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Cairns Water Comparative Analysis

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CONTENTS

FIGURES

TABLES

1 INTRODUCTION

This section introduces the regional context for the analysis and outlines the purpose of the research.

1.1 Context

Cairns Regional Council (CRC) is pursuing water security solutions with a focus on water infrastructure, particularly augmentation of supply. Existing water management data shows that per capita water usage rates are relatively high and therefore demand management may also be an option to pursue water security solutions.

In line with achieving the goals set forward in the Water Demand Strategy 2016-2025, Cairns has previously implemented both customer-side actions including media campaigns, permanent water conservation measures and incentives as well as system-side actions such as the installation of district meters, real-time leak detection and repairs and the optimisation of raw water treatment plant operations (Cairns Regional Council, 2015). Level 0 (e.g., "Permanent Conservation Measures") through to level 4 water restrictions also have the potential to be imposed when required, which largely target external water uses such as irrigation and washing/cleaning purposes (Cairns Regional Council, 2022a). Level 4 water restrictions do not allow any watering of gardens, public or private, except by watering can/bucket between 7am to 8am and 7pm to 8pm. The 2020 Drought Response Plan estimated that demand reductions for each restriction level between 1 and 4 were 10%, 15%, 20% and 25% respectively (Cairns Regional Council, 2020).

These levels have been designed in relation to the current Essential Minimum Supply Volume (EMSV) for residences in Cairns of 104L/person/day[1] (Cairns Regional Council, 2020). The EMSV calculates the socially acceptable demand target during severe drought conditions that should be achieved, incorporating characteristics and requirements specific to Cairns. Restrictions are largely imposed in response to water capacity levels at nearby Copperlode Falls Dam. Activation trigger levels for implementing water restrictions are 80% dam capacity for level 1, 70% capacity for level 2, 60% capacity for level 3 and 50% capacity for level 4 (Cairns Regional Council, 2020). Within recent years, water restrictions were at level 2 in January 2020 when Copperlode Falls Dam dropped to 69% capacity, with restrictions easing in May 2020 (127 days in total). In 2021, a total of 7 days were also spent with level 3 restrictions enforced (Cairns Regional Council, 2021).

As of September 2022, Permanent Conservation Measures (equivalent to level 0 restrictions) are in place with Copperlode Falls Dam capacity at 99% (Cairns Regional Council, 2022b). Despite this, without action that addresses augmentation of supply or high per capita water usage rates, modelling suggests that Cairns could face the risk of reaching a drinking water supply shortfall by 2026.

1.2 Purpose

While the proposal for new water security solutions will focus on local infrastructure initially, it will likely call for a new allocation under the Wet Tropics Water Plan in the latter stages of the Water Security Strategy. This will call for accessing water from the Tablelands. Ideally such decisions would need to be assessed against all other soft and hard infrastructure options, and cognisant of the environmental implications of expanding the consumptive pool. CRC has a Water Demand Management Strategy (Cairns Regional Council, 2015) but has indicated that the efforts for demand management have been exhausted, and that further pursuit of demand management would not be cost effective. It is understood that this assumption has not been tested to any degree.

[1] The total EMSV calculated for Cairns Regional Council is 207L/person/day, consisting of 104L for residential purposes, 81L for non-residential purposes, 20L for system leakages and 2L for water treatment plant losses (Cairns Regional Council, 2020)

A wealth of data exists that provides information on water demand management strategies being employed by local government areas comparable to that of Cairns, in addition to proposed water infrastructure. By collating and comparing consumption data and water infrastructure data against a common metric, it is possible to benchmark options and identify potential opportunities where CRC may be better off focusing on demand management as opposed to augmenting supply. This comparison will add to the valuable body of work aimed at improving CRC longer-term planning and decision making for future water security.

2 APPROACH

A comparative analysis aims to provide a comprehensive understanding of variables that can be used to describe differences and similarities in regions. To provide the most accurate assessment, regions should share common characteristics to reduce the number of explanatory variables.

To assess the rates of water usage most effectively within the Cairns Regional Council, the two comparator regions of Mackay and Townsville have been selected. The two most dominant characteristics that provide a comparative position for the regions are their proximity and population size when compared to Cairns. These three regions comprise of the largest coastal cities located north of Bundaberg and share similar characteristics in the form of their employment, tourism, and climate. While these regions are certainly not identical, they share the most comparable attributes for the scope of this assessment for Cairns. South-East Queensland (SEQ) has also been provided as a benchmark figure where applicable, along with the greater average for the state of Queensland.

Relevant data has been evaluated from a wide variety of sources that share identical metrics or indicators between the three key regions. Sources of data or time periods that could not be comparatively assessed against all three regions have not been included. The Statewide Water Information Management (SWIM) database, retrieved from the Queensland Government Open Data Portal, provided key performance indicators for water consumption variables between 2015 and 2021.

This report has been divided into two main sections; key factors that have historically and are currently driving the levels of water demand being experienced, and key factors that are likely to drive demand into the foreseeable future. Consideration has also been given both to residential and non-residential water usage where data was not a limiting factor, as well as the transient population (i.e., tourists) that are consuming water and are not generally included within population estimations. Anticipated changes in any demographic trends or climate variables for regions have also been considered in the scope of this comparative assessment. Reflecting on some of the key learnings of this analysis, some qualitative discussion surrounding current water saving policies of councils has also been provided.

Key points

- A comparative analysis has been used to better understand water use in Cairns compared to Cairns, Townsville, Mackay and South-East Queensland (SEQ).
- Historical factors and projections for future factors influencing water demand in Cairns are discussed.
- Water use efficiency opportunities are also discussed.

3 HISTORICAL DATA ON WATER USAGE

3.1 Proportion of water demand across different uses

Statewide Water Information Management data has been compiled across the key comparable regions of Cairns, Mackay, Townsville and South-East Queensland to provide an assessment of potable water usage by sector. These sectors are discussed individually in the following sections, however are provided in aggregate in Figure 1 to demonstrate the proportion of water demand for each region. Water usage within the Cairns LGA demanded for residential purposes has consistently reached over 70% within all years assessed, with an average of 71% between 2017 and 2019. This is 10% higher than residential water demand in Mackay (at 61%) and 15% higher than in Townsville (at 58%). SEQ averaged 65% over the same period.

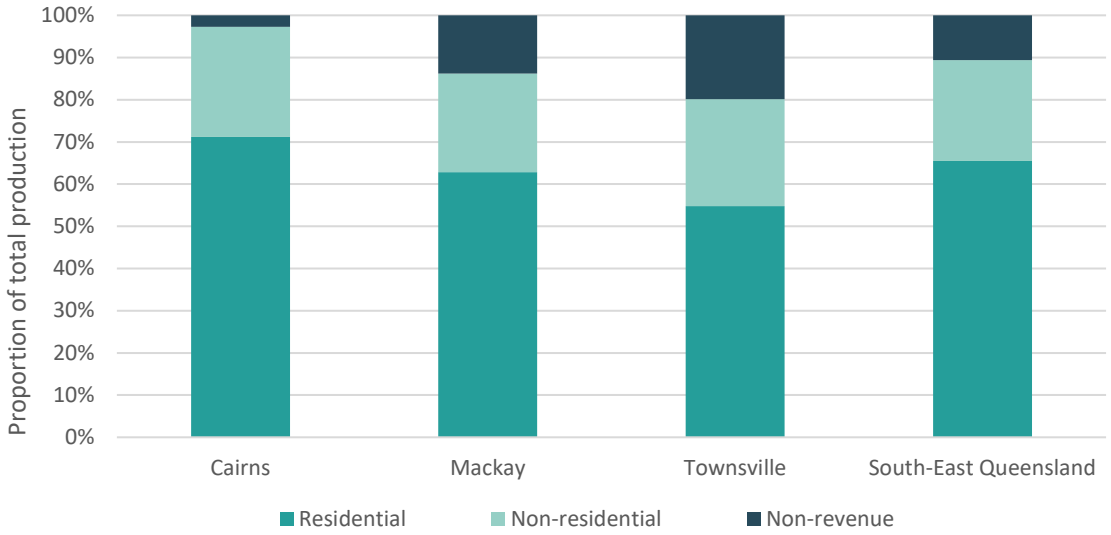

Figure 1. Aggregate proportion of water usage by sector
Source: Statewide Water Information Management (SWIM, 2022)
Note: Data provided is the 3-year average between 2017 and 2019.

Non-residential water usage consists of the aggregate demand of commercial, municipal, industrial and agricultural businesses within a region (BoM, 2018). Cairns displays comparable, marginally higher rates of non-residential water usage across the regions at 26%, with all other regions demanding between 23% and 25% of water. Water demands of businesses within the LGA's of Cairns, Mackay and Townsville should be comparable, with differences likely being a result of varying demand for the agricultural sector (high-water use) as well as the size of the tourism industry in the region.

Non-revenue water includes unbilled/unmetered supply water, as well as both real losses (leakage or overflows at storage) and apparent losses (unauthorised use and metering inaccuracy) (BoM, 2018). Cairns has been significantly more efficient than all other regions at reducing non-revenue water, making up an average of 3% of total water demand across the time period assessed. Mackay displays rates of non-revenue water that are similar to SEQ (13% and 11% respectively), while non-revenue water in Townsville consisted of one-fifth (20%) of total water demand. Assuming that non-revenue water largely consists of leakages, there is significant potential for Townsville as well as some potential for Mackay to improve water saving rates by investing in the maintenance of pipes and delivery systems. Cairns however displays exceptional rates of efficiency in its water delivery system. Consequently, there is likely to be limited return on investment (beyond maintenance/business as usual spending) from attempting to further reduce non-revenue water. Therefore, savings must be considered from the demand-side, that is, attempts at reducing water usage rates are likely to

represent more effective outcomes in reducing Cairns' water usage rates compared to efforts aimed at improving efficiency in its water delivery system.

Key point

- There is evidence to suggest that system losses in Cairns are relatively low. Therefore, any savings would need to be considered from the demand side.

3.2 Residential water usage rates

Residential (potable) water usage was compiled across the most recent 5-year period for the five regions, presented in Figure 2. This initial comparison does not include the demand for water from the equivalent additional tourist population calculated for each region. Water usage rates have been converted to the metric of litres per person per day to provide a comparable standard across all regions. Both Cairns and Townsville recorded significantly higher rates of residential water usage compared to Mackay, SEQ and Queensland. 2020 recorded the highest water use rates for both Cairns and Townsville, with 294L/person/day being supplied in Cairns and 415L/person/day being supplied in Townsville. Cairns has demonstrated largely constant rates across the period while Townsville has demonstrated a marked increase since 2018, reflecting the drier weather experienced in Townsville over the same period.

Residential water consumption averages for Cairns, Mackay, Townsville, SEQ and Queensland in L/person/day are displayed in Table 1 below. Compared to the rest of SEQ, residents within Cairns use around 70% more water on a daily basis, and 57% more than Mackay residents. Townsville residents on average use just over double (104%) of SEQ residents water usage on a daily basis.

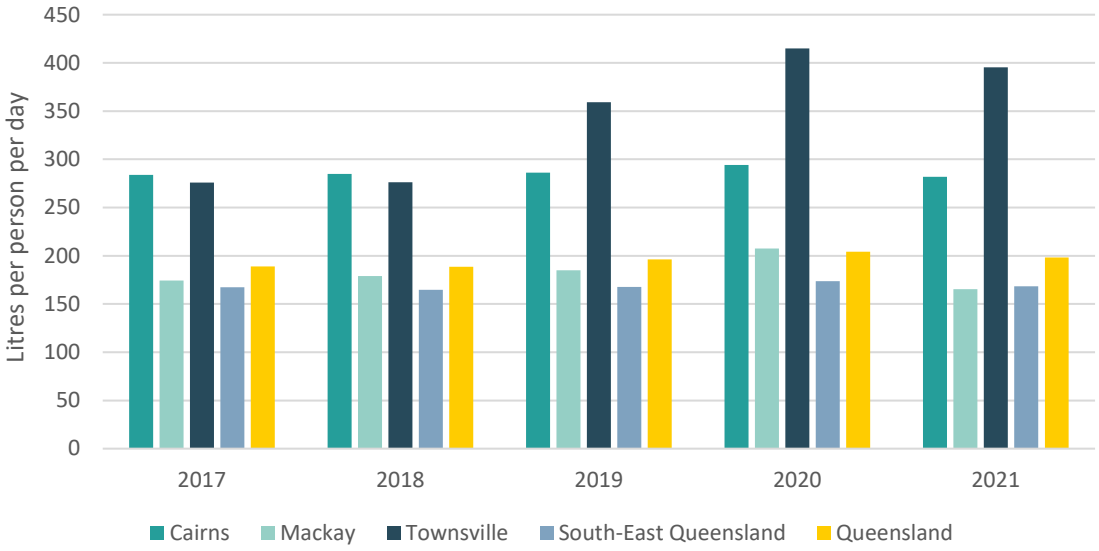

Figure 2. Daily residential potable water consumption per person per day (excluding tourist population)
Source: Statewide Water Information Management (SWIM, 2022)

To allow a more accurate assessment of residential water use on a per capita basis, average tourist populations for each region have been included in addition to the local population in Figure 3, with average water usage rates presented in Table 1. Cairns has the largest number of overnight tourists of the three regions (equivalent to an additional 26,033 residents), therefore residential water consumption rates reduced most significantly when this population was included (a reduction of 38 litres per person per day). Average rankings of water usage however did not change significantly after this addition, except for marginal changes in 2017 and 2018 where Cairns' consumption rate was slightly below that of Townsville.

Note that this measurement assumes that all water consumption by tourists is incorporated into residential water usage, and not non-residential businesses. However, it is likely that some hotels' water usage is incorporated within the non-residential water rates (i.e. if a hotel is considered as a commercial business). Therefore, these estimations that include tourist equivalent populations should be considered as the lower bound for water consumption rates per capita, while the true water usage rates would lie somewhere between the two calculated figures in Table 1.

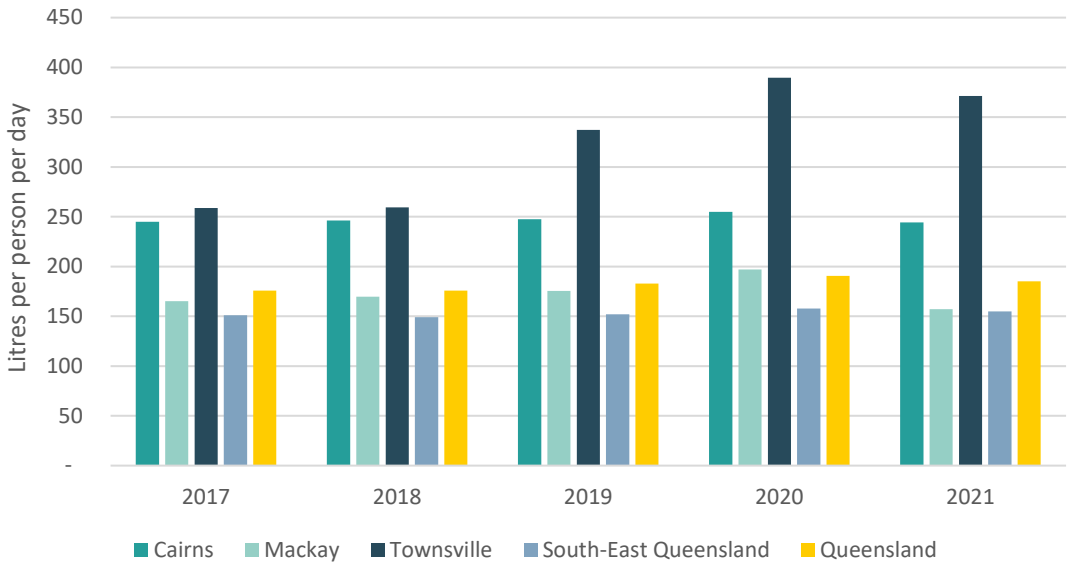

Figure 3. Daily residential potable water consumption per person per day (including tourist population)
Source: Statewide Water Information Management (SWIM, 2022), Tourism Research Australia (TRA, 2019) and Economy.id (2021)
Note: Tourist average populations from 2015 to 2019 have been applied across all years assessed.

Table 1. Average residential water consumption with and without tourist population

LGA/Region	Average litres of water used per person per day excluding tourist population	Average litres of water used per person per day including tourist population
Cairns	286	248
Mackay	182	173
Townsville	344	323
South-East Queensland	168	153
Queensland	195	182

Source: Statewide Water Information Management (SWIM, 2022), Tourism Research Australia (TRA, 2019) and Economy.id (2021)

Note: Average taken between 2017 and 2021

Key point

- Both measures of per capita water consumption (including and excluding tourist equivalent populations) show that water consumption per capita in Cairns and Townsville is significantly higher than benchmark regions.

A study undertaken by Beal & Stewart (2011) in South-East Queensland indicated that the four biggest end water uses within a household are: shower, tap, washing machine and toilet. Additionally, Gan & Redhead (2013) provide a breakdown of household water use in summer and winter months, as shown in Figure 4. Irrigating gardens is a major discretionary use of urban water, particularly for detached dwellings. As discussed further in Section 3.5 (Figure 8), rainfall in all comparable regions in the dry months between May and October is minimal, and therefore watering gardens is a major demand driver during this period. As outlined in Section 3.7, there is nothing in the analysis of the mix of residential housing stock that would suggest consumption in Cairns or Townsville should be any higher.

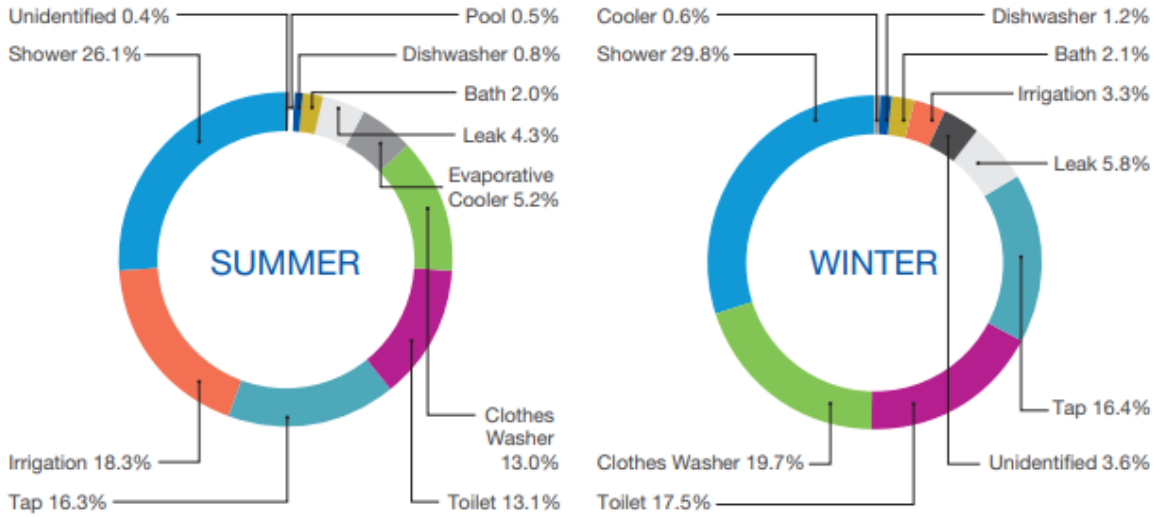

Figure 4. Residential water use (end use percentage shares by volume)
Source: Gan & Redhead (2013)

Water restrictions imposed by Cairns Regional Council were implemented at level 2 between January 2020 and May 2020, however these restrictions did not appear to have any measurable effect on average residential potable water usage rates within that year[2]. In contrast, Cairns recorded an average of 294L/person/day in 2020, the highest (by a small margin) of the assessed period. The effect of water restrictions however is convoluted by the increased dependence of residences to draw on water supplies when localised storage (i.e. water tanks) are running empty. Localised stores of water will be higher in other years of normal rainfall and therefore actual aggregate water usage will be higher in these years.

Key points

- Cairns residential water consumption is significantly higher than Mackay, SEQ and Queensland.
- Townsville has the highest comparable water consumption, driven by the drier weather conditions experienced over the same time period.

[2] February, March, and April of 2020 recorded monthly rainfalls well below averages in Cairns, with 443mm of rain recorded over the 3-months as opposed to the 5-year average of 1,024mm over the same months (BoM, 2022). Furthermore, water restrictions did not appear to have any measurable effect on average residential potable water usage rates in 2020 (SWIM, 2022). However, it should be noted that SWIM (2022) data on residential potable water usage rates is recorded annually rather than monthly.

3.3 Non-residential water usage rates

Non-residential potable water usage rates that are collected annually by SWIM combine all commercial, municipal, industrial and agricultural supplies (BoM, 2018). Figure 5 presents a comparison of non-residential water usage of businesses in litres per day.

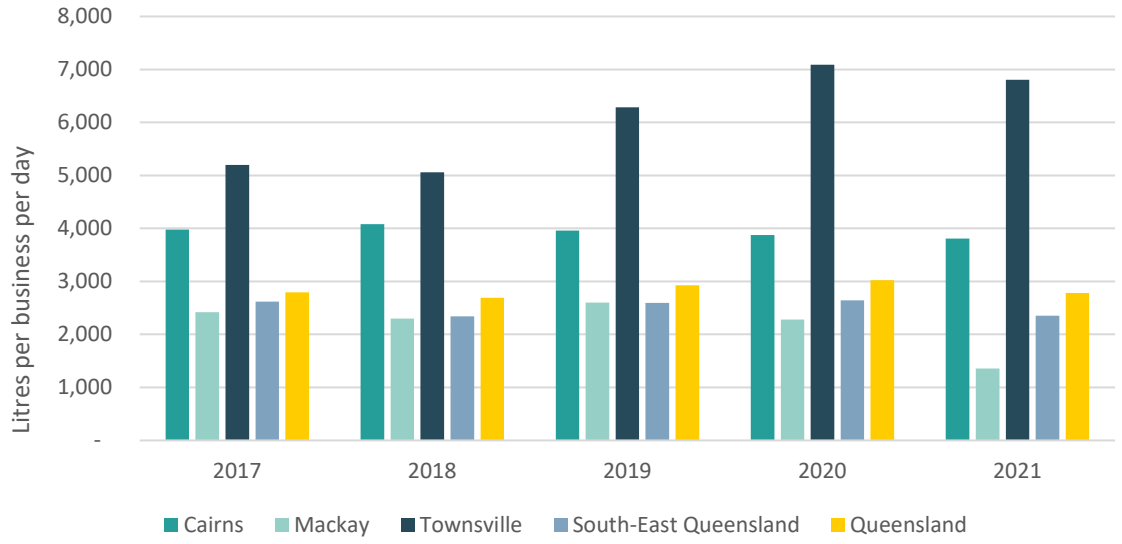

Figure 5. Total non-residential potable water litres per day per business
Source: Statewide Water Information Management (SWIM, 2022)

Townsville's relatively high rates of non-residential water usage are likely a result of relatively high levels of industrial demand when low rainfall for the region is factored in. As non-residential potable sources are aggregated across widely varied sectors and businesses, there is minimal explanatory power in these water usage rates. However, as highlighted in section 3.1, all three regions as well as SEQ show very similar proportions (i.e., 23-26%) of non-residential water demand when aggregated against non-revenue and residential sectors. It should be noted that there are limitations in the relevance of benchmarking non-residential potable water usage as the diversity of uses and commercial opportunities for water use efficiency vary significantly.

Key points

- Non-residential water usage rates are accumulated from a wide range of sectors and businesses.
- Non-residential water usage is comparable at a proportional level across all regions and SEQ.

3.4 Non-revenue water per person

Non-revenue water includes unbilled/unmetered supply water, as well as both real losses (leakage or overflows at storage) and apparent losses (unauthorised use and metering inaccuracy) (BoM, 2018). As seen in Figure 6, Townsville has displayed exceptionally high non-revenue water usage rates over recent years, while Mackay recorded higher rates than SEQ until 2019. It is worth highlighting that Mackay exhibits a trend of reducing its non-revenue water usage rates over the years assessed. Townsville on the other hand has increased, which suggests there is potential for council to invest in pipe maintenance to reduce any excess leakage. Cairns performed by far the most efficiently in its non-revenue water usage with an average daily per person rate of 10L over the period. Unlike

Townsville and Mackay, there is limited potential benefit from Cairns further investing in improving the maintenance of its current water delivery system.

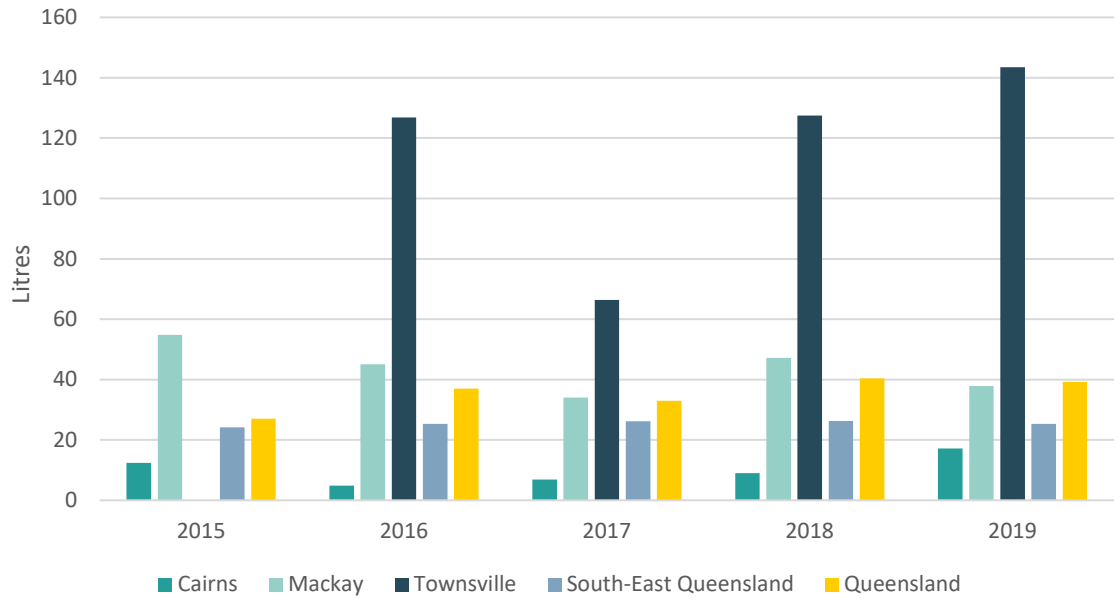

Figure 6. Daily residential potable non-revenue water per person
Source: Statewide Water Information Management (SWIM, 2022)
Note: No data for Townsville in 2015

Key points

- Cairns has exceptionally efficient non-revenue water usage rates, so negligible potential for improvements in the delivery system.
- Townsville has displayed very high rates of non-revenue water usage in recent years, while Mackay is also above the South-East Queensland average.

3.5 Influencing factors on water usage

There are a number of factors that influence demand across regions and time, particularly for household demand. Key factors apart from water use efficiency programs are briefly outlined below.

Rainfall data

SWIM data is a key analytical tool for comparing water usage between regions, however it cannot account for independent water supplies that are excluded from a provider's delivery system. The primary factor here within the scope of residential water use is that of collected rainwater. With an adequate system of collection installed (i.e., roof guttering, downpipes, and a suitably sized rainwater tank), locally collected rainwater should provide a good supply of water for external use (i.e., gardening, irrigation, pool and outdoor cleaning) as well as internal use for toilet cisterns and cold water taps for washing machines. Furthermore, as outlined in Figure 4, outdoor use (irrigating gardens) is a major use of water, and this will be significantly higher during very dry periods and the dry season. Recent Queensland State policy has emphasised the benefits of captured rainwater, and as of the 1st of July, 2022, all new residential and commercial buildings within reticulated water networks must have a rainwater tank installed as part of the build (Queensland Government, 2022).

Annual rainfall data shown in Figure 7 is a strong indicator for the capacity for private residences to collect and utilise rainwater tanks, and the potential low need for irrigating/watering gardens during the wet season. Cairns has consistently recorded the highest levels of rainfall since 2017 of the comparable regions, recording more than triple that of Townsville in 2021 (2,737mm in Cairns compared to 759mm in Townsville). Mackay recorded rainfall of a little over half that of Cairns in 2021 at 1,554mm. Across the 7-year period since 2015, Cairns, Townsville and Mackay have recorded an average annual rainfall of 2,020mm, 940mm and 1,455mm respectively.

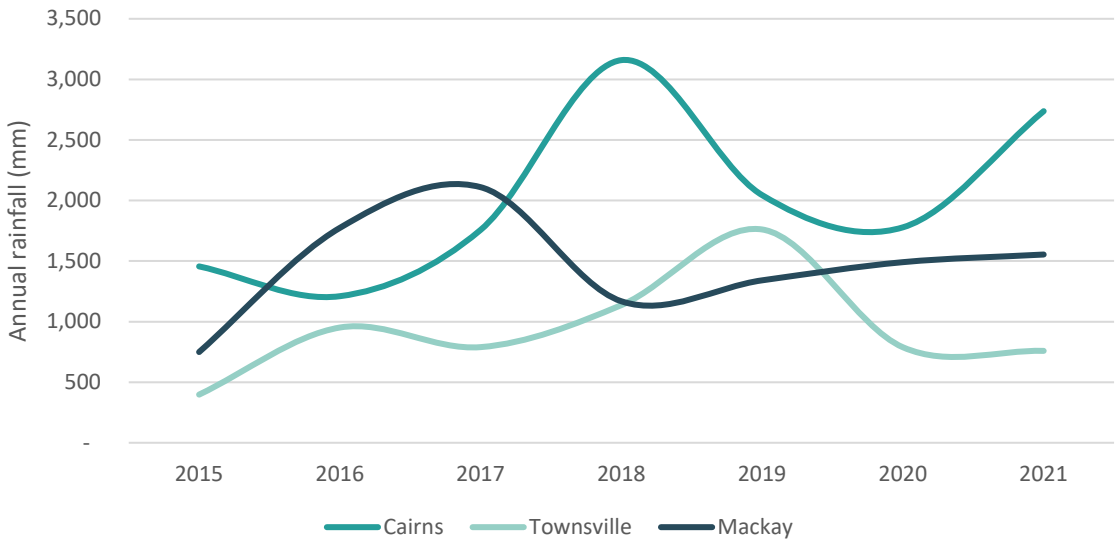

Figure 7. Annual rainfall comparison
Source: Bureau of Meteorology (BoM, 2022)
Note: Rainfall measurements were recorded from stations at Cairns Racecourse (Cairns), Townsville Aero (Townsville) and Alert Station (Mackay)

Monthly rainfall data across the same 7-year period was assessed and is displayed in Figure 8 below. Trends across the three regions are comparable, with larger amounts of rainfall between the months of December and April on average before minimal amounts over the May to October period (the dry season). When incorporating the capacity for residents to effectively capture and store rainwater, monthly rainfall data suggests that residents are likely to access higher amounts of the water provider's supply over these May to November months.

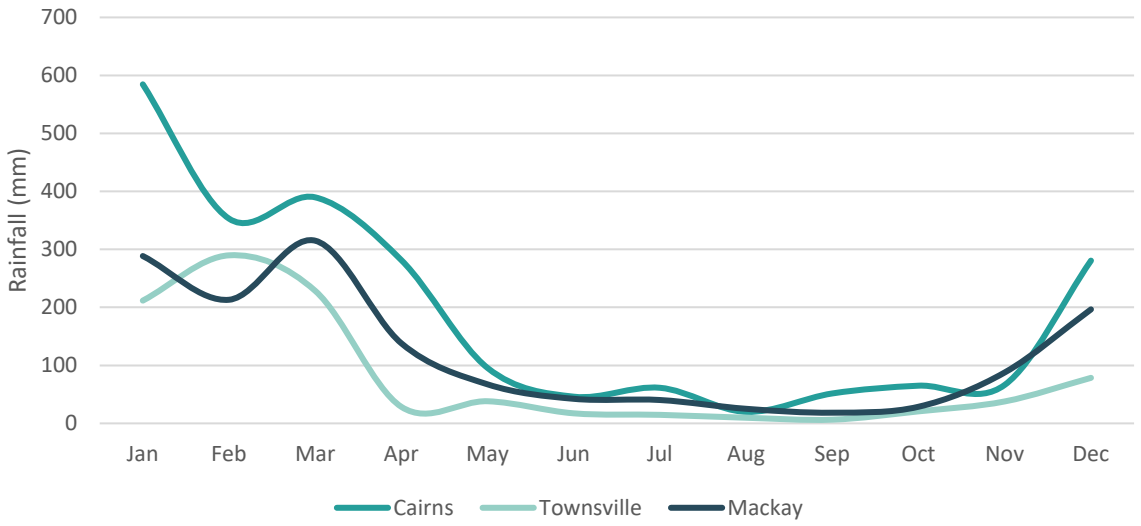

Figure 8. Monthly rainfall comparison (7-year average)
Source: Bureau of Meteorology (BoM, 2022)
Note: Rainfall measurements were recorded from stations at Cairns Racecourse (Cairns), Townsville Aero (Townsville) and Alert Station (Mackay)

Plotting residential water usage rates for each region against annual rainfall helps demonstrate the predominantly inverse relationship that exists between the two variables. As seen in Figure 9 below, Mackay's fairly consistent annual rainfall has been mirrored by its residential water usage rates, while a reduction in rainfall in Townsville since 2019 has seen an inverse increase in water usage rates over that period. In comparison, Cairns has displayed marginal inverse changes in water usage rates while rainfall changes have been widely variable from year to year. The inverse relationship anticipated here for Cairns is small at best, as changes in annual rainfall do not appear to be materially influencing residences' demand for provider supplied water.

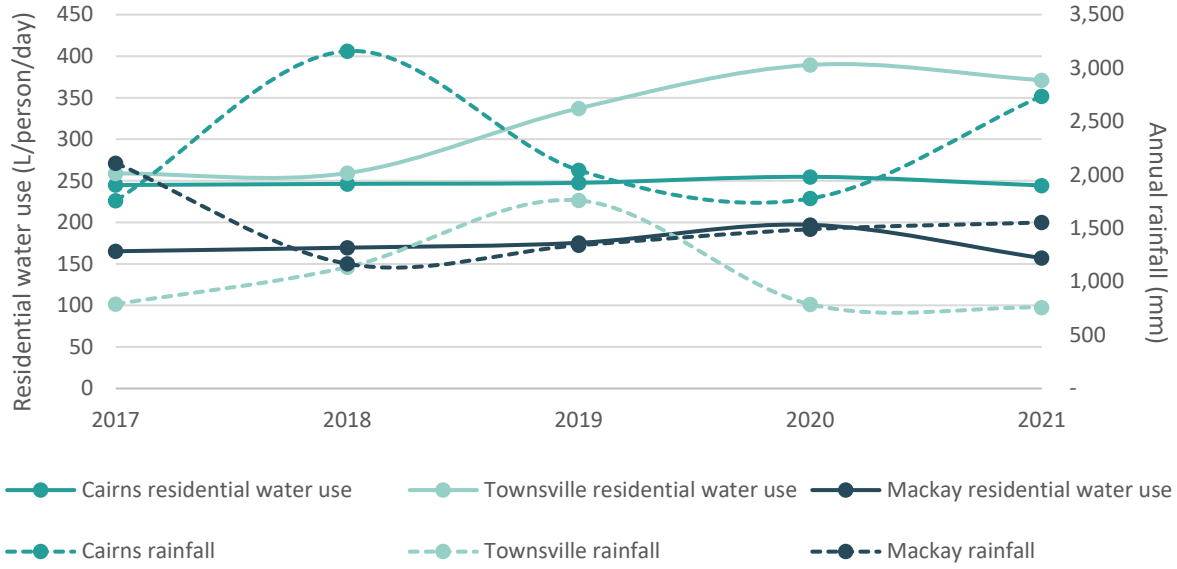

Figure 9. Residential water usage against annual rainfall
Source: Statewide Water Information Management (SWIM, 2022) and Bureau of Meteorology (BoM, 2022)

Key points

- Rainfall appears to be a major driver for residential water usage rates within Townsville, but less so for Mackay and Cairns.
- Cairns has recorded the highest annual rainfall in recent years; however all regions experience a low dry season where dependence on water provider is greatest.

Water service charges

Water service charges for residential connections will have an impact on demand and are set by council each financial year. These generally consist of a fixed access connection fee, as well as a volumetric charge based on the amount of water used. It is the volumetric charge that has the greatest impact on demand as it provides a continuous incentive to reduce water consumption (and avoid costs). Table 2 below compares the various charges for the 2022/23 FY.

Table 2. Comparison of residential water rate charges across councils (2022/23 FY)

LGA/Region	Annual connection fee (fixed)	Volumetric charges (variable)
Cairns	$289.34	$1.48/kL
Mackay	$377.10	$1.85/kl (0-150kL in 6 months) $2.76/kl (150kL+ in 6 months)
Townsville	"Standard Plan": $899	"Standard Plan": $0 up to 772kL $3.44/kL over 772kL
	"Water Watcher Plan": $411	"Water Watcher Plan": $1.65/kL

Source: Various Council websites (2022) and SWIM (2022)

Mackay and Townsville have both implemented incremental or inclining block charging schedules that provide greater incentives for reduced water usage (particularly excessive usage levels). Mackay offers a discount of $0.94 per kL for properties using under 150kL over the 6-month period (equivalent to 822L per household per day), while Townsville offers residents two alternative pricing schedules based on their expected water usage. For Townsville's "Standard vs Water Watcher Plan", cost optimisation implies that households using less than 296kL per year (equivalent to 810L per household per day) are better off selecting the Water Watcher Plan.

Cairns currently has the lowest water charges for the fixed connection fee as well as the variable volumetric charge, and offers no incentives within its pricing structure to benefit residents that reduce their water usage below a certain amount (or penalise residents above a certain amount). This is of particular note when considering that the Cairns Regional Council (2015) has estimated that more than 50% of metered water consumption is billed to only 10% of billing accounts[3]. Cairns' variable water rate increased by $0.05/kL in the 2021/22 FY (Bowles, 2022). However, it should be noted that Cairns, like the other benchmarked councils does implement complementary approaches to water use efficiency such as behavioural change programmes, Water Efficiency Labelling and Standards (WELS), and requirements for water efficient appliances and fixtures in new dwellings.

[3] In Cairns Regional Council's (2015) estimation, metered consumption includes residential and non-residential consumption, of which residential consumption made up 70% of total metered consumption data. This analysis also found that much of the data was concentrated in a relatively small proportion of customers. This may indicate a targeted water usage efficiency program focusing on very large users could be very effective.

Key points

- Water service charges and tariff structures can provide an important and complementary incentive for water use efficiency beyond other behaviour changes programmes and regulated approaches (such as water efficient appliances in new dwellings).
- Cairns offers the lowest rates for both the annual fixed access fee as well as the variable volumetric charge when compared to Mackay and Townsville.
- Townsville and Mackay have both implemented incremental block charging schedules for the variable water usage charge, while Cairns only offers a single rate.
- Based on publicly available information, there is little evidence to suggest that Cairns is using water service charges as a means to incentivise water use efficiency.

Dwelling types and building approvals

Dwelling types refer to the type of living quarters in which a person resides. The composition of a region's types of dwellings is likely to provide partial insight toward its per capita water usage rates. This is because gardening and landscaping are often major sources of residential water usage (e.g., watering lawns and gardens), and the type of dwelling will typically be indicative of garden and landscaping size and requirements (Gan & Redhead, 2013). For example, detached dwellings (which usually represents a separate house) are often built with both a front and back garden or grassed area. Semi-attached dwellings (which represents a row or terrace house, townhouse, duplex etc.) are typically built with a small back garden area, while attached dwellings (which usually represent an apartment or flat) often do not have any form of garden area.

It should be noted that semi-attached and attached dwellings are often built with common area gardens, but these areas are typically significantly smaller per dwelling occupant than what is observed in detached dwellings. It is also worth noting that semi-attached and attached dwellings are often set up on a single meter basis, incentivising residents to use more water as the water costs are shared amongst all residents and a user will not be charged proportionally to their usage. This situation may partially offset the phenomenon described above, that is, water usage rates being higher for detached dwellings than attached dwellings due to larger per resident garden and grassed areas.

Figure 10 below presents 2011 and 2021 dwelling type proportions in the Cairns, Townsville, and Mackay LGA's, as well as the state of Queensland.

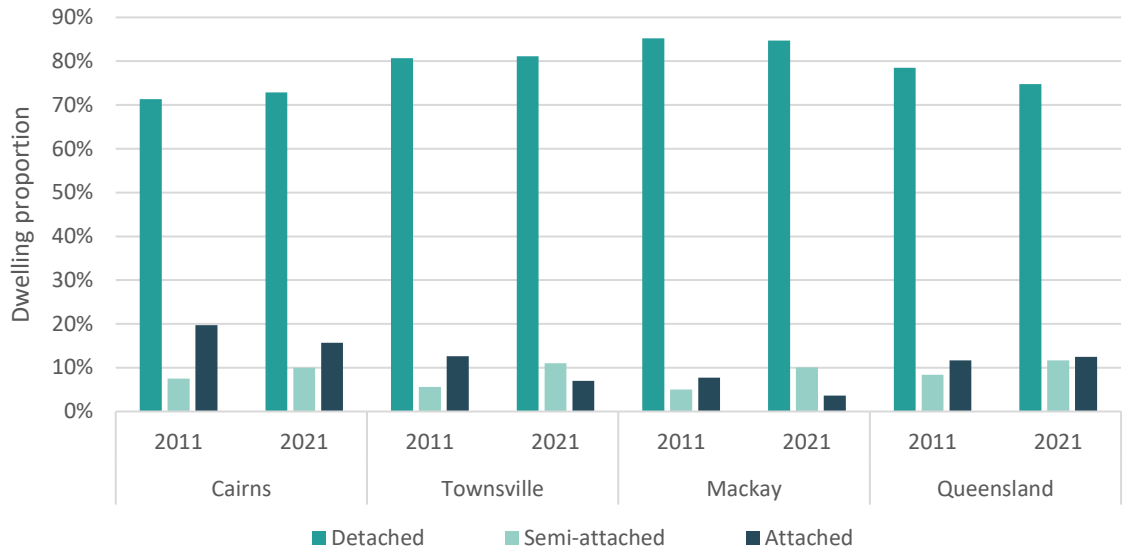

Figure 10. Dwelling types
Source: ABS (2021a)

From the regions analysed, Cairns has the lowest percentage of detached dwellings and the highest percentage of attached dwellings in both 2011 and 2021. Evidently, this suggests that the makeup of dwelling types within Cairns is not a driver in water consumptions among residences. However, Cairns is observed to be the region with the largest increase in detached dwellings between 2011 to 2021. This is an observation that is supported when analysing ABS (2022) building approval data displayed in Figure 11.

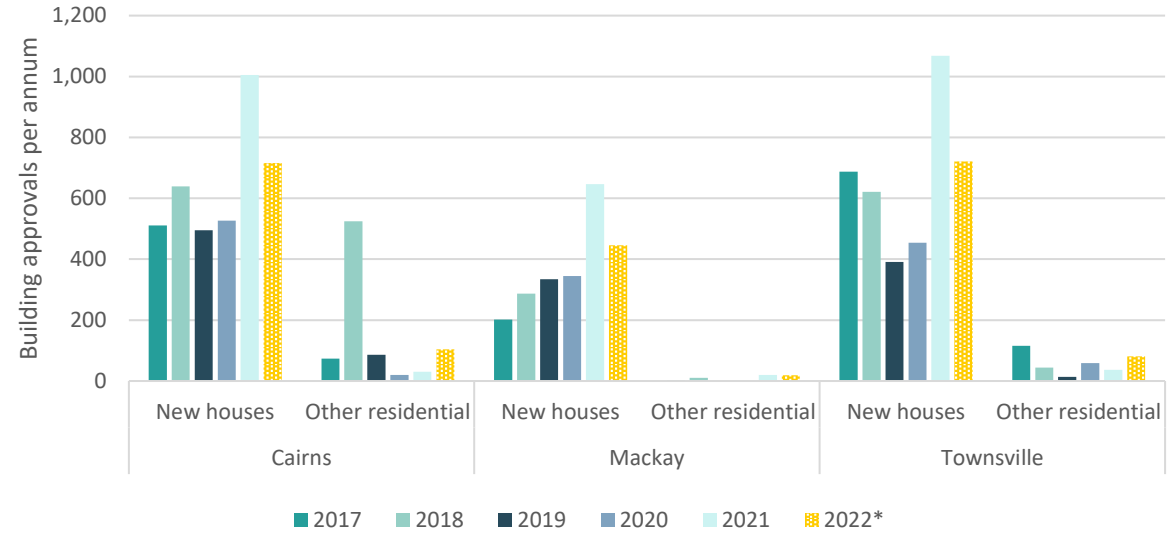

Figure 11. Building approvals
Source: ABS Building Approvals (2017 to 2022)
Note: Other residential includes semidetached, row or terrace houses or townhouses; and flats, units or apartments
*2022 figures up to July

Figure 11 shows that building approvals for new houses increased substantially in 2021 to 1,005 approvals. 2022 has already recorded 716 approvals and appears likely to exceed 2021 approvals given that 2022 figures only represent approvals up to the month of July. This significant growth in building approvals for detached houses is common across Mackay and Townsville as well and is likely

to be a factor in future increased water demand if a preference for detached dwellings over attached dwellings continues.

Dwelling density data collected in the most recent 2021 Census placed the average household density for both Cairns and Townsville at 2.5 persons per dwelling, while Mackay recorded slightly higher at 2.6 (ABS, 2021). Higher density dwellings will generally consume less water per person than lower density dwellings, due to fixed and shared water usages such as outdoor irrigation and washing (Chang, 2017). Considering the comparable density of these three regions, it is unlikely that household size is driving any significant differences in residential water consumption.

Key points

- Detached dwellings have higher associated water usage rates per capita when compared to attached dwellings (i.e., apartments).
- Townsville and Mackay both have higher proportions of detached dwellings compared to Cairns, suggesting that dwelling type would result in higher consumption per capita than Cairns.
- Growth in building approvals for detached dwellings into the future will likely increase water demand across all regions.

4 FUTURE DEMAND DRIVERS

4.1 Population growth

Residential water demand has, historically, largely followed population growth. The Cairns region has a current population of around 169,312, which is expected to grow steadily over the next 30 years. Population growth forecasts supplied by the Queensland Government Statistician's Office (2021) are presented in Figure 12 for the Cairns, Mackay and Townsville LGA's.

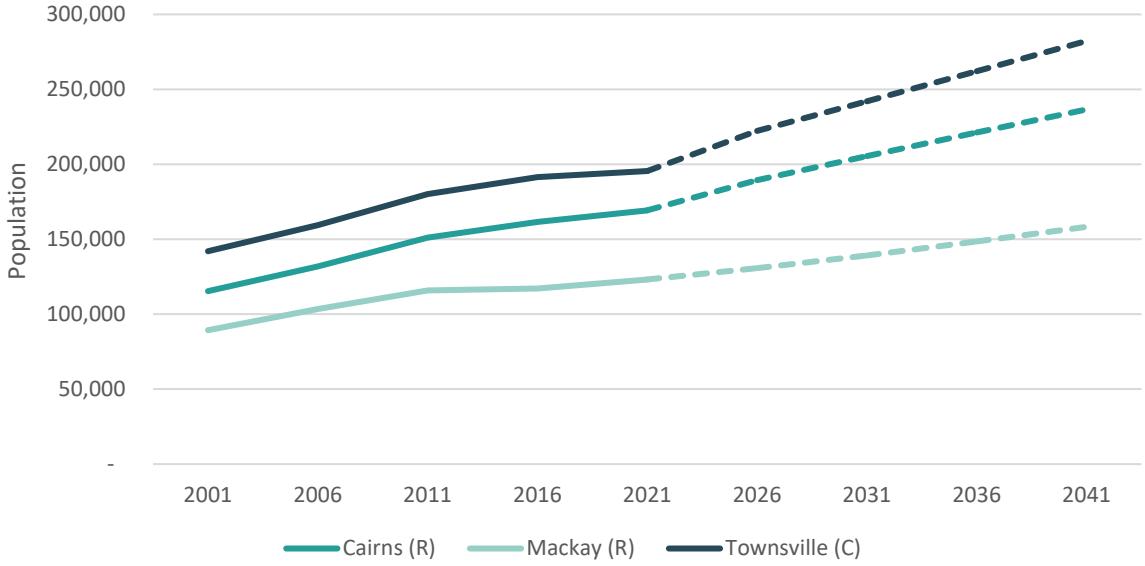

Figure 12. Historical and projected population growth
Source: ABS (2021b) and Queensland Government Statistician's Office estimates (2021)

Population growth forecasts indicate that by 2041, the population in the Cairns LGA will have grown to around 236,593, equivalent to a rate of around 1.7% per annum (see Table 3 below). The LGA's of Mackay and Townsville are projected to increase to 158,280 and 282,281, equivalent to rates of around 1.3% and 1.9% per annum, respectively.

Table 3. Population growth by number of residents

	Increase in number of residents (%)			
LGA/Region	**2016 to 2021**	**2001 to 2021**	**2021 to 2026**	**2021 to 2041**
Cairns	1,548 (0.9%)	2,697 (1.9%)	4,025 (2.3%)	3,364 (1.7%)
Mackay	1,193 (1.0%)	1,692 (1.6%)	1,506 (1.2%)	1,755 (1.3%)
Townsville	833 (0.4%)	2,675 (1.6%)	5,354 (2.6%)	4,338 (1.9%)
South-East Queensland	64,966 (1.8%)	67,072 (2.2%)	85,234 (2.1%)	81,223 (1.8%)

Source: ABS (2021b) and Queensland Government Statistician's Office estimates (QGSO, 2021)

Although Cairns' growth rate is marginally smaller than that of the Townsville (1.9%) and South-East Queensland (1.8%) regions, Cairns' 2020-2041 population growth rate of 1.7% per annum exceeds the expected 1.6% average across Queensland. Overall, Cairns' expected population growth will result in increased urban water demand in the region. With a finite water supply, demand-side allocation will continue to grow in importance.

Key points

- Expected population growth is an indicator of future urban water demand.
- Cairns population is forecasted to rise from 169,312 to 236,593 by 2041, equivalent to a rate of approximately 1.7% per annum. Expected population growth will likely result in increased urban water demand in the region.

4.2 Tourism rates – equivalent population

When considering future urban water demand, it is important to account for the water requirements of a region's tourists in addition to a region's local population. It has also been documented, at an international level, that per capita water use by tourists tends to exceed that of local residents (see, for instance, Narasaiah 2005; De Stefano 2004). Australian specific research is minimal, however Mclennan et al. (2017) found average per guest water use by hotels in Australia was around 313L, exceeding the daily residential water usage rates (tourist population included) for all regions seen in Figure 3 (with the exception of Townsville).

Using 2019 overnight stay data collected by Tourism Research Australia (TRA), a tourist equivalent population for Cairns, Mackay and Townsville was calculated. Furthermore, using TRA's (2022) tourism forecast for domestic overnight stays in Queensland, a tourist equivalent population was projected for 2025-26. Figure 13 details current (2019) and projected (2025-2026) tourist equivalent population for the LGA's of Cairns, Mackay and Townsville.

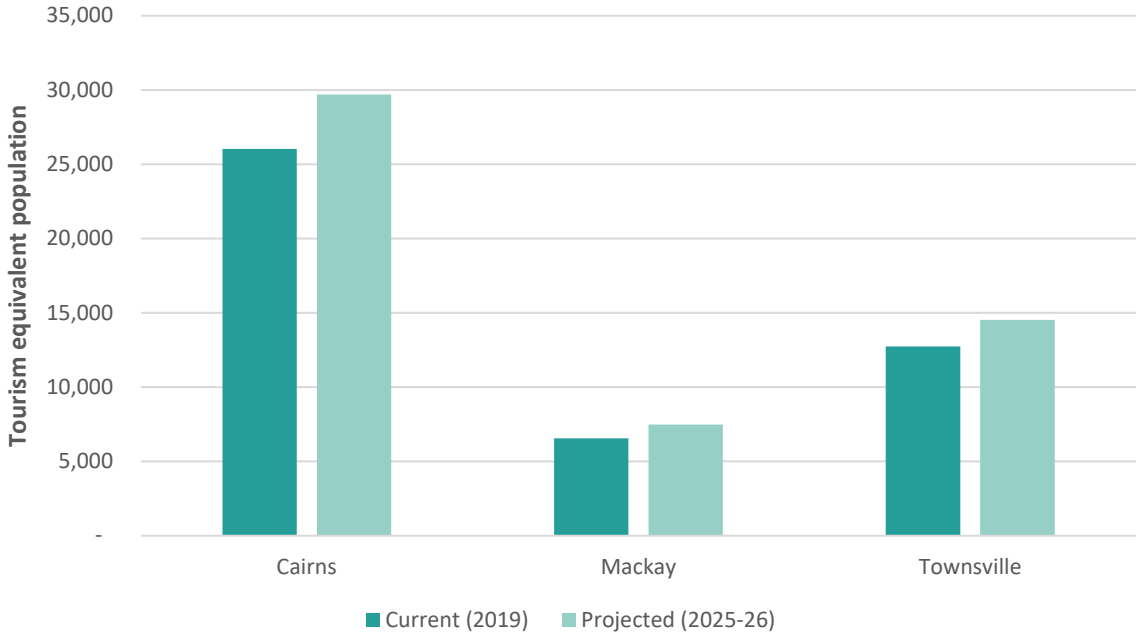

Figure 13. Tourism equivalent populations
Source: TRA (2019) and QGSO (2021)

When evaluated against the key comparable regions, Cairns is found to possess a substantially higher tourism equivalent population, of which is projected to further increase in the future. Furthermore, understanding what a region's tourist equivalent population is as a proportion of its standard population can provide further insight on how its demand for water is affected by tourist's high water usage rates. Table 4 displays the tourist equivalent population as a proportion of standard population for the LGA's of Cairns, Mackay and Townsville.

Table 4. Tourist equivalent population as % of population

LGA/Region	Current (2019)	Projected (2025-26)
Cairns	15.6%	15.7%
Mackay	5.5%	5.7%
Townsville	6.6%	6.5%

Source: TRA (2019), TRA (2022) and QGSO (2021)

When compared to Mackay and Townsville, Cairns is found to possess a significantly higher tourist equivalent population as a proportion of its standard population. Consequently, Cairns' proportionally high tourism levels may play a considerable role in the high per capita water usage rates that are observed in the region.

Due its suspected high tourism equivalent population, the Gold Coast LGA was another region observed and benchmarked against Cairns. The Gold Coast was found to possess the highest tourist equivalent population amongst the comparable regions, with a population of 65,282. The Gold Coast, however, was found to possess a lower tourist equivalent population as a proportion of its standard population (10.6%), than Cairns. Considering its relatively high tourist equivalent population, the Gold Coast's Demand Management Plan (City of Gold Coast, 2019) was examined to understand if effective initiatives were in place that seek to best manage the region's high tourist equivalent population. No such strategies were observed to be in place, which is likely because the region experiences minimal water supply issues. Furthermore, the initiatives outlined in the Gold Coast's Demand Management Plan were found to be similar to those that are discussed in this report.

Key points

- Tourists typically use more water per person than local residents.
- Tourist equivalent population as a proportion of standard population is considerably higher for Cairns, which may partially explain its high per capita water usage rates.
- Tourism and tourist equivalent population as a proportion of standard population is projected to increase in the future.

4.3 Climate change

The increased variability of climatic conditions resulting from climate change is likely to impact the future supply of water in the Cairns region, increasing the need for greater demand-side efficiencies. There are many different climate models that can be used to consider potential climate change impacts in the future. This section utilises the Queensland Government's eleven high-resolution climate models (10 km grid) to understand the likely long-term changes of both precipitation and pan evaporation within the Cairns, Mackay, Townsville and South-East Queensland regions across the various time periods of 2020-2039, 2040-2059, 2060-2079, and 2080-2099. Precipitation and pan-evaporation projections under the RCP8.5 climate change scenario are detailed below in Figure 14, and Figure 15, respectively[4]. Data points correspond to the average values across the set of eleven models for each region, while the error bars represent the minimum and maximum estimates.

[4] RCP stands for 'Representative Concentration Pathway'. RCPs try to capture future climate trends and predict how concentrations of greenhouse gases in the atmosphere will change as a result of human activities. The four RCPs range from very high (RCP8.5) through to very low (RCP2.6) future concentrations. The numerical values of the RCPs (2.6, 4.5, 6.0 and 8.5) refer to the concentrations in 2100. (Coastadapt.com, 2017)

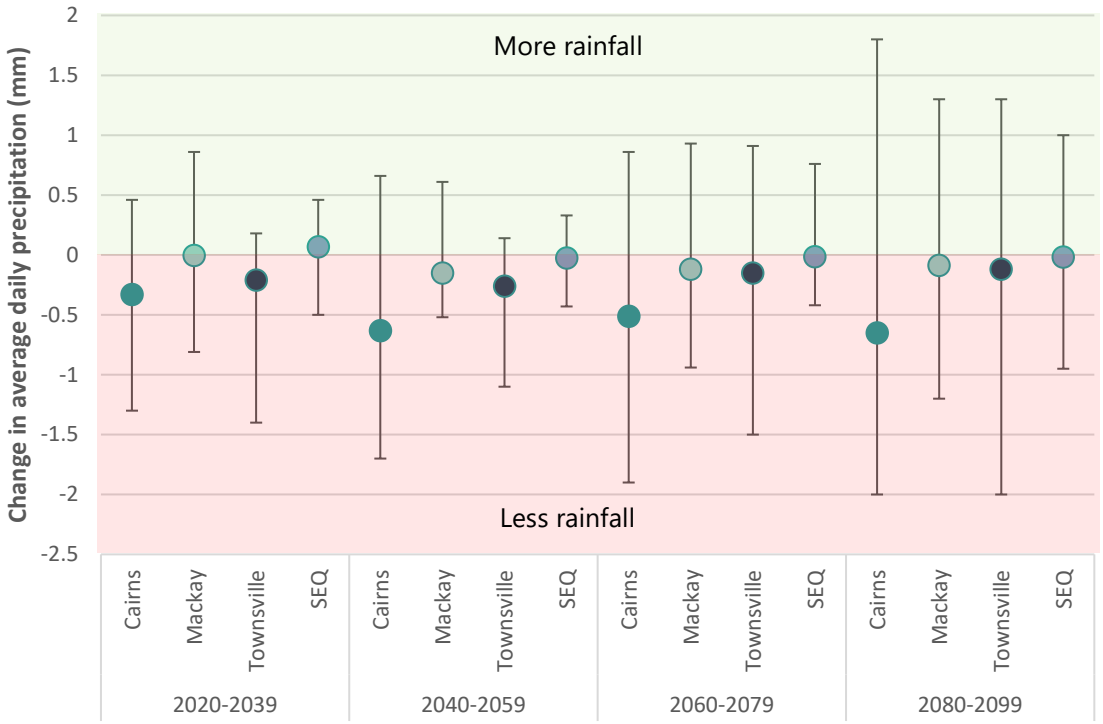

Figure 14. Precipitation projections
Source: Queensland Government (n.d.)
Note: Change (mm/day) relative to the reference period 1986–2005

The models project that, on average, precipitation levels are likely to be below reference period levels for all regions across all time periods (with the exception of South-East Queensland in 2020-2039). From the regions analysed, Cairns is found to be the region with the largest potential decrease in precipitation levels across all time periods. Furthermore, Cairns is also found to be the region with the largest range between min and max projections for the eleven climate models across all time periods. With the average across all models suggesting a decline in precipitation of up to 0.65 mm/day by 2080-2099, the Cairns LGA's need for reducing demand side inefficiencies to ensure future water security will continue to grow due to decreasing water supply (in the scenario that current storage capacity is held constant).

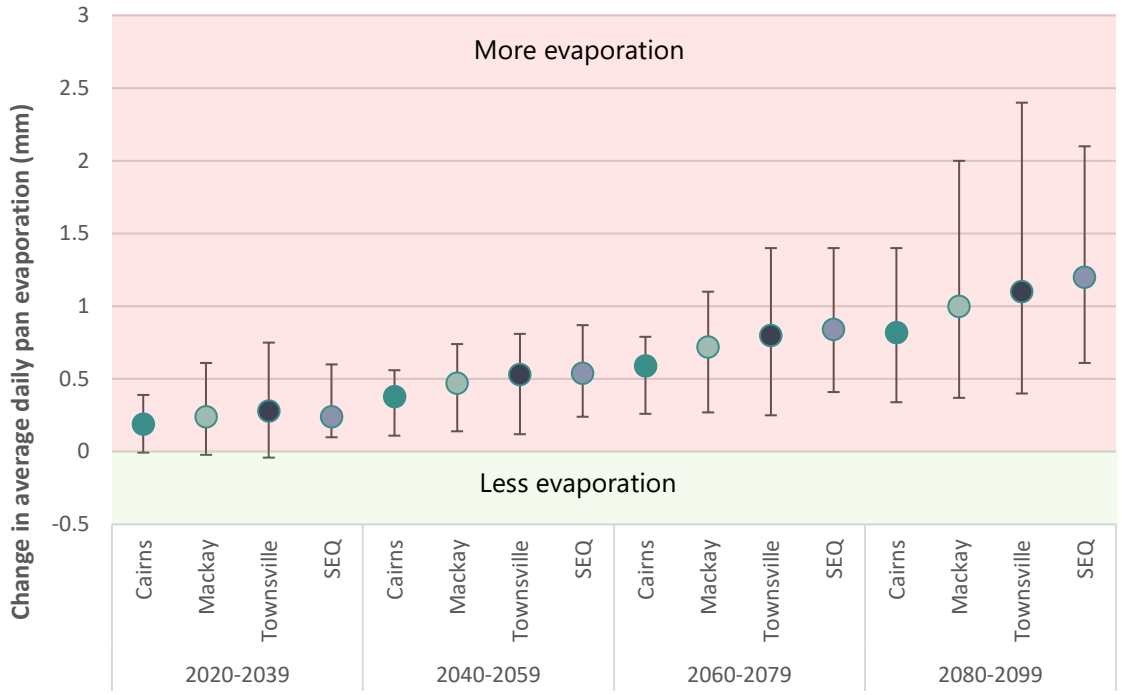

Figure 15. Pan evaporation projections
Source: Queensland Government (n.d.)
Note: Change (mm/day) relative to the reference period 1986–2005

For pan evaporation, the models project that, on average, levels are likely to be above reference period levels for all regions across all time periods. From the regions analysed, Cairns is found to be the region with the smallest decrease in pan evaporation levels across all time periods. Furthermore, Cairns is also found to be the region with the smallest range between min and max projections for the eleven climate models. Although when evaluated against key comparison regions, Cairns is found to possess the lowest changes in pan evaporation levels from reference period levels. That said, pan evaporation levels are still projected to increase. Increasing pan evaporation levels are likely to decrease water supply, increasing the need for the reduction of demand side inefficiencies to ensure future water security.

Key points

- Reducing levels of precipitation resulting from climate change are likely to decrease water supply, exacerbating existing water management issues.
- Increasing levels of pan evaporation resulting from climate change are likely to decrease water supply, exacerbating existing water management issues.
- While future climate scenarios do vary widely, there is evidence to suggest that Cairns may be more vulnerable than the benchmark regions.

4.4 Policy discussion

Future water security has been a considerable point of discussion in recent years for local councils within Queensland, with a range of local and state driven initiatives being introduced. Cairns, Townsville, and Mackay are no exception, with Cairns first introducing its first Water Security Strategy investment plan in 2005. The situation since then has grown significantly in magnitude, with the most

recent 2021 Water Security Business Case projecting that demand could exceed supply by as early as 2026 if nothing is done.

Cairns Regional Council has invested in both system-side and customer-side actions since its first Water Security Strategy was put in place, and it is evident from the non-revenue volumes of Cairns' water distribution that there is little potential improvement remaining on increasing efficiencies on system-side infrastructure. The installation of real-time leak detection meters, as well as the ongoing maintenance and optimisation of raw water treatment plant operations are some of the major efficiency-enhancing factors that have driven this improvement (Cairns Regional Council, 2015).

Key point

- Beyond the current infrastructure efficiency improvement initiatives being progressed by Cairns Regional Council, opportunities to improve *existing* supply infrastructure to meet future needs and risks may be limited. This infers that options are becoming limited to demand measures and major augmentations of supply.

Considering the comprehensive analysis of likely drivers of water usage rates within Cairns, residential rates of water usage are still higher than would be expected. The lower detached dwelling makeup, in addition to the higher average rainfall experienced in Cairns would suggest that water usage rates would be highly comparable or less than the demands of both Townsville and Mackay. Incorporating the larger tourism adjusted population does provide some explanation for higher residential water consumption rates in Cairns, but evidently there are still significant inefficiencies present on the customer-side. This is most obvious when compared against Mackay and South-East Queensland.

Key point

- Even when accounting for several factors that drive residential demand, the benchmarking indicates that per capita water use in Cairns is higher than would normally be expected. This indicates there may be significant untapped opportunities for demand management.

One demand-side initiative that has likely assisted in Mackay's low water usage rates has been the implementation of integrated or "Smart Water Meters" (Mackay Regional Council, 2020). These devices provide accurate and real time information of properties' water consumption to providers, while also allowing residents to access their water usage and track peak-times. Previously, this data was collected intermittently by council workers, with residents being informed of water usage upon receiving their annual or bi-annual water bill. Cairns is also currently in the process of rolling out a Smart Water Meter project. Phase 1 of the project was completed at the end of 2019, with a small-scale installation of 697 gauges in the suburb of Palm Cove. 50,000 gauges are expected to be installed by mid-2025 within the region (Cairns Regional Council, 2022d). Access to real-time data is anticipated to provide residents with a better understanding of their demand, however, a regional comparison of the relatively low current pricing schedules for water charges in Cairns suggests that efficiencies can be gained from introducing newer pricing policies.

Both fixed connection charges and variable volumetric charges in Cairns were considerably lower than Townsville and Mackay, which have both elected to offer properties tiered water consumption rates or multiple pricing plans. Cairns Regional Council's adoption of a constant variable charge per kL does not provide any extra incentive for residents to reduce water consumption beyond a point, while also not providing a relative cost-saving to residents that are consciously reducing their household water usage. Townsville and Mackay have elected to use a threshold annual water consumption rate equivalent to 295kL and 300kL per household per annum respectively (translating to 810L and 822L of water per household per day). South-East Queensland also uses a tiered water consumption rate with a threshold of 822L per household per day (Urban Utilities, 2022). Equivalent consumption charges

increase significantly (more than double) when residents exceed these thresholds, providing incentive to be more water conscious. Cairns has the opportunity to implement similar pricing policies, in addition to increasing the base fixed and variable usage charge rate to align with rates seen in Mackay and Townsville.

Key point

- Initiatives including smart water meters and inclining block water service tariffs have been deployed in other councils with a degree of success. Such initiatives have not been utilised in Cairns to date, with the exception of a small-scale rollout in Palm Cove.

It is instructive to consider a 'what if' scenario when considering the potential demand in Cairns if the demand was more akin to the best-case users in the region (i.e., Mackay). A basic scenario for future residential water demand has been calculated, using projected population figures from QGSO combined with the 5-year average residential water consumption rates of Cairns and Mackay. Mackay has been used as a best-case scenario benchmark for this purpose, with the assumption that Cairns is able to reduce its per capita water consumption rates to the same levels. Figure 16 presents a 20-year assessment of these two models out to 2041, with water usage rates for each model held constant but with the population of Cairns increasing as projected. Note that this scenario does not include a tourist equivalent population for either region, as there are no projections available past 2025.

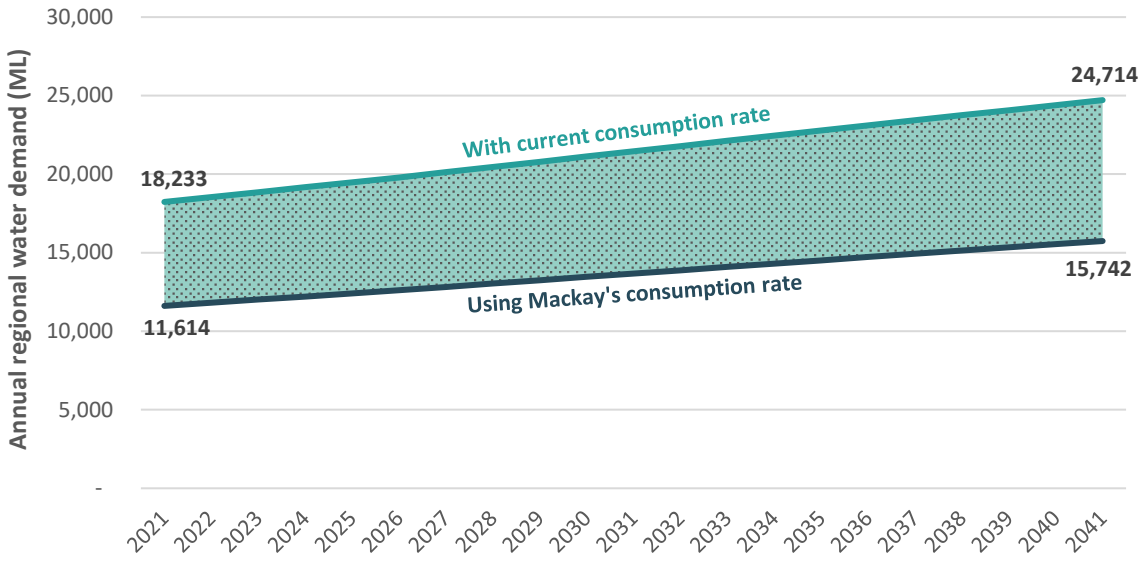

Figure 16. Scenario analysis of projected annual residential water consumption
Source: Statewide Water Information Management (SWIM, 2022) and QGSO (2021)

Assisted by effectively implemented policy, if residents within Cairns were able to reduce their current water usage per person to Mackay's levels, this would reduce current demand in 2021 by 6,619ML, growing to a saving of 8,972ML by 2041[5]. Across the 20-year period, this would save the region a total of 163,603ML. In fact, if Cairns could achieve the same levels of residential water use efficiency as Mackay, demand in 2041 would be significantly lower than current levels.

[5] 1 Megalitre (ML) is equivalent to 1,000,000 Litres.

Key point

- If Cairns could achieve residential per capital use levels similar to Mackay via efficiency measures, residential usage would be almost 9,000 ML per annum lower than the current trend by 2041.

5 CONCLUSIONS AND RECOMMENDATIONS

This comparative analysis has assessed a variety of factors that influence water consumption rates across the regions of Cairns, Mackay and Townsville. By quantitatively contrasting these regions, as well as benchmarking them against greater South-East Queensland, a more informed evidence base can be drawn upon for decision-making in the future. Cairns has already established the need for urgent action with growing demand expected to outstrip current storage capacities within the next five years. Cairns Regional Council has already made significant investment in enhancing infrastructure that supports more efficient water delivery and has now yielded nearly all potential improvements within the confines of their current system and storage capacities.

This report has provided evidence to suggest that within the short-term, there are still significant gains for Cairns to be made on improving efficiency on the customer-side of demand. All key drivers of water usage have been compared across regions, with current data (i.e. dwelling type proportions, average rainfall, and tourism visitation) suggesting that Cairns residential water usage rates should be in closely in line with that of Mackay but are in fact considerably higher. Future key drivers, namely projected population growth, building approval rates and climate change scenarios all indicate that urban water demand will continue to grow strongly into the future. While residential water usage rates within Townsville consistently exceeds those of Cairns, supply held by the Ross River Dam that supplies the Townsville region far exceeds that of the Copperlode Dam (approximately 233,000ML compared to 38,400ML). Non-residential water rates within Cairns largely align with those of other key regions and are therefore unlikely to be a driving factor in high levels of total water consumption.

Since 2015, customer-side investments in the form of community education and water-awareness programs[6], Water Efficiency Labelling and Standards (WELS) and the installation of water efficient appliances for new residential and non-residential developments have been implemented with the aim of reducing consumer demand. Residential water usage rates however have remained effectively constant over the period since.

However, there are further opportunities that could be further utilised, including but not limited to:

- Introduction of Smart Water metres may provide some efficiencies though better and more timely information for users.
- Pricing and tariffs such as inclining-block tariffs to incentivise water use efficiency.

These initiatives would be deliberately implemented to incentivise reduced household use and decrease the current strain on the limited water supply where supply-side opportunities are limited.

Non-residential water charges should also be incorporated into this price restructure. Evidently, demand-side policies are the most effective short-term solution available to reducing current water demand for Cairns, while funding for longer-term storage expansion is pursued.

[6] Community education in recent years has come in the form of online resources targeted towards children/schools. Queensland Water Regional Alliance Program (2016) notes the importance of educating a wide range of audiences for effective community engagement, including consumers who pay for water.

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