CGW
Consulting Engineers

Water Use and Loss Report

Water Take Resource Consent

Nelson City Council

Document Number: 14000-278-02

Date: 4/11/2014

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1. Introduction

CGW Consulting Engineers (CGW) have been engaged by Nelson City Council (NCC) to provide information to support the application for a new Water Supply Resource Consent in 2016-17. This report addresses the following items.

Water Loss: Comparing water loss downstream of the NCC Water Treatment Plant (WTP) to other councils in New Zealand using the Infrastructure Leakage Index.

Water Demand: Providing an estimated water demand for NCC over the forward planning period and comparing this to other regions.

Source Data

NCC provided the following data

- Total water billed and number of connections for residential and non-residential users from 2000-2014 on a biannual basis
- Daily water treatment plant output from 2004-2014
- Infrastructure Leakage Index calculations from 2005-2013
- Total water billed for all NCC Parks and Reserves from 2008-2013

In addition, data was requested from the following local authorities:

- Tauranga District Council: All connections metered and billed
- Tasman District Council (Richmond): All connections metered and billed
- Hastings District Council: 2% residential, 60% commercial and 85% industrial users metered
- New Plymouth District Council: Commercial metering only, small number of residential properties metered for reference
- Christchurch City Council: All users metered, currently not billed since earthquake
- Dunedin City Council: All commercial users metered, residents have meters for council reference only

All councils with the exception of Dunedin were able to provide some data. In some cases data received was incomplete or inconsistent with the NCC recording methodology. In the case of Richmond, New Plymouth and Christchurch, data was only provided for an individual year. Where data was provided for a longer duration, consumption for the last 5 years was averaged.

Consumption data was also obtained from a report previously completed for Tauranga City Council (Blakemore, R., and Burton, S., 2006). This data is for 2005 and hence a different time period to the data directly sourced from local authorities however it provides a useful reference. Water loss data was also obtained from the Water New Zealand National Performance Review 2011/12.

2. Water Losses

Water loss data using the Infrastructure Leakage Index (ILI) was obtained from the following councils. Some data supplied by councils could only be used in part due to incomplete or inconsistent reporting. Data from the Water New Zealand National Performance Review 2011/12 is indicated by * on the list below.

- NCC
- Tauranga City Council (TCC)
- Christchurch City Council (CCC)
- Tasman District Council (TDC - Richmond)
- Hamilton City Council* (HCC)
- Invercargill City Council* (ICC)
- Rotorua District Council* (RDC)
- Veolia Water Papakura* (VWP)
- Whangarei District Council* (WDC)
- Waikato District Council* (WKDC)

Previous work undertaken by Water New Zealand has noted the difficulty in comparing water loss between different councils due to the variability in measurement and reporting of data. In 2009-10, Water New Zealand found that ILI values reported by councils varied from 0.2 to 5.8. Upon review by Water New Zealand, these figures were adjusted to 0.9 to 3.5. Despite this adjustment, ILI data was omitted from reporting that year due to poor reliability (Water New Zealand, 2010, pg 13). This report highlighted the need for consistent national reporting of water loss statistics.

A summary of the data obtained as part of this investigation is summarised in Figure 2.1 below.

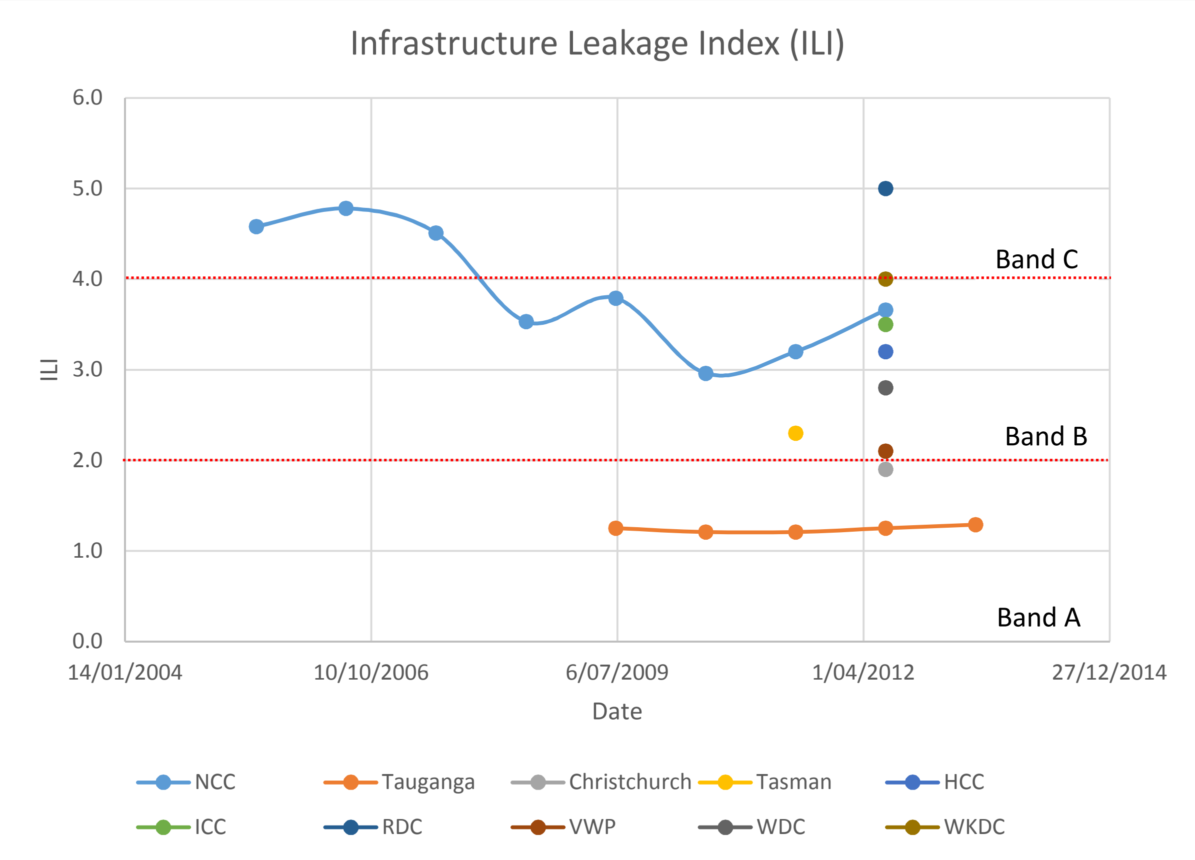

Figure 2.1: Infrastructure Leakage Index

TDC and CCC were able to provide data for one year only. All data only provided for one year should be viewed with a degree of caution however it provides a useful reference. Data for NCC and TCC was available for a minimum of five years. In both cases the data was consistent and is therefore considered reliable.

Figure 2.1 includes reference to the performance bands defined by the World Bank as follows.

Band A: Indicates future attempts to reduce loss may be uneconomic

Band B: Potential for marked improvement

Band C: Indicates a poor leakage record

NCC are currently tracking towards the upper end of Band B; this is in the upper quartile when compared to other regions for which data was obtained. The average real loss in NCC over the past 5 years is approximately 290 L/day per connection, compared to Tauranga at 100 L/day per connection. If losses in the NCC system could be reduced to that observed in Tauranga, annual water production in NCC could be reduced by 1400 ML/year or 20% of current production.

Further analysis of NCC water loss shows that the ILI was consistently trending lower until the 2011-2012 financial year. This coincided with the commencement of the installation of Ultrafast Broadband network and hence a significantly greater amount of construction work in the NCC region. This could impact on NCC water loss, both through an increased number of strikes on NCC water services and more contractors taking water from NCC hydrants.

Use of water produced by the NCC water treatment plant over the past 6 years is represented graphically in Figure 2.2 below. This shows that the average unbilled usage is roughly equivalent to commercial use over this period. On average, approximately 30% of the WTP output is unbilled, indicating there is significant opportunity to reduce water treatment and reticulation costs by identifying and reducing sources of loss within the reticulation system.

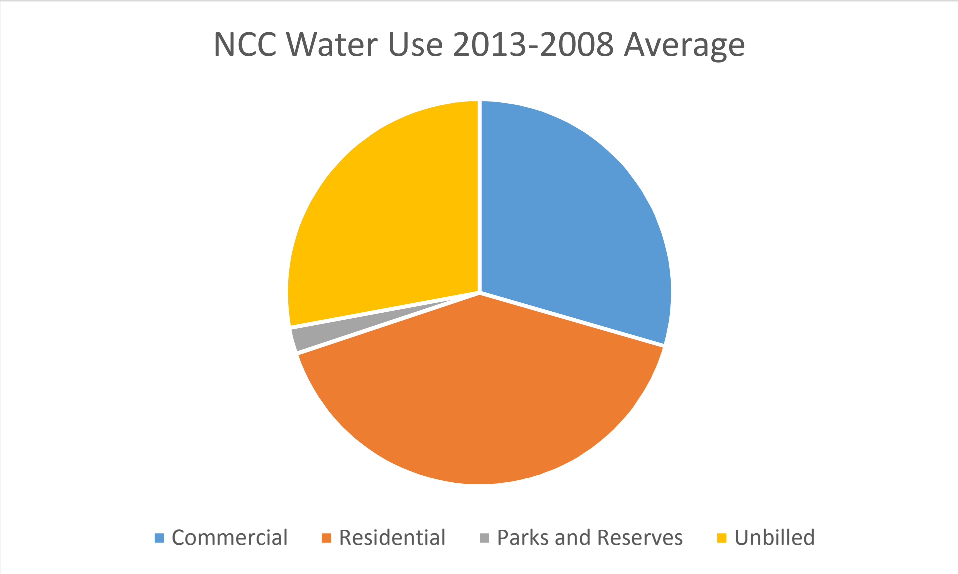

Figure 2.2: NCC Water Use 2013-2008 Average

2.1. Water Loss Reduction Methodologies

This report considered the experience of other councils to determine methods to identify sources of water loss.

These approaches fit into two categories, a reduction in real losses and improvements in the calculation of losses.

Real Loss Reduction

Monitoring of Supply Zones

To more readily identify the sources of water loss, the NCC reticulation should be monitored as a number of discrete zones. In the case of Waitakere City Council, this approach lead to real water losses being reduced from 130 L/day per connection to 60-70 L/day per connection over 10 years and maintained at this level (Taylor, R., 2008). CGW understand NCC has completed some work monitoring losses in individual supply zones. In order to be effective, a systematic approach is required to allow the worst performing areas to be identified and targeted for leak detection work. NCC could implement a similar procedure as follows

- Identify discrete supply zones within the city which can be monitored using existing flow meters to log instantaneous flow rates
- Identify areas where additional flow meters are required
- Compare 24hr flow rates to the standard diurnal curve to identify areas for improvement, for example where night flows exceed minimum expected values
- Use the results of flow monitoring to recommend areas for further investigation, for example leak detection

From discussions with NCC, it is understood that Atawhai and Stoke could be monitored as discrete supply zones using current infrastructure. Whilst priority could be given to monitoring areas based on infrastructure age, recorded bursts etc, all areas need to be monitored as separate zones to obtain full benefit from this work. Zone size can be dictated by the existing supply system however initially, separating Nelson into 6-7 supply zones would be adequate to identify target areas.

Water Balance

Following on from the supply zone monitoring outlined above, the total volume of water supplied to a given zone could be compared to billed water use within those zones. The ratio of billed vs unbilled use could be compared to the NCC average to identify areas for further investigation.

Similarly, the total volume of water leaving the treatment plant could be compared to the total water entering specific zones to identify losses within trunk water mains.

Leak Detection

Leak detection work by Waitakere City was prioritised based on the zone monitoring work as detailed above. Leak detection was only completed when minimum night flows exceeded a specific value. Contracts for leak detection were paid so that 50% of the contract sum was based on performance in reducing night flows.

Pressure Management

It is understood that NCC have previously undertaken a pressure reduction program. It is not known if the results of this program have been analysed and opportunities for further improvement have been identified. This analysis should be completed to determine if pressure management should be extended to other areas.

Loss Calculation Accuracy

Main Bursts and Flushing

From the 2012-13 NCC water loss calculation Spreadsheets, water losses due to mains bursts or strikes are estimated based on 500 events per year. No losses are attributed due to mains flushing because there is no routine mains flushing program currently in place. Anecdotally, it is understood NCC have had a number of water quality complaints over the past 12 months and flushing of the reticulation has generally been completed in response to these complaints.

If the number and duration of flushing events and mains bursts were accurately recorded, the accuracy of the ILI calculations could be improved.

Flow Meter Calibration

Bulk flow meters must be installed and operated in accordance with manufacturer's requirements to ensure the accuracy of ILI calculations, this includes:

- No flow disturbances within the specified distance of the flow meter
- Flow rates are within the specified range; flow meters are typically inaccurate at velocities of less than 1m/s
- Calibration of flow meters completed in accordance with manufacturers requirements

Modification of equipment at some time after installation or flowmeters incorrectly sized to measure the full range of flow rates expected flows are common issues that contribute to flow meter inaccuracy. It is assumed that errors in individual meters significant enough to contribute to perceived water loss would be identified by either extremely high or low bills.

3. Water Demand

3.1. Residential Water Consumption

3.1.1. Water Demand

Average Demand

A summary of average daily residential water consumption for a range of council areas is presented in Figure 3.1 below.

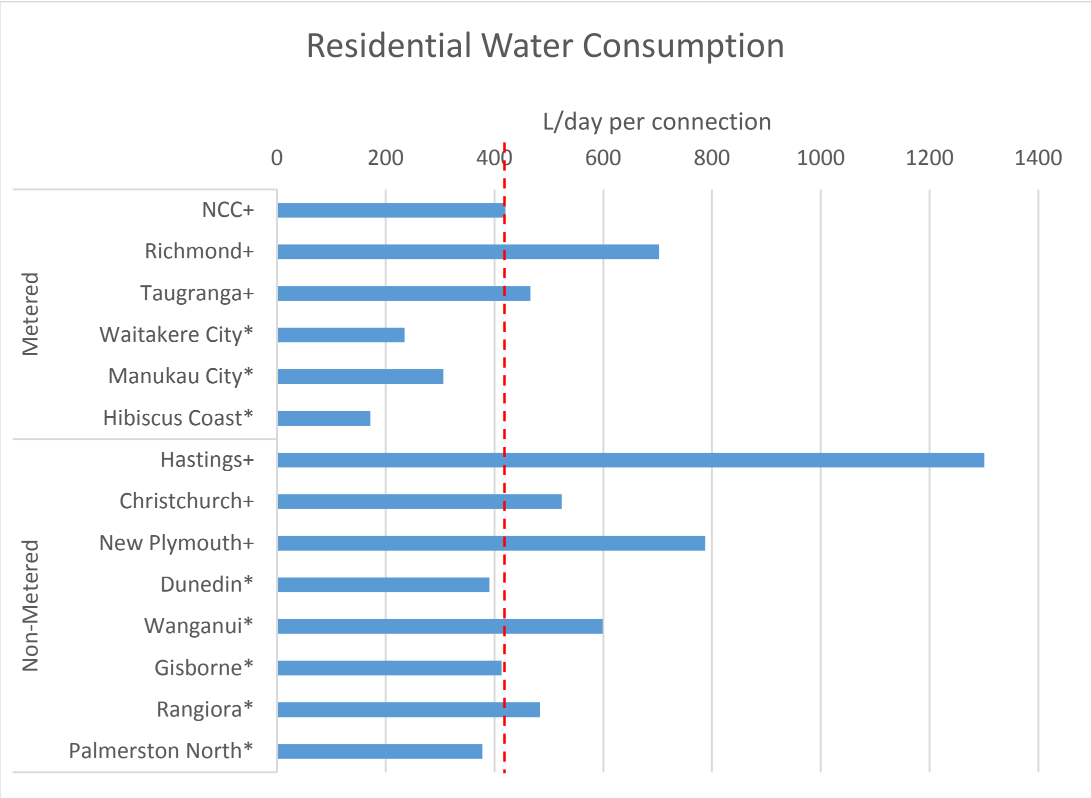

Figure 3.1: Residential Water Consumption

+Indicates data obtained directly from the relevant Council

*Indicates data from report prepared by others (Blakemore, R., and Burton, S., 2006)

Five year consumption data based on universal metering was provided for NCC and Tauranga, therefore this data is considered the most reliable. Consumption within Nelson City and Tauranga is reasonably consistent at 420 and 466 L/day per connection respectively.

The Richmond water supply services a number of restricted, but un-metered rural connections. Residential consumption for New Plymouth is unmetered however it is calculated based on the few properties that are metered and accounts for an industry standard 20% reticulation losses. New Plymouth also supplies a number of rural properties.

Data for Hastings district was also available for every year since 2001. This data was relatively consistent and is hence considered reliable, however as there is no universal metering, this data was calculated by subtracting metered commercial use (60% of commercial and 85% of industrial connections) from the total volume of water leaving the treatment plant. This includes some commercial and industrial connections as well as reticulation system losses. Actual residential usage is likely to be lower.

This data demonstrates the effect water metering has on reducing consumption. NCC's average residential water consumption of 420 L/day per connection or 165 L/day per person is relatively low when compared to other towns. As a comparison, AS/NZS1547:2012 states that typical daily wastewater flows (i.e. internal water use only) for reticulated water systems are in the order of 200L/day per person. This indicates that water consumption within the NCC area is unlikely to include significant discretional usage, for example outside use, and is therefore unlikely to drop further in terms of water use per connection.

Peak Demand

Water meter reading for NCC is completed biannually, therefore peak water use has been assessed by reviewing production from the water treatment plant (WTP). The following assumptions have been made

- Non-Residential use is consistent throughout the year, peaks in demand are entirely due to residential use
- The proportion of water lost/unbilled water remains constant, ie more water is lost as the treatment plant output into the reticulation is increased.

The data supplied by NCC is presented in Figure 3.2.

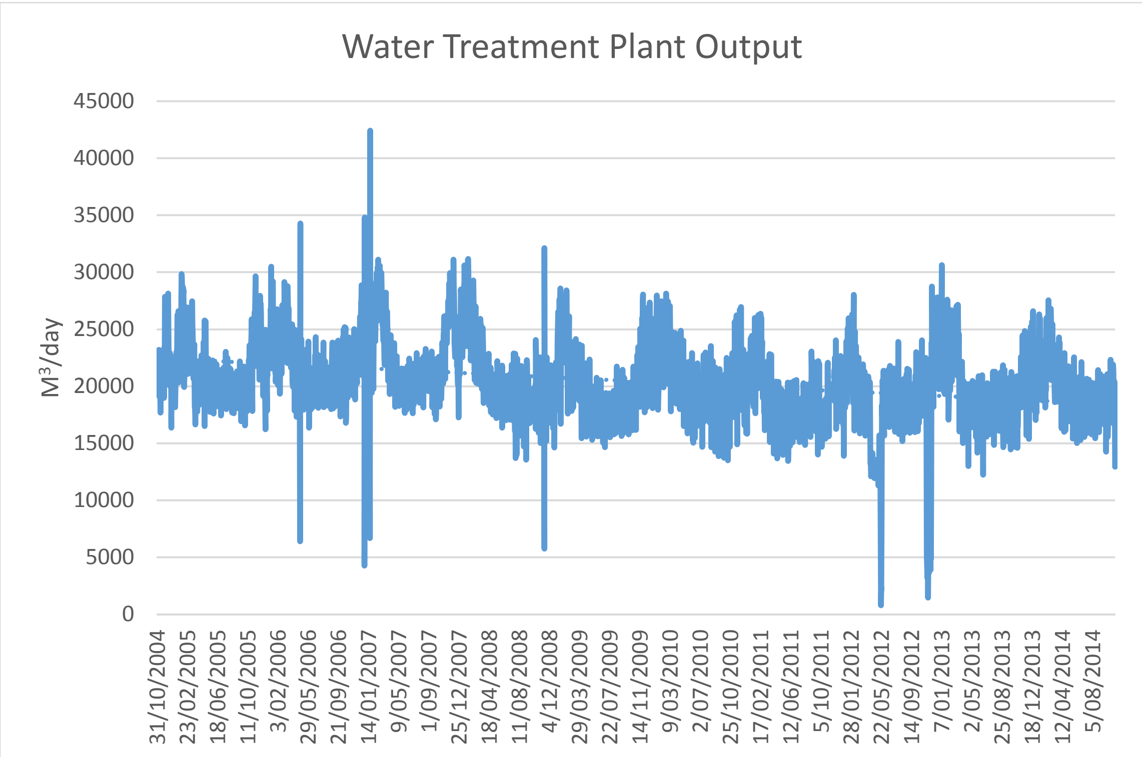

Figure 3.2: NCC WTP Outlet Flow Rate

Based on 2 standard deviations from the median WTP output, the peak output 95% of the time is 27,100m^3/day. The highest consistent WTP output occurred over 3 days between the 29th and 31st of January 2008; the output over these 3 days was approximately 31,000m^3 per day. This value was adopted as the peak WTP output and on this basis, the NCC peaking factor is 1.8. It is noted that WTP output has only exceeded 30,000m^3/day on two occasions since January 2008. A summary of the peaking factor calculation is included in Table 3.1.

Table 3.1 – WTP Output	
WTP Median Output	20,200 m^3/day
Adopted WTP Peak Output	31,000 m^3/day
Average Non-Residential Use	6,000 m^3/day
NCC Residential Peaking Factor	$= \frac{(31,000 - 6,000)}{(20,200 - 6,000)}$ =1.8

3.1.2. Residential Connections

Population growth has been assumed to be in accordance with data presented by Statistics New Zealand, as provided by NCC (NCC, 2014). A summary of this data is presented in Figure 3.3 below.

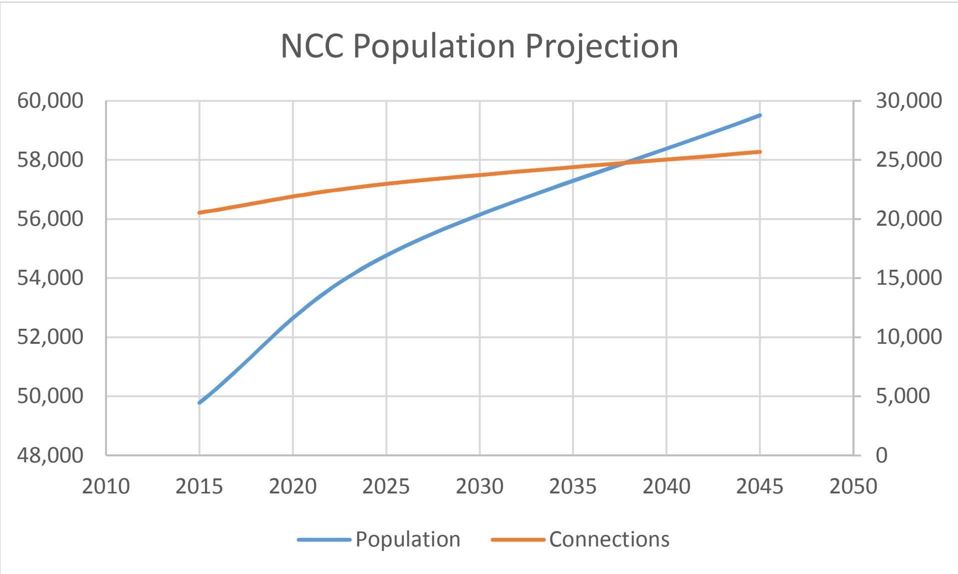

Figure 3.3: NCC Population Growth

It has been assumed that every new household in Nelson, Stoke and Tahunanui will connect to the NCC water reticulation. On this basis, 5,160 new connections are expected over the next 30 years. It is recognised that the number of dwellings in the Statistics New Zealand data in 2013 is different to the number of NCC connections at present. This may be due to differences in the classification of properties as residential/non-residential or properties not connected to the NCC reticulation.

3.1.3. Future Demand

Factors which could impact on future water demand have been considered as follows

Tourism

Historical statistics for guest nights in Nelson City have been gathered by the Ministry of Business, Innovation and Employment (MBIE, 2014). This information has been reviewed and is presented as Figure 3.4 below. The number of guest nights in Nelson varies from approximately 30,000 in July-August to 100,000 in January, contributing to peak summer usage. These numbers have stayed relatively consistent over the past 12 years and therefore it was assumed that changes in tourism will not influence changes in NCC water consumption.

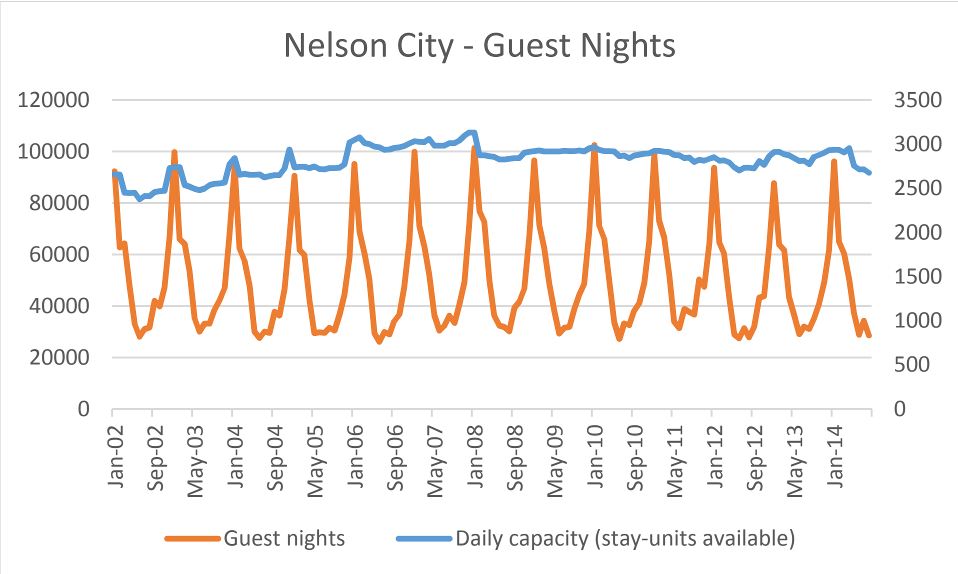

Figure 3.4: Nelson City Guest Nights 2002-2014

Pricing to control demand

A comprehensive investigation into factors affecting water use was completed across a range of climatic areas in the USA. This work found that a 1% increase in the price of water reduced overall consumption by approximately 0.4% (Grafton, R, Q., et al, 2009). The authors noted that increases in price reduced outdoor use whilst having minimal impact on indoor use. As discussed previously, discretionary use in Nelson, for example garden watering is likely to be low when compared to similar towns. NCC have not indicated there is any intention to use pricing signals to control demand. It has been assumed that pricing to control demand will have no impact on future water consumption.

Use of water saving devices

Based on AS/NZS1547, the use of water saving facilities can be expected to reduce internal water consumption by 15-30% (AS/NZS1547:2012). To ensure a suitably conservative estimate, it is assumed that newly constructed houses will have 10% lower water consumption than existing houses. The impact of retrofitting such fixtures to existing houses is considered negligible.

Increased climate variability

A research project has previously been completed investigating the impact of climate variability on residential water consumption in Phoenix, Arizona (Balling R., and Gober, P., 2006). This work found that a 1°C temperature increase caused an increase in water consumption of approximately 1.5%. It is noted by the authors that outdoor water use in Phoenix accounts for 74% of total use; this is consistent with expectations for a hot dry climate. As noted previously, outdoor water use in Nelson is likely to be low compared to other towns included in this assessment. The effect of changes in average Nelson water consumption in response to increased climate variability is considered relatively small over the 30 year planning window considered by this assessment. It is possible that increased hot and dry periods could cause an increase in the peak water consumption as evident in January 2008 (refer Section 3.1.1). The adopted peak WTP output is considered suitably conservative to account for such demand spikes.

Community Education

Balling R., and Gober, P (2006) noted that whilst a 1°C temperature increase caused a 1.5% increase in water consumption, a community water conservation education campaign caused a reduction in water consumption of 15%. As discussed previously, discretionary water use in Nelson is likely to be quite low, therefore further decreases in water consumption due to community education are likely to be relatively small.

3.1.4. Adopted Residential Demand

Future residential demand has been adopted as follows

Table 3.2 – Adopted Residential Demand					
Demand			Connections		
	Average Demand	Peak Demand	2014	2025	2045
Existing Properties	420 L/day per connection	756 L/day per connection	18,418	21,248	23,978
New Properties	380 L/day per connection	680 L/day per connection			

Note that these figures are for billed usage, it is not recommended to adopt the use of these figures for the planning of future subdivisions or the inclusion in the NCC Land Development Manual because they do not include losses between the WTP and the point of use.

3.2. Non-Residential Water Consumption

3.2.1. Water Demand

Due to discrepancies in the recording or reporting of non-residential water consumption, data could only be obtained for a small number of New Zealand towns. Data was also obtained for similar sized towns in Victoria, Australia, where metering is universal. Data for NCC and Tauranga was averaged over the past 5 years. Data for Christchurch was only available for 2010. Data for the 4 Victorian towns was averaged over the past 2 years. A summary of this work is presented in Figure 3.5.

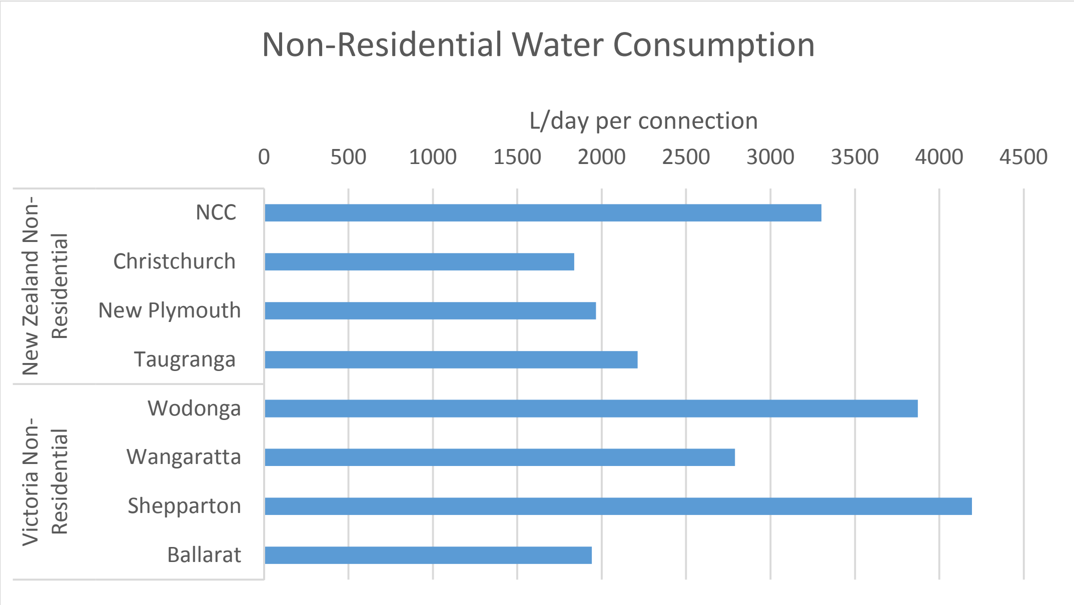

Figure 3.5: Non-Residential Water Consumption

Comparison of non-residential water demand between different towns is considered less reliable than a comparison of residential water consumption due to the variation in consumption between different industries. This data shows that, whilst high, NCC non-residential water consumption is within the range expected. As a comparison, the town of Shepparton in Victoria is also a regional service centre with a number of fruit packing and processing facilities. It is noted that Shepparton has a significantly hotter, drier climate than Nelson however it demonstrates NCC non-residential water consumption is within the expected range.

3.2.2. Non-Residential Connections

Two approaches were considered to determine the future increase in the number of non-residential connections.

Trade Waste Constrained: This approach is consistent with that assumed in the NCC Water Supply Asset Management Plan (AMP). The NCC Resource Management Plan limits trade waste discharge to 0.54 L/s per hectare. Based on the Nelson Urban Growth Strategy, the AMP has assumed that development of industrial land needs to occur at a rate of 65 hectares of industrial land per 10,000 population increase.

Assuming population growth as outlined previously, the increase in non-residential water consumption would be approximately 400,000 m^3/year to 2,600,000 m^3/year by 2045 based on an eight hour working day. This number would increase if development of non-residential land exceeded the theoretical value or a 'wet industry' obtained resource consent to exceed the allowable trade waste discharge rate.

Historical growth rate: Over the past 13 years, the number of industrial connections serviced by NCC has increased at an average rate of 1.4% per year. Assuming this rate of growth continues, and a water demand of 3300L/day per connection, non-residential demand would increase to 2,700,000 m^3/year by 2045.

The two approaches yielded relatively consistent results. The Trade Waste Constrained approach has been adopted as it is recognised that development of industrial sites within the NCC region will be restricted by land availability. The number of connections was calculated assuming the average water consumption per connection as outlined below.

3.2.3. Future Demand

Following further analysis, it was noted that there was significant decline in NCC non-residential demand per connection over the period investigated. A summary of this data is shown in Figure 3.6 below.

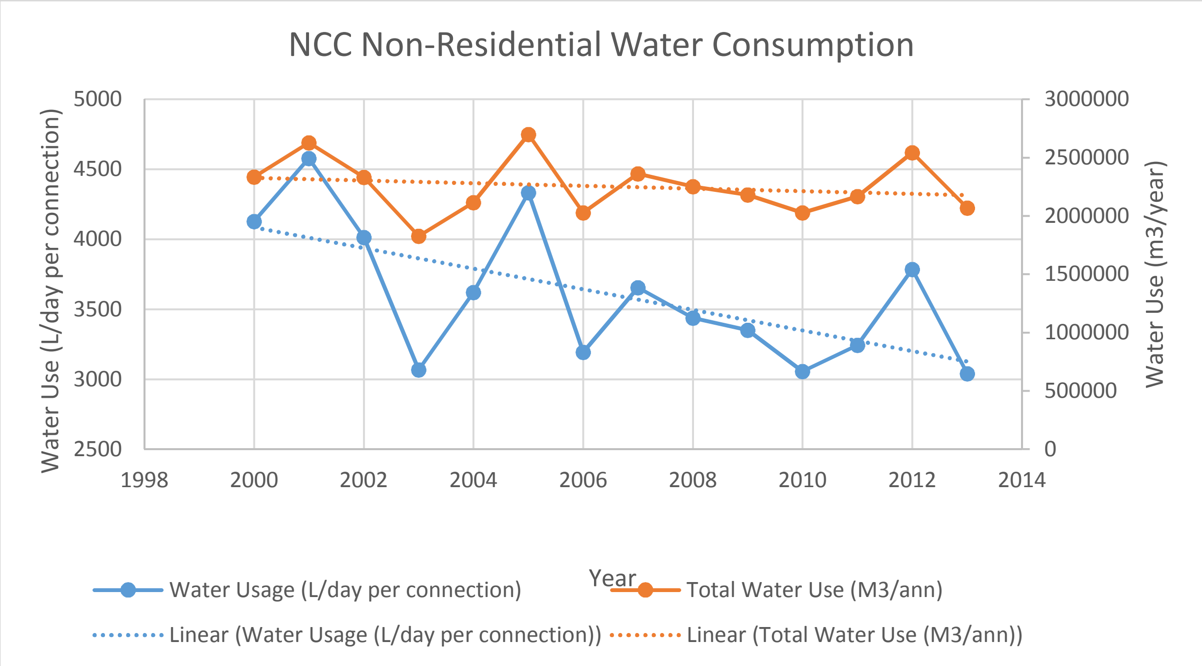

Figure 3.6: NCC Non-Residential Water Consumption

This chart shows that the total non-residential water use for NCC is fairly consistent but generally trending lower; the use per connection is trending down at a significantly greater rate. This may be due to a range of factors including

- The closure of one or more large water users

- Businesses trying to reduce their costs by reducing water consumption
- Processing facilities identifying alternative sources of water or recycling to reduce potable water consumption

Without undertaking further analysis of the reasons for the reduction in non-residential consumption it is not possible to determine if this will continue. Consistent with the AMP, it is assumed that a new 'wet industry' will not commence operation in the NCC region. It is assumed that simple/low cost water efficiency improvements have already been made to existing businesses and use per connection for existing customers will not drop below the 5 year average of 3300L/day per connection. It has been assumed that new water users will consume water at the same rate per connection as existing users. This information is summarised in Table 3.3 below.

Commercial water use tends to be more uniform than residential use and is affected by production rates rather than the standard diurnal curve. On this basis, peaking factors for non-residential use have not been considered.

3.2.4. Adopted Non-Residential Demand

Table 3.3 – Adopted Non-Residential Demand				
Demand		**Connections**		
	Average Demand	2014	2025	2045
Existing Connections	3300 L/day per connection	1,873	2,059	2,204
New Connections	3300 L/day per connection			

As discussed for residential consumption, these figures are for billed usage, they do not reflect losses in the reticulation and therefore should be used with caution for planning purposes.

3.3. Parks and Reserves

NCC requested that water used on parks and reserves was also reviewed as part of this work. Despite requests, no other councils provided water consumption data for parks and reserves, indicating they were unable to easily separate this usage. New Plymouth did provide the total water billed to council; this includes council facilities other than parks and reserves such as libraries and public toilets. This data indicated that 3.6% of total water usage in New Plymouth was billed to council. Over the past 5 years, an average of 3% of billed NCC water has been used on parks and reserves.

NCC water use for parks and recreational areas was compared to annual average rainfall, as shown in Figure 3.7. This comparison showed a reasonably clear correlation between rainfall and parks and reserves water consumption. This indicates that it is likely that the irrigation of parks and reserves is well managed, with irrigation being matched to climate conditions. It is noted that NCC water use data included water consumption for Nayland and Riverside pools.

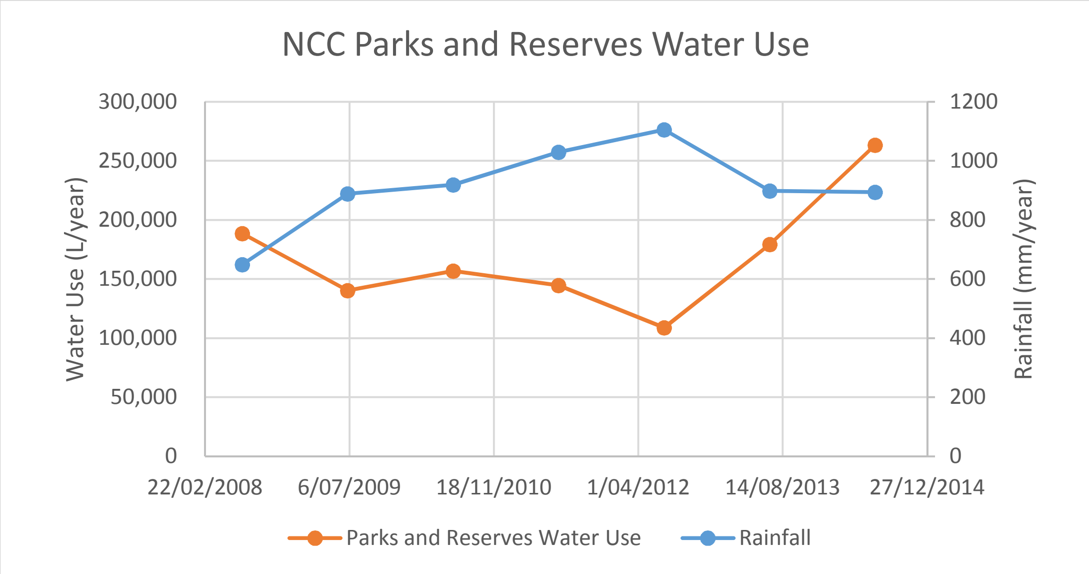

Figure 3.7: Parks and Reserves Water Consumption

Water use at Saxton Field increased from 20-60,000L/year in 2007-2013 to 140,000L in the 2013-14 financial year. This caused the significant increase in parks and reserves water consumption in 2013/14. In the past year, water use at Saxton Field represented over 50% of total use for parks and reserves in NCC.

As shown previously in Figure 2.2, average water consumption for parks and reserves represents approximately 2% of the total WTP output. This is considered relatively low and work to improve efficiency in this area is unlikely to lead to a significant reduction in NCC water consumption. For the purposes of calculating peak water consumption, it has been assumed that 80% of parks and reserves irrigation occurs in the 3 summer months.

3.3.1. Future Use

NCC has not indicated any likely change in the irrigation of parks and recreational areas. In other municipalities with hotter drier climates, the irrigation of such areas with 'fit for purpose' water sources including reclaimed stormwater and treated effluent is already well established. It is possible NCC may implement similar water saving measures however for the purpose of this assessment, it is assumed that future irrigation of parks and recreational areas will remain consistent with the current 5 year average.

4. Conclusions

Future NCC water demand has been calculated as follows. This assumes water loss remains consistent as a fraction of total throughput and no further reductions in water loss are made.

Table 4.1 – NCC Future Water Demand Summary

	Average Demand (m^3/day)	Peak Demand (m^3/day)
2025		
Residential	8,809	15,845
Non-Residential	6,766	6,766
Parks and Reserves	124	1,517
Non Billed	4,710	7,238
Total	20,409	31,366
2045		
Residential	9,846	17,701
Non-Residential	7,244	7,244
Parks and Reserves	124	1,517
Non Billed	5,164	7,939
Total	22,379	34,401

5. Limitations

This report has been prepared solely for the benefit of Nelson City Council for the purpose of providing information relating to the Water take Resource Consent. The reliance by any other parties on the information or opinions contained in this report shall, without our prior agreement in writing, be at such parties' sole risk.

The information contained within this report is based on the investigations as described in detail above.

This report has been prepared solely to address the issues raised in our brief, and shall not be relied on for any other purpose. Councils who assisted this investigation by providing information have requested that the information is used for NCC reference only.

6. References

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