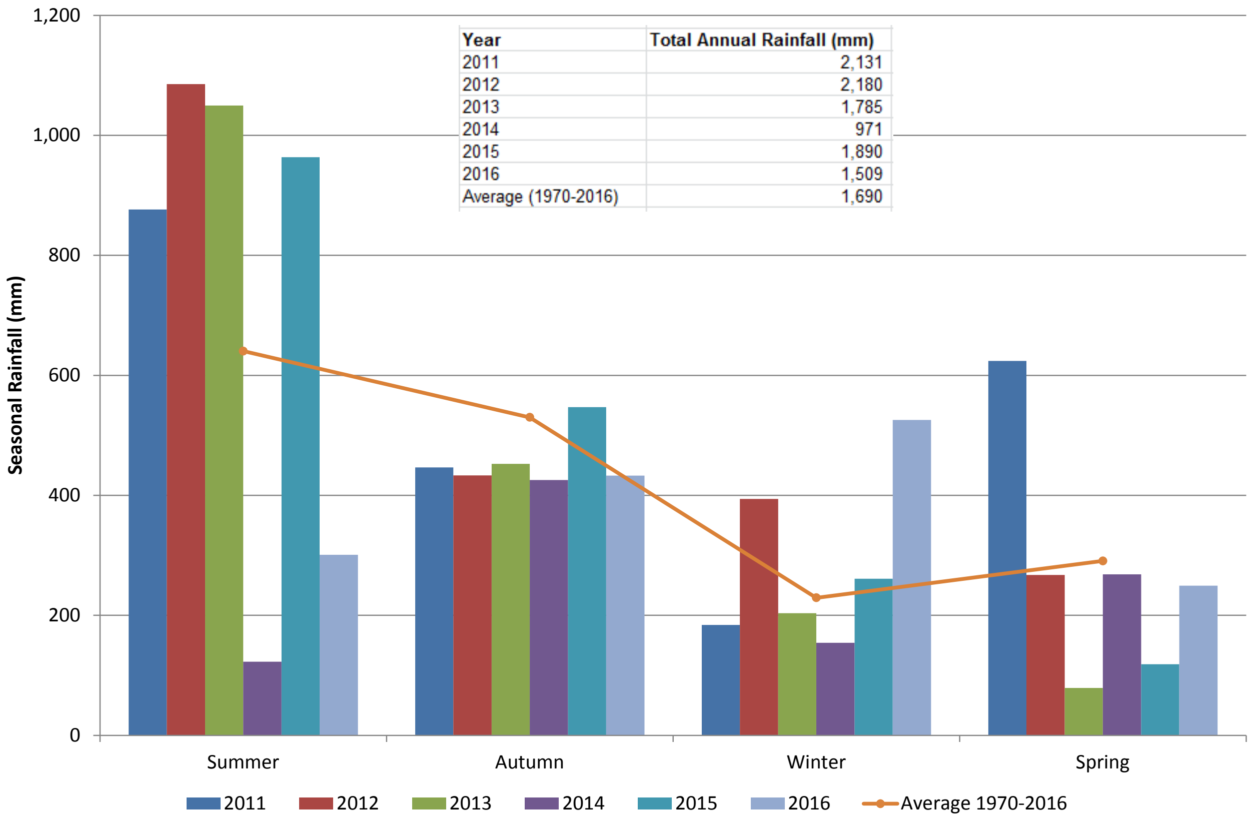

Figure 52: Seasonal rainfall 2011 - 2016: Murwillumbah

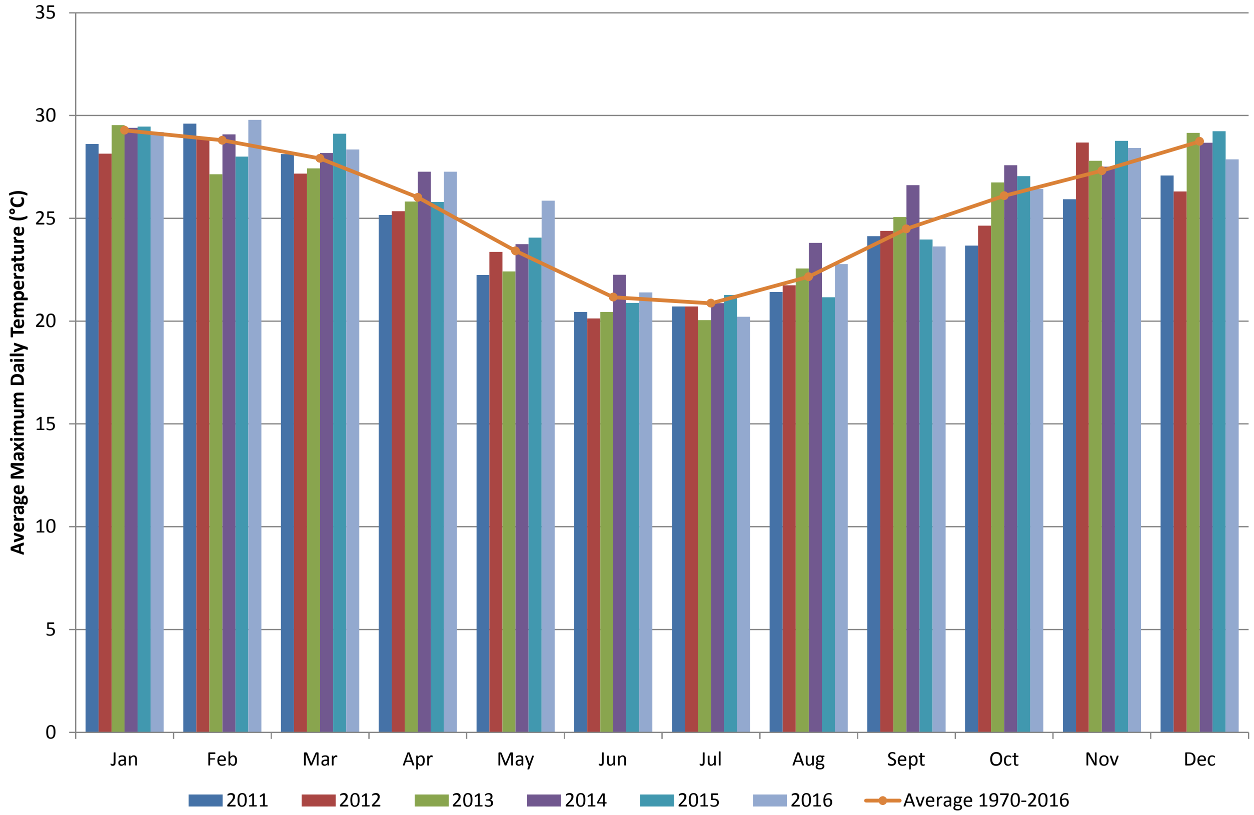

Figure 53: Monthly maximum daily temperature 2011 - 2016: Murwillumbah

Figure 54: Seasonal maximum daily temperature 2011 - 2016: Murwillumbah

Tyalgum

Climate data for Tyalgum (Data Drill for Lat, Long: -28.35 153.20 (decimal degrees), 28 21'S 153 12'E, elevation 185m) is presented below (SILO, 2016).

Table 32: Analysis of climate data – Tyalgum

Data	2011		2012		2013		2014		2015		2016		Average 1970-2016
Annual rainfall (mm)	1,948	*126%*	2,054	*132%*	1,831	*118%*	963	*62%*	1,430	*92%*	1,559	*101%*	1,551
Rainfall comparison with average	*much wetter*		*much wetter*		*wetter*		*much drier*		*drier*		*average*		
Annual evaporation (mm)	1,308	*91%*	1,417	*98%*	1,523	*105%*	1,703	*117%*	1,685	*115%*	1,695	*116%*	1,447
Annual rainfall deficit (mm)	-640		-637		-308		740		255		136		-104
Summer rainfall (mm)	935	*147%*	1,070	*169%*	1,145	*181%*	158	*25%*	612	*97%*	407	*64%*	634
Autumn rainfall (mm)	354	*76%*	387	*83%*	430	*93%*	404	*87%*	493	*106%*	335	*72%*	464
Winter rainfall (mm)	131	*70%*	342	*181%*	171	*91%*	149	*79%*	170	*90%*	497	*264%*	188
Spring rainfall (mm)	529	*199%*	256	*97%*	85	*32%*	252	*95%*	154	*58%*	320	*121%*	265
Summer max. temp (°C)	28.1	*97%*	27.4	*95%*	28.7	*99%*	29.4	*102%*	28.8	*100%*	28.9	*100%*	28.9
Temp. comparison with average	*colder*		*much colder*		*average*		*hotter*		*average*		*average*		
Autumn max. temp (°C)	24.4	*97%*	24.7	*98%*	24.5	*97%*	26.0	*103%*	25.7	*102%*	26.7	*106%*	25.2
Temp. comparison with average	*colder*		*colder*		*colder*		*hotter*		*hotter*		*much hotter*		
Winter max. temp (°C)	20.0	*97%*	20.0	*97%*	20.2	*98%*	21.5	*104%*	20.4	*99%*	20.7	*100%*	20.7
Temp. comparison with average	*colder*		*colder*		*colder*		*much hotter*		*average*		*average*		
Spring max. temp (°C)	24.0	*92%*	25.7	*99%*	26.8	*103%*	27.5	*106%*	27.2	*105%*	26.2	*101%*	26.0
Temp. comparison with average	*much colder*		*average*		*hotter*		*much hotter*		*much hotter*		*average*		
Annual max. temp (°C)	35.0	*96%*	35.5	*97%*	37.0	*101%*	39.5	*108%*	39.0	*107%*	35.0	*96%*	36.6
Temp. comparison with average	*much colder*		*colder*		*average*		*much hotter*		*much hotter*		*much colder*		

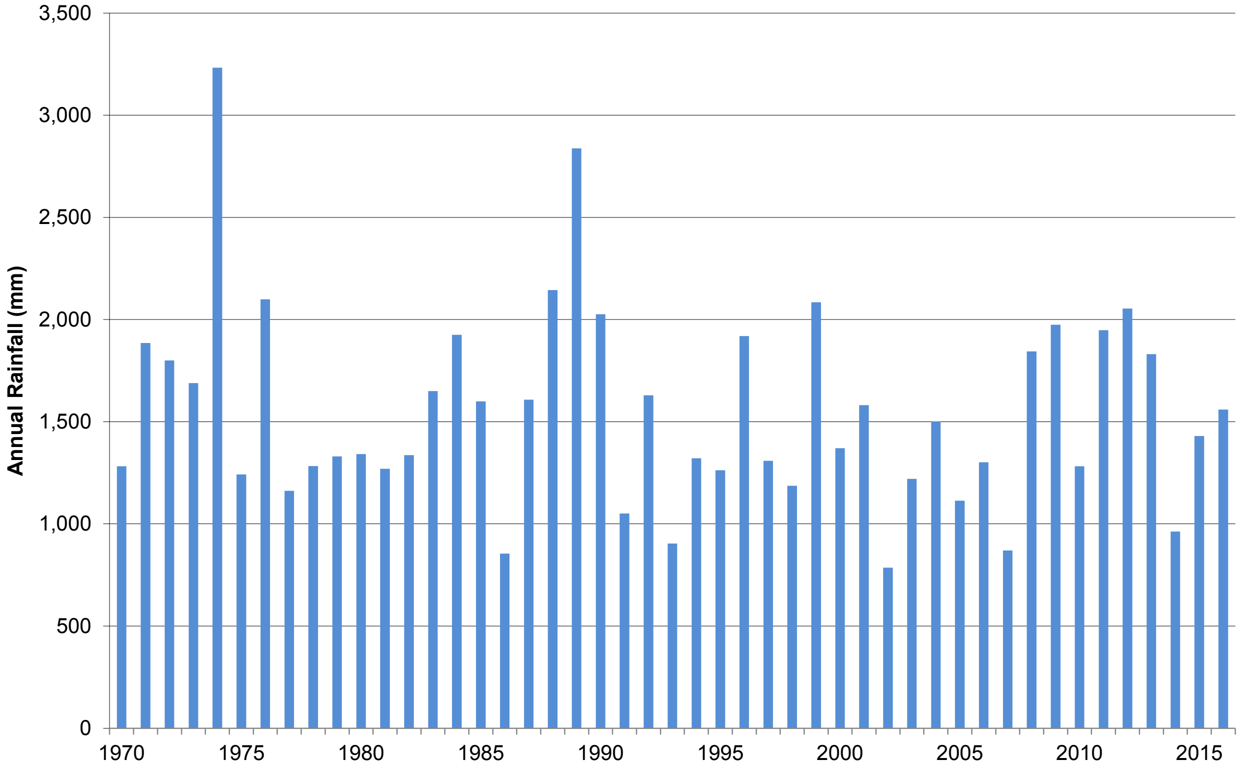

Figure 55: Annual rainfall 1970 – 2016: Tyalgum

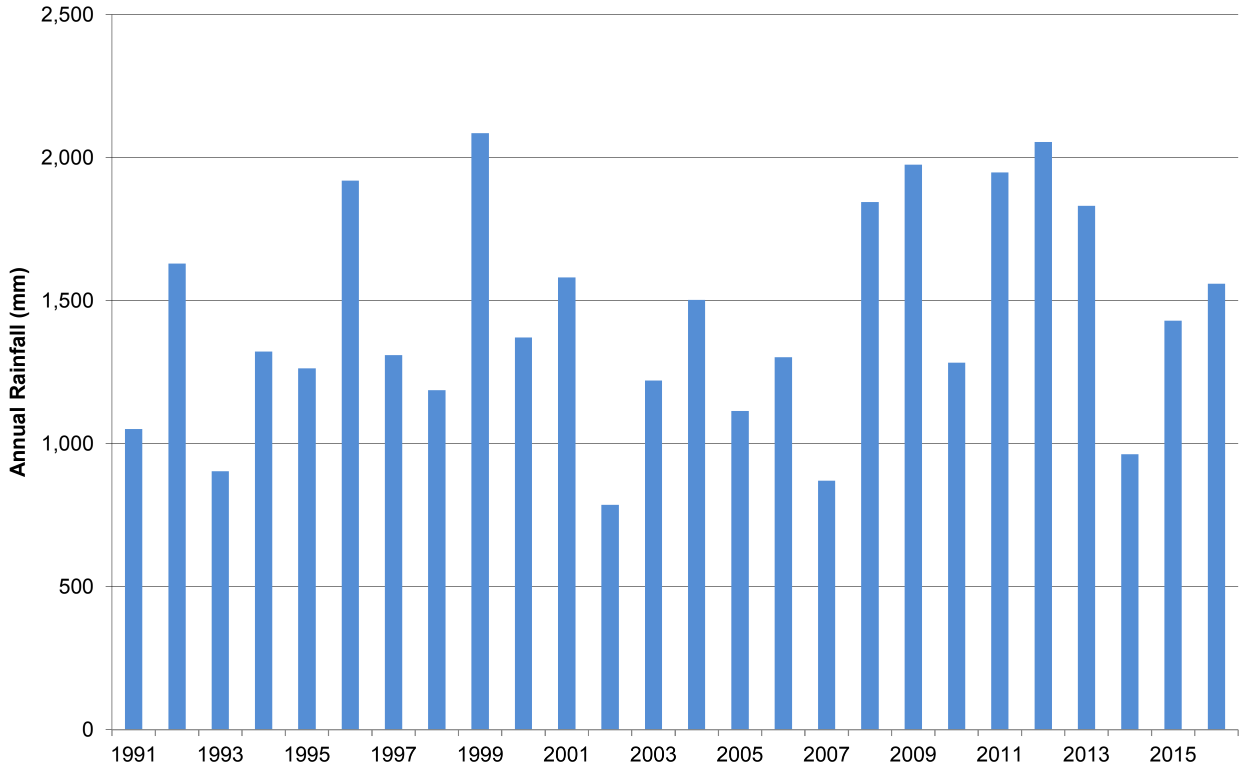

Figure 56: Annual rainfall 1991 – 2016: Tyalgum

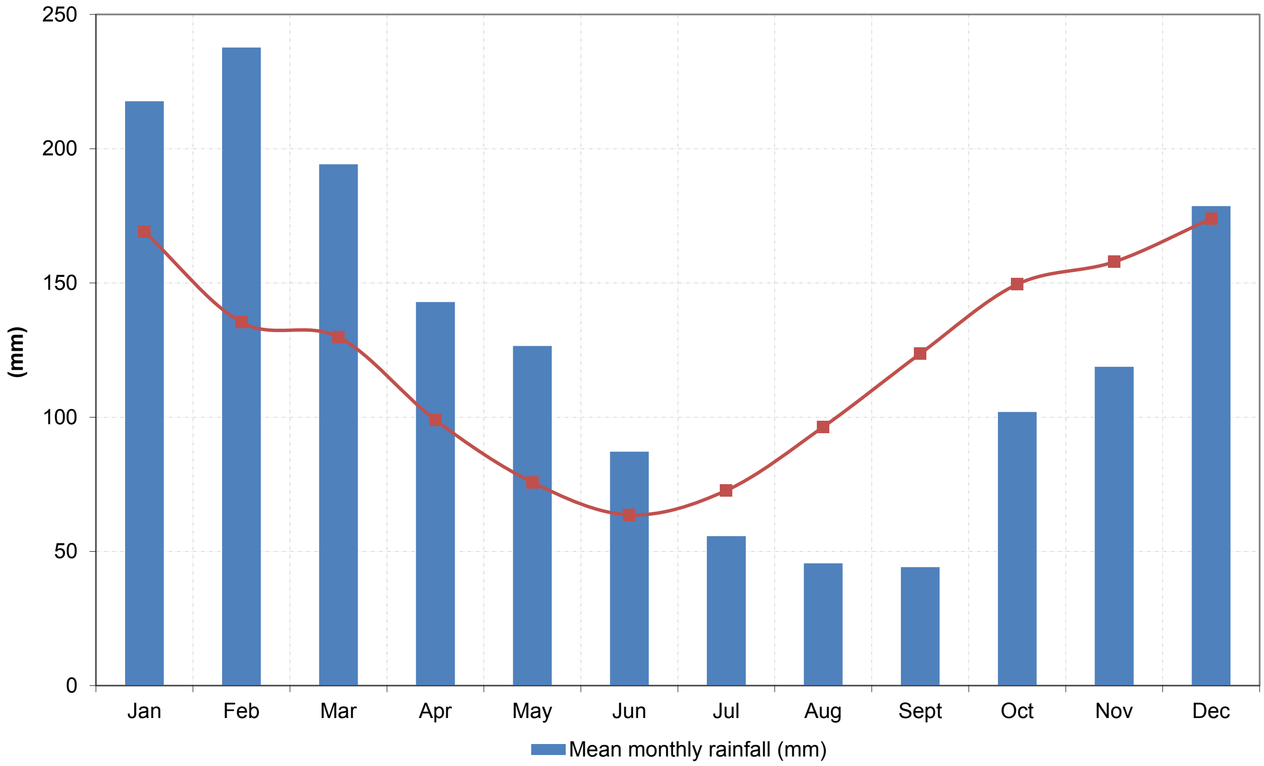

Figure 57: Monthly rainfall and evaporation 1970 - 2016: Tyalgum

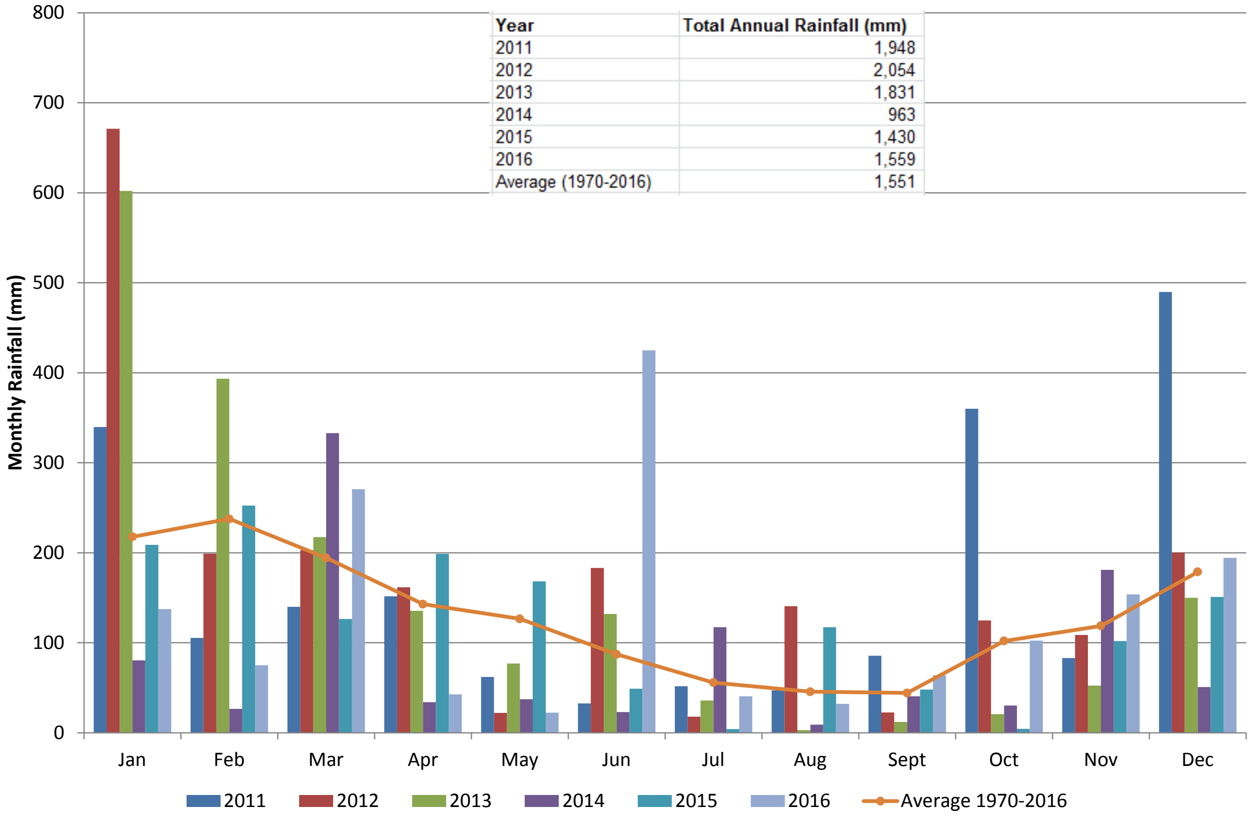

Figure 58: Monthly rainfall 2011 - 2016: Tyalgum

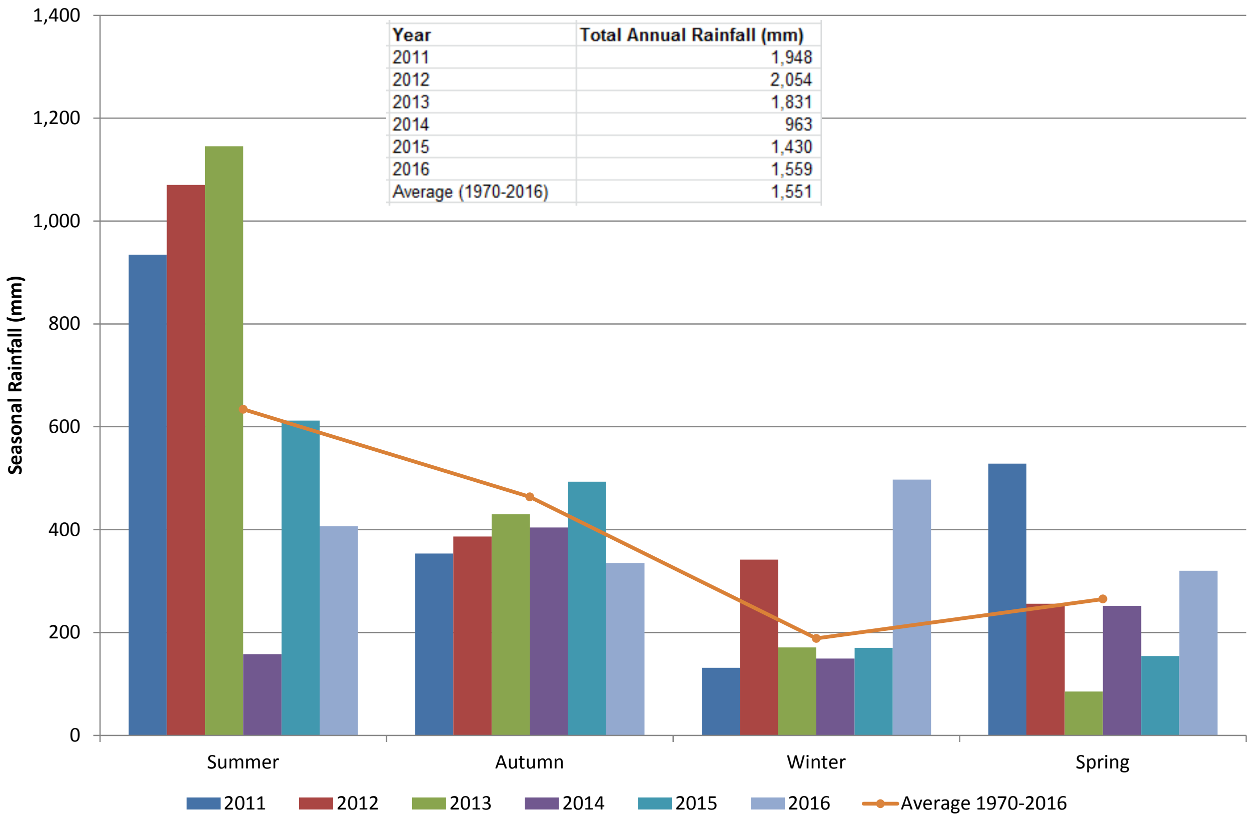

Figure 59: Seasonal rainfall 2011 - 2016: Tyalgum

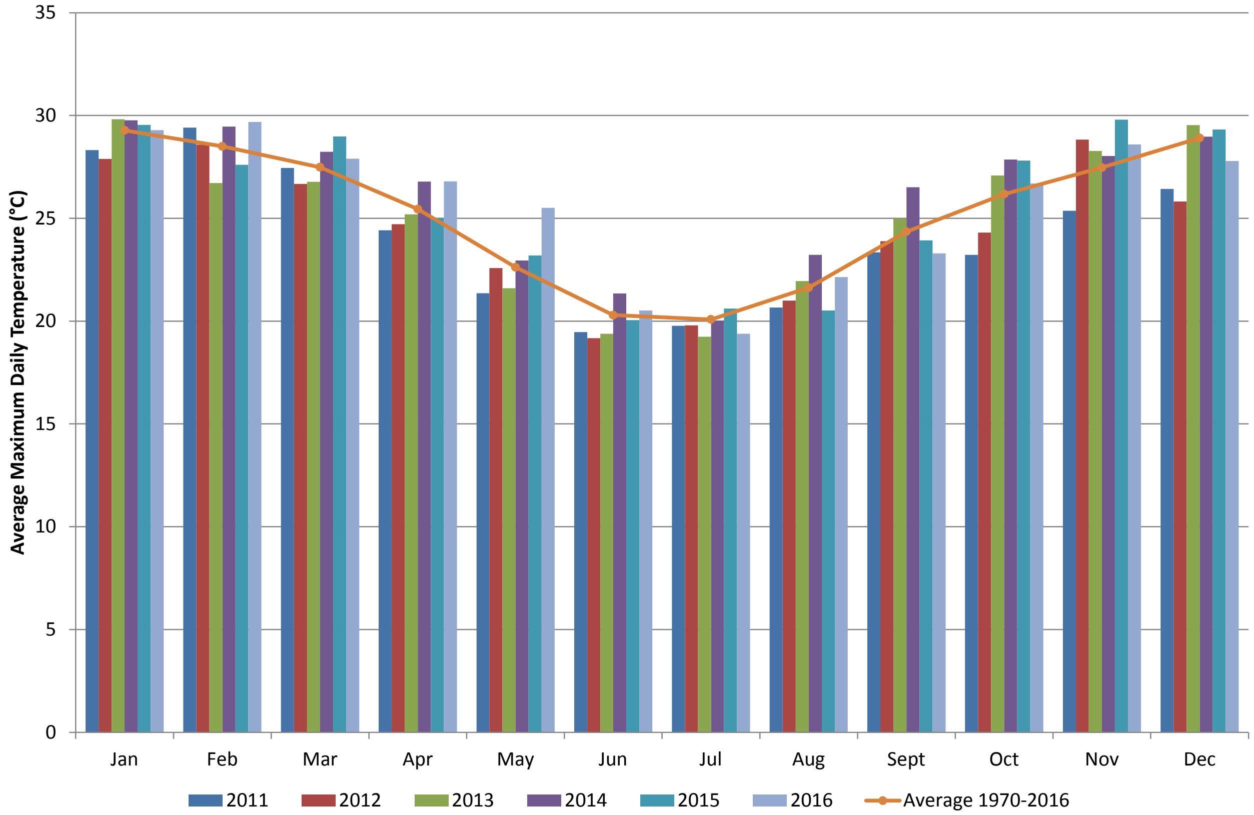

Figure 60: Monthly maximum daily temperature 2011 - 2016: Tyalgum

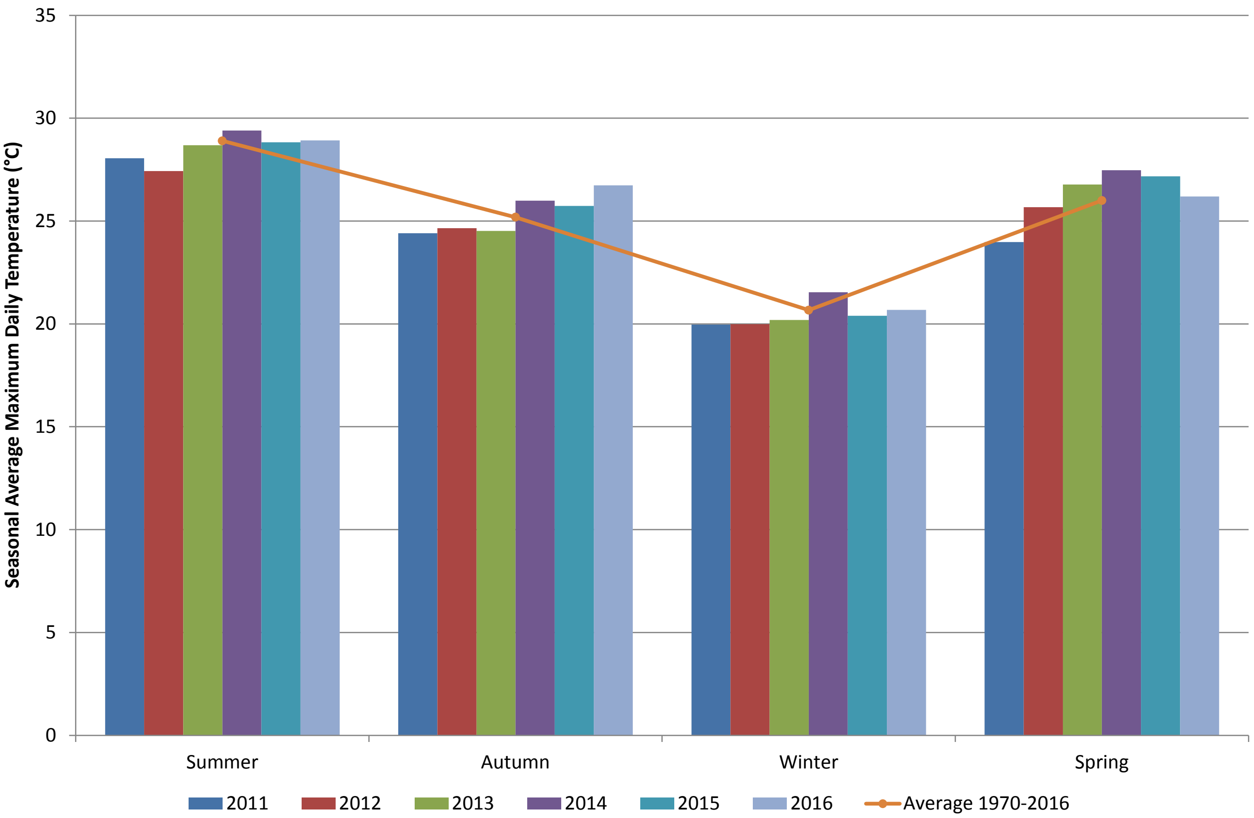

Figure 61: Seasonal maximum daily temperature 2011 - 2016: Tyalgum

Uki

Climate data for Uki (Data Drill for Lat, Long: -28.40 153.35 (decimal degrees), 28 24'S 153 21'E, elevation 89m) is presented below (SILO, 2016).

Table 33: Analysis of climate data - Uki

Data	2011		2012		2013		2014		2015		2016		Average 1970-2016
Annual rainfall (mm)	2,058	*125%*	2,061	*125%*	1,838	*112%*	1,063	*65%*	1,800	*109%*	1,531	*93%*	1,647
Rainfall comparison with average	*much wetter*		*much wetter*		*wetter*		*much drier*		*drier*		*drier*		
Annual evaporation (mm)	1,355	*91%*	1,457	*97%*	1,561	*104%*	1,731	*114%*	1,694	*112%*	1,718	*113%*	1,499
Annual rainfall deficit (mm)	-702		-604		-277		668		-107		187		-148
Summer rainfall (mm)	983	*154%*	1,018	*159%*	1,165	*182%*	137	*21%*	915	*143%*	336	*52%*	640
Autumn rainfall (mm)	411	*80%*	420	*82%*	446	*87%*	498	*97%*	510	*100%*	407	*79%*	513
Winter rainfall (mm)	149	*69%*	382	*177%*	158	*73%*	167	*77%*	236	*110%*	514	*238%*	216
Spring rainfall (mm)	515	*185%*	241	*86%*	69	*25%*	261	*93%*	138	*50%*	275	*98%*	279
Summer max. temp (°C)	28.4	*98%*	27.6	*95%*	28.6	*99%*	29.1	*100%*	28.9	*100%*	28.9	*100%*	29.0
Temp. comparison with average	*colder*		*much colder*		*average*		*average*		*average*		*average*		
Autumn max. temp (°C)	24.9	*97%*	25.0	*98%*	24.9	*97%*	26.2	*103%*	26.1	*102%*	27.0	*106%*	25.6
Temp. comparison with average	*colder*		*colder*		*colder*		*hotter*		*hotter*		*much hotter*		
Winter max. temp (°C)	20.5	*97%*	20.5	*97%*	20.7	*98%*	22.0	*104%*	20.8	*98%*	21.2	*100%*	21.1
Temp. comparison with average	*colder*		*colder*		*colder*		*much hotter*		*colder*		*average*		
Spring max. temp (°C)	24.4	*94%*	25.9	*99%*	26.7	*103%*	27.3	*105%*	26.8	*103%*	26.2	*100%*	26.1
Temp. comparison with average	*much colder*		*average*		*hotter*		*much hotter*		*hotter*		*average*		
Annual max. temp (°C)	35.0	*95%*	35.0	*95%*	37.0	*100%*	39.0	*105%*	37.5	*101%*	34.5	*93%*	37.0
Temp. comparison with average	*much colder*		*much colder*		*average*		*much hotter*		*average*		*much colder*		

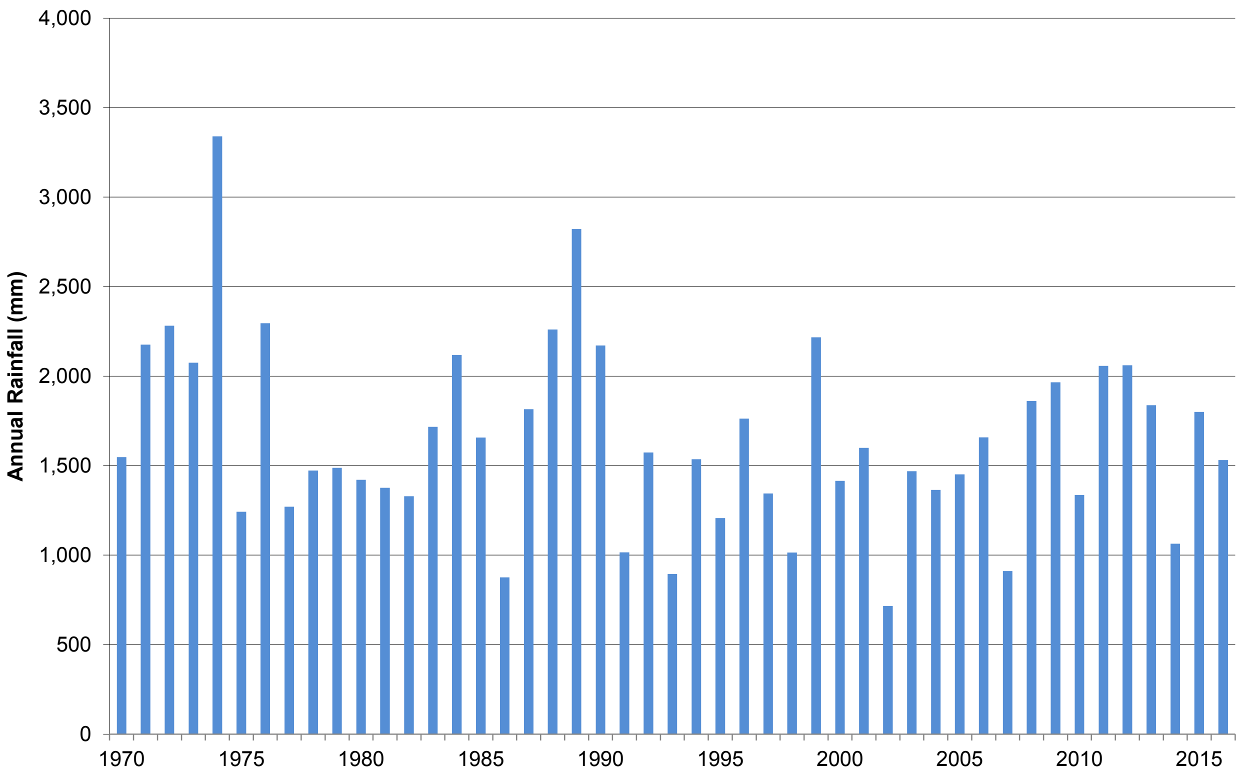

Figure 62: Annual rainfall 1970 – 2016: Uki

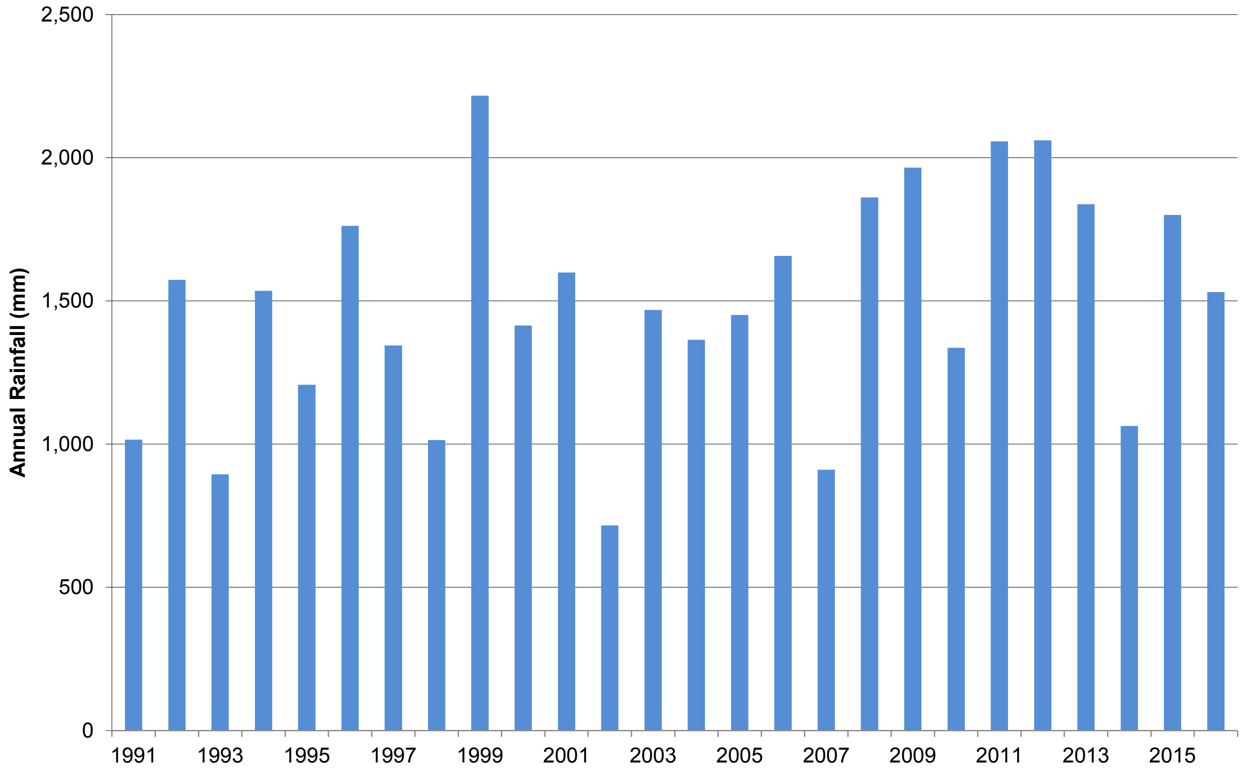

Figure 63: Annual rainfall 1991 – 2016: Uki

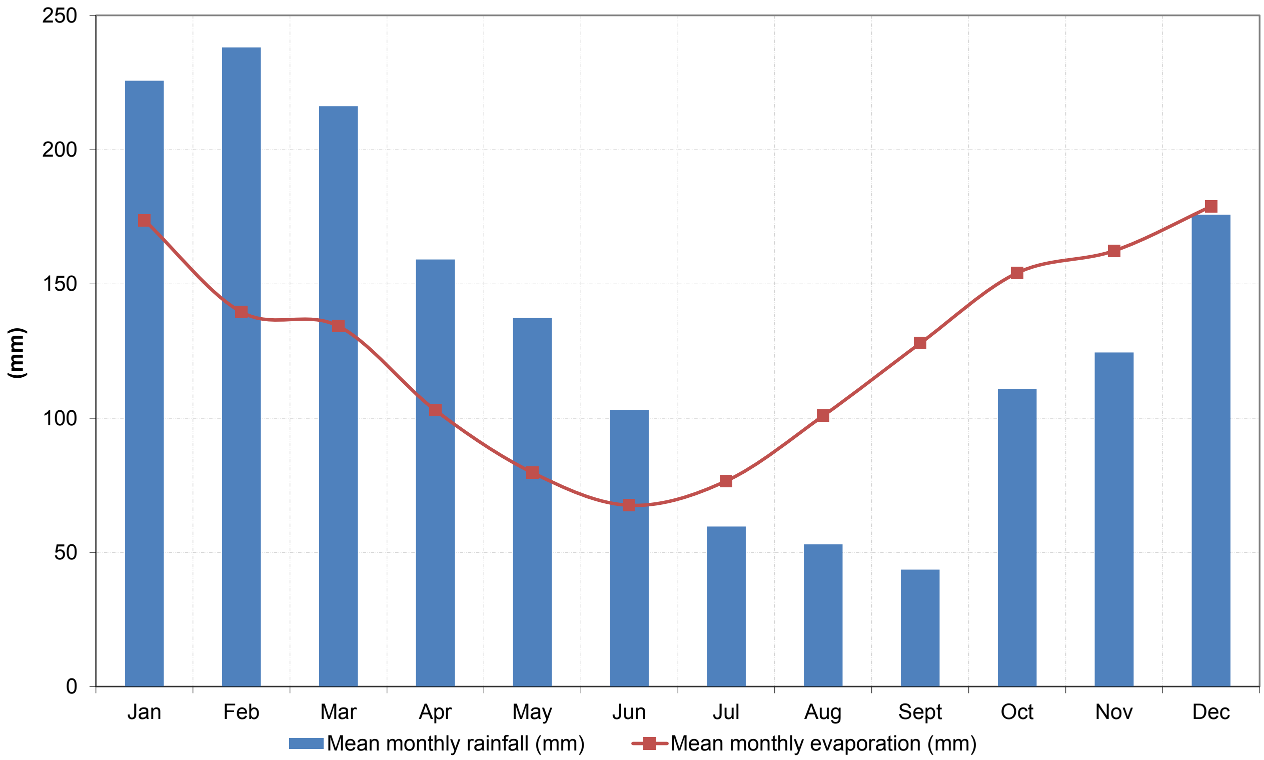

Figure 64: Monthly rainfall and evaporation 1970 - 2016: Uki

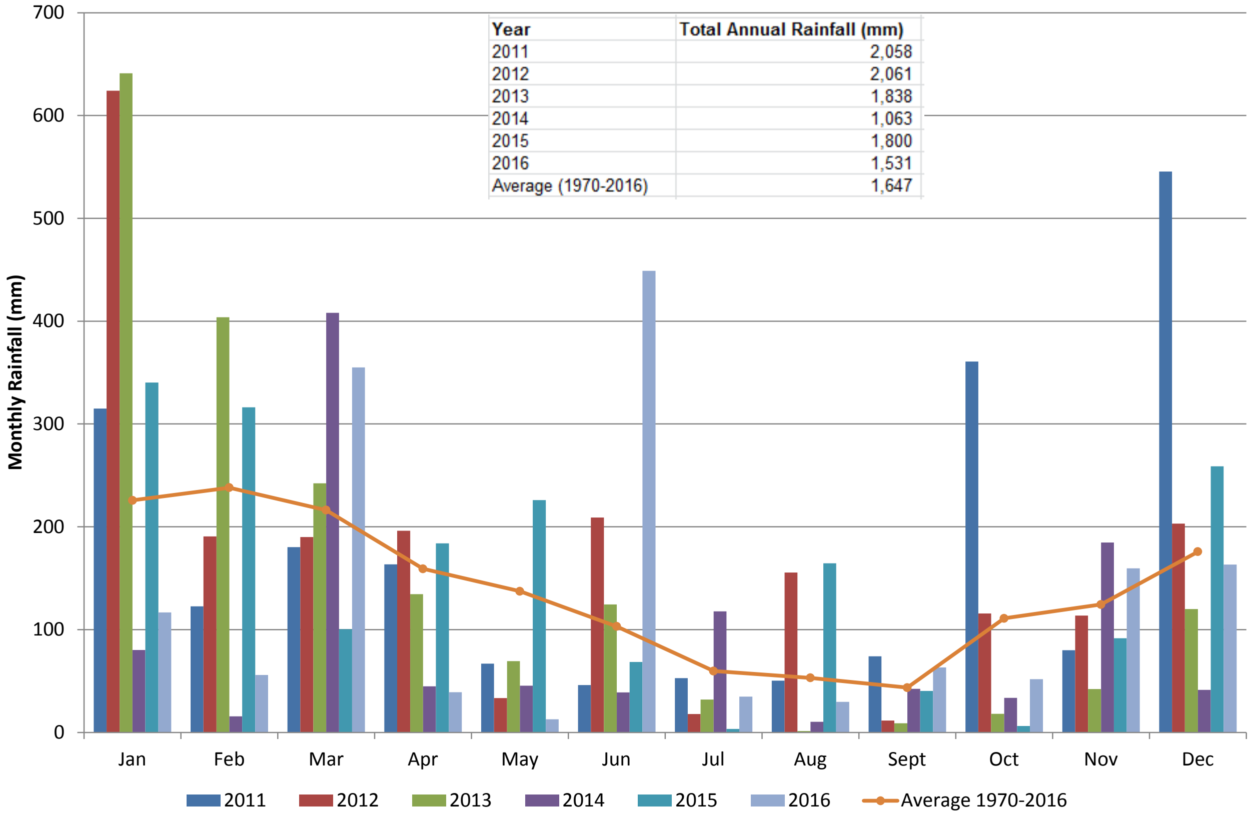

Figure 65: Monthly rainfall 2011 - 2016: Uki

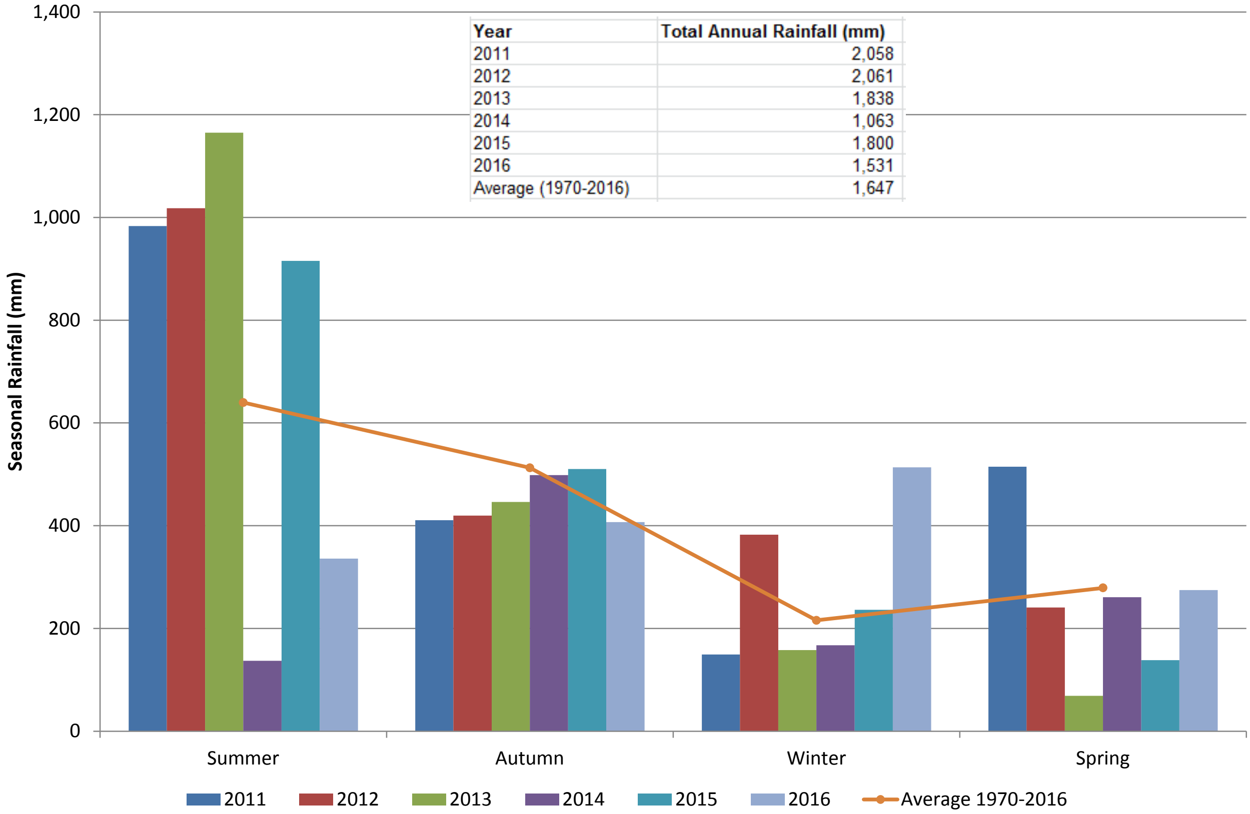

Figure 66: Seasonal rainfall 2011 - 2016: Uki

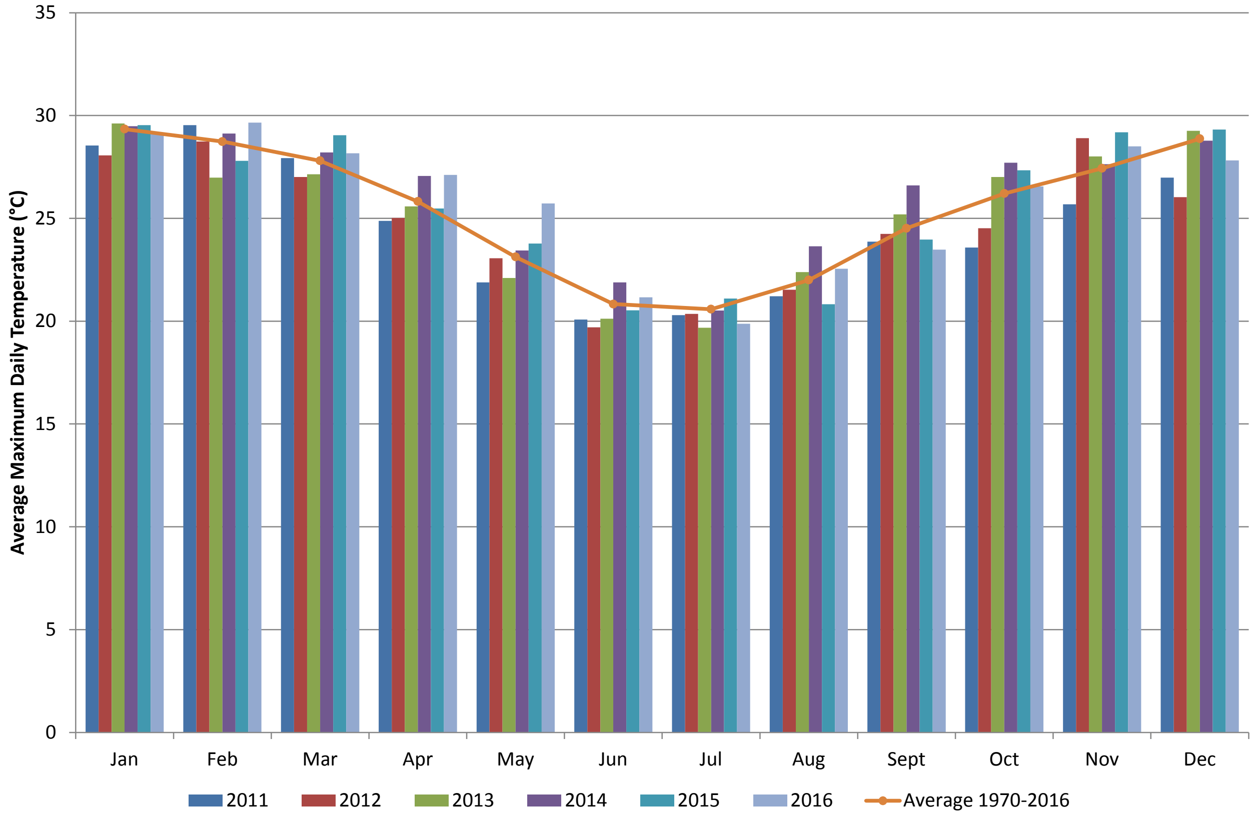

Figure 67: Monthly maximum daily temperature 2011 - 2016: Uki

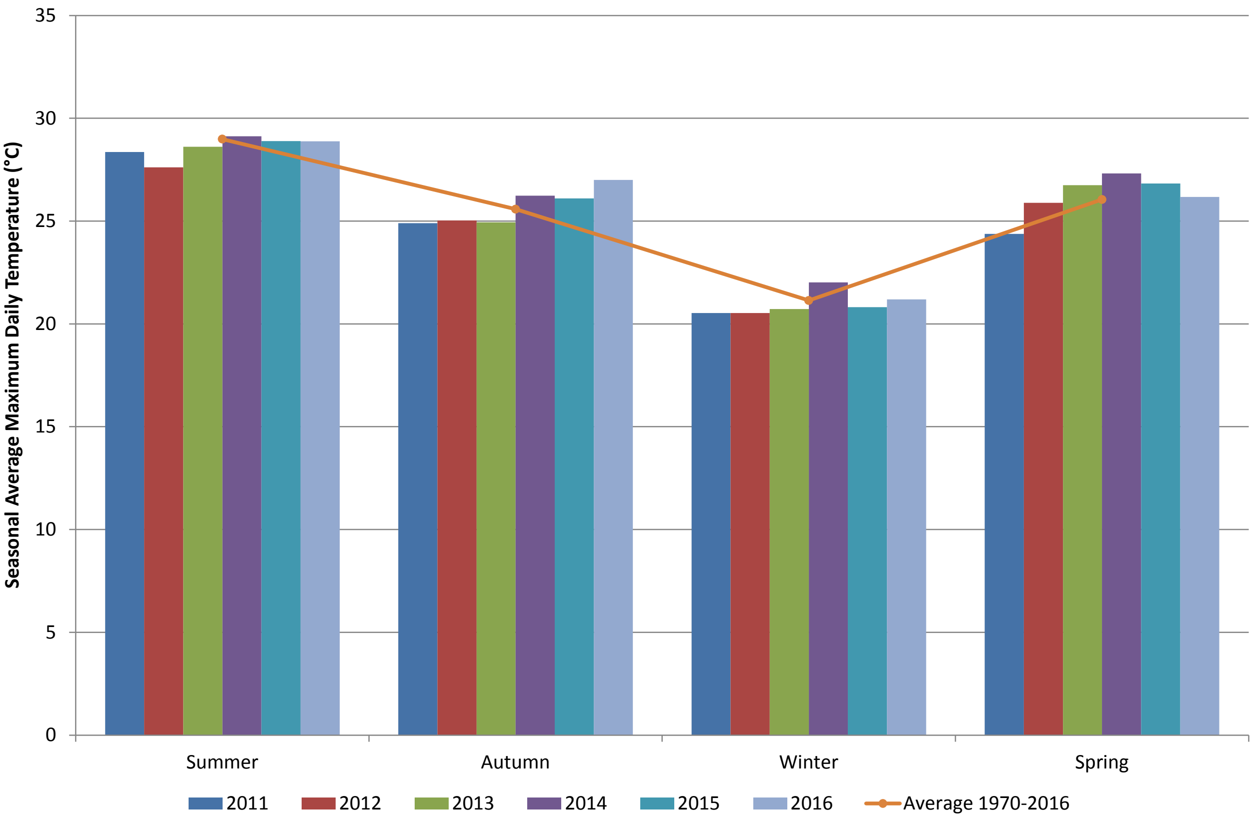

Figure 68: Seasonal maximum daily temperature 2011 - 2016: Uki

APPENDIX 3: ANNUALISED COSTS OF INVESTMENT ACTIONS

Tapware					
Year	**1**	**2**	**3**	**4**	**5**
TSC expenditure	$50.00				
Water Savings (kL)	5.0	5.0	5.0	5.0	5.0
NPV water savings	22.7				
TSC savings	$3.00	$3.00	$3.00	$3.00	$3.00
Net TSC expenditure	$47.00	-$3.00	-$3.00	-$3.00	-$3.00
NPV TSC expenditure	$36.36				
Annualised cost to TSC	$1.60	per kL			
Customer expenditure	$50.00				
Customer savings	$12.25	$12.25	$12.25	$12.25	$12.25
Net customer expenditure	$37.75	-$12.25	-$12.25	-$12.25	-$12.25
NPV expenditure	-$5.69				
Annualised cost to customer	-$4.00	per kL			

Aerators/flow controllers					
Year	**1**	**2**	**3**	**4**	**5**
TSC expenditure	$25.00				
Water Savings (kL)	5.0	5.0	5.0	5.0	5.0
NPV water savings	22.7				
TSC savings	$3.00	$3.00	$3.00	$3.00	$3.00
Net TSC expenditure	$22.00	-$3.00	-$3.00	-$3.00	-$3.00
NPV TSC expenditure	$11.36				
Annualised cost to TSC	$0.50	per kL			
Customer expenditure	$25.00				
Customer savings	$12.25	$12.25	$12.25	$12.25	$12.25
Net customer expenditure	$12.75	-$12.25	-$12.25	-$12.25	-$12.25
NPV expenditure	-$30.69				
Annualised cost to customer	-$0.74	per kL			

Showerheads					
Year	**1**	**2**	**3**	**4**	**5**
TSC expenditure	$50.00				
Water Savings (kL)	15.0	15.0	15.0	15.0	15.0
NPV water savings	68.2				
TSC savings	$9.00	$9.00	$9.00	$9.00	$9.00
Net TSC expenditure	$41.00	-$9.00	-$9.00	-$9.00	-$9.00
NPV TSC expenditure	$9.09				
Annualised cost to TSC	$0.13	per kL			
Customer expenditure	$50.00				
Customer savings	$36.75	$36.75	$36.75	$36.75	$36.75
Net customer expenditure	$13.25	-$36.75	-$36.75	-$36.75	-$36.75
NPV expenditure	-$117.06				
Annualised cost to customer	-$0.58	per kL			

Toilets															
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
TSC expenditure	$200.00														
Water Savings (kL)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
NPV water savings	327.0														
TSC savings	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00
Net TSC expenditure	$182.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00	-$18.00
NPV TSC expenditure	$3.82														
Annualised cost to TSC	$0.01	per kL													
Customer expenditure	$200.00														
Customer savings	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50	$73.50
Net customer expenditure	$126.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50	-$73.50
NPV expenditure	-$601.05														
Annualised cost to customer	-$0.54	per kL													

Top 20										
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
TSC expenditure	$97,296									
Water Savings (kL)	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650	34,650
TSC savings	$20,790	$20,790	$20,790	$20,790	$20,790	$20,790	$20,790	$20,790	$20,790	$20,790
Net TSC expenditure	$76,506	-$20,788	-$20,787	-$20,786	-$20,785	-$20,784	-$20,783	-$20,782	-$20,781	-$20,780
NPV expenditure	-$71,225.42									
NPV water savings	280,936									
Annualised cost to TSC	-$0.25	per kL								
Customer expenditure	$1,584									
Customer water savings	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650
Customer savings	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043
Net customer expenditure	-$2,458	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043
NPV expenditure	-$31,192									
NPV water savings	13,378									
Annualised cost to customer	-$2.33	per kL								

Top 100

Year	1	2	3	4	5	6	7	8	9	10
TSC expenditure	$1,000									
Water Savings (kL)	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650
TSC savings	$990	$990	$990	$990	$990	$990	$990	$990	$990	$990
Net TSC expenditure	$10	-$990	-$990	-$990	-$990	-$990	-$990	-$990	-$990	-$990
NPV expenditure	-$7,027									
NPV water savings	13,378	kl								
Annualised cost to TSC	-$0.53	per kL								
Customer expenditure	$1,000									
Customer savings	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043	$4,043
Net customer expenditure	-$3,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043	-$4,043
NPV expenditure	-$31,776									
Annualised cost to customer	-$2.38	per kL								

Murwillumbah Pool Leak

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
TSC expenditure	$10,000																			
Water Savings (kL)	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825	1,825
TSC savings	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095	$1,095
Net TSC expenditure	$8,905	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095	-$1,095
NPV expenditure	-$4,328																			
NPV water savings	23,881	kl																		
Annualised cost to TSC	-$0.18	per kL																		

Les Burger Fields

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capital Investment	$320,575																			
Recurrent cost	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Water savings (kL)	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846	13,846
TSC savings	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308	$8,308
Net TSC expenditure	$317,267	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308	-$3,308
NPV expenditure	$277,293																			
NPV water savings	181,181	kl																		
Annualised cost to TSC	$1.53	per kL																		