Background Handout for Field Trip 6 – 3rd October

Introduction: Christchurch is New Zealand's largest groundwater sourced drinking water supply. Water is provided via a network of treatment plants/pump stations spread across 10 different pressure zones that make up the city (including the Lyttelton Harbour basin). There are currently 126 operational bores providing water to the combined urban supply. The bores are scattered across the city clustered around 44 different sites in groups of between1 and 6 wells. The sources vary in depth from 28m to 232m deep. Each of these sites were historically just pump stations delivering the water into the surrounding network, some via a suction tank and others directly, but now they all have chlorination treatment.

There are two major sources of water that provide recharge to the aquifers under Christchurch: seepage flow from the Waimakariri River to the north and rainfall recharge on the plains to the west of the city.

A little bit of history: On 10th February 1864 workmen from the Christchurch City Council developed the first Public well on the corner of Tuam and High Streets, it produced water at a rate of 60 gallons (227litres) of water per minute and was available to be collected for those living in the area. By January 1872 there were at least 654 wells, including 23 Christchurch City Council public water wells in the central area bounded by Moorhouse, Fitzgerald, Bealey and Rolleston Avenues (Geology and Geomorphology of urban Christchurch and eastern Canterbury J.G. Begg, K.E. Jones, D.J.A. Barrell GNS Science Geological Map 3 2015). The proximity of rivers and the ready availability of groundwater meant many people had their own wells in their backyard and so reticulation of high pressure water from council wells did not happen until 1909. The ready availability of source water across the city means Christchurch's water supply has developed in a somewhat non-traditional manner. As the city limits expanded another pump station and associated bores were added to the water supply to accommodate the increasing demand. The network is quite different from what might be expected in a 'typical' city our size (registered drinking water population of 389,290).

This storymap provides some more historical details: What am I drinking?

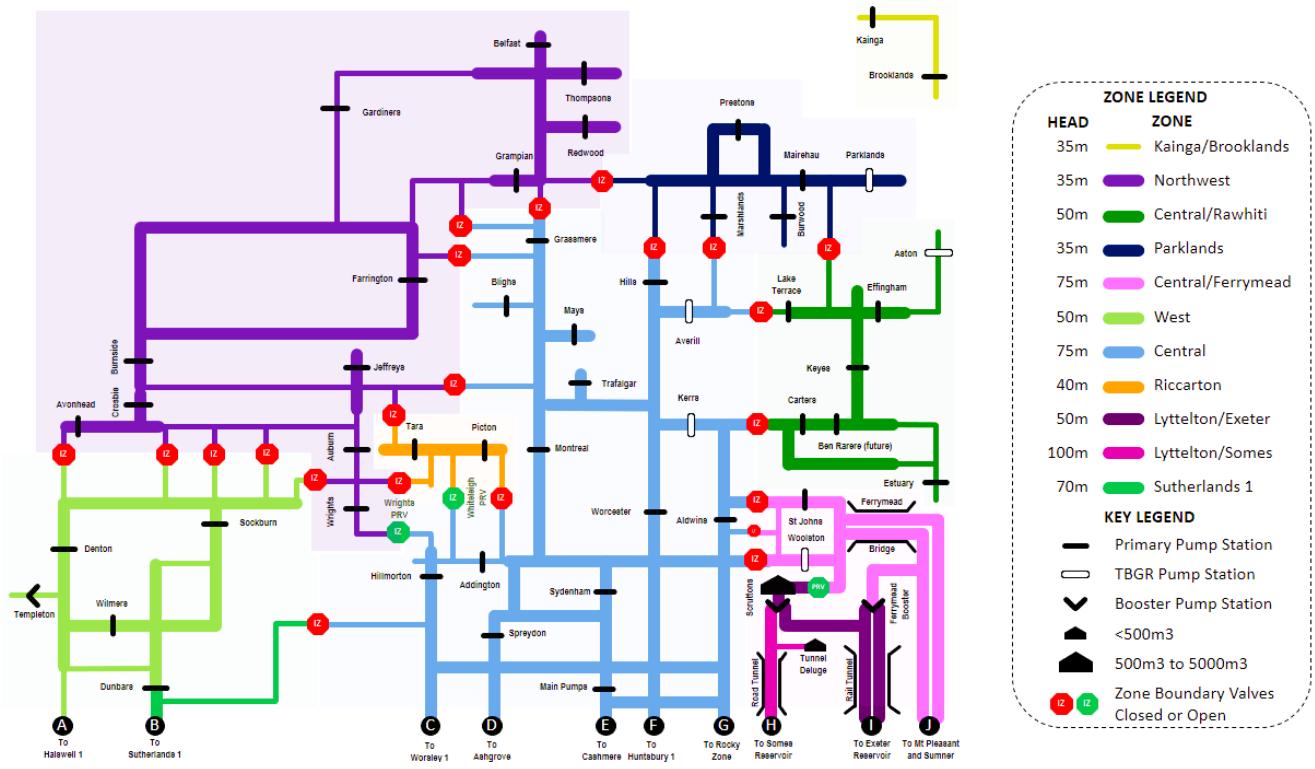
Compliance: Under the previous regulatory regime, prior to 2022, compliance was generally able to be achieved without any treatment. What we now refer to as treatment plants were only pump stations. Bacterial compliance was demonstrated through monitoring for E. coli and protozoal compliance was afforded through E. coli monitoring and a combination of modelling of the aquifers and aging of the source water.

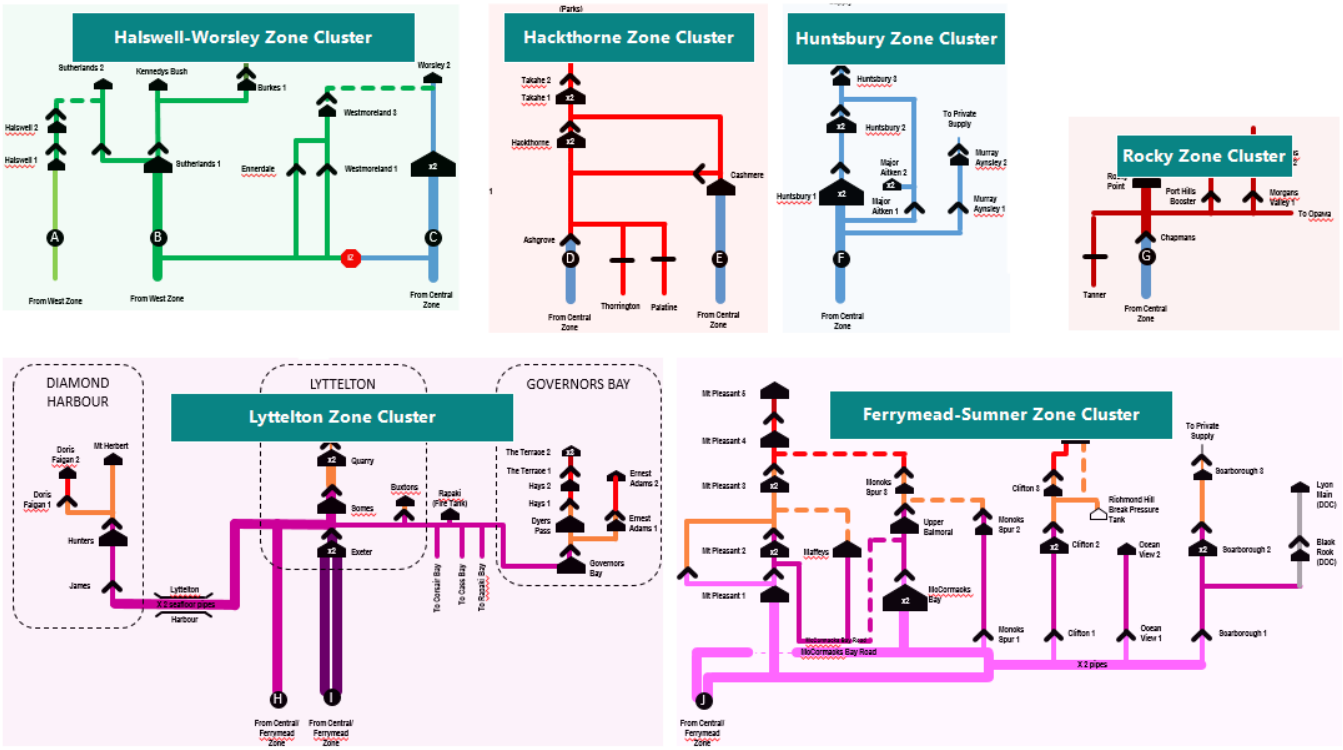
Many of our wells were originally built in below undertookmbers, following the investigation into the Havelock North campylobacter outbreak in 2016 there became concerns about the security of these and having lost the security status afforded in the

previous NZ Drinking Water Standards the Council under took to raise the well heads of over 100 wells, completing this work between June 2018 and Sept 2020.

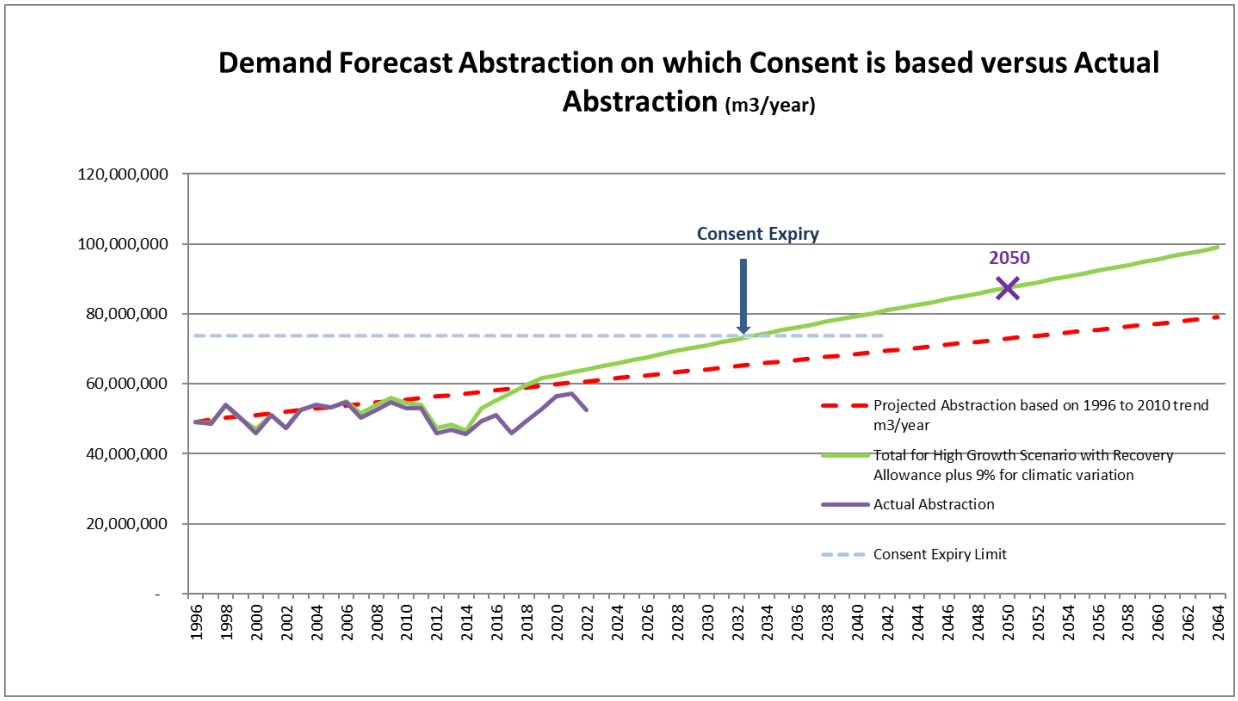
With the mandatory requirement for chlorine in the distribution the pump stations have been forced to change into treatment plants. This has initially been done through use of 'temporary' flow paced hypo chloride solution dosing units.

The primary pump stations/treatment plants and secondary network with booster pumps and reservoirs are represented diagrammatically below:





Abstraction of groundwater is through a global consent from Environment Canterbury (CRC204470). The current consent has an overall limit of 73.6million m^3/year with extraction currently well below that limit. The introduction of charging for excess water use in October 2022 for those households using more than an average of 700l/day (subsequently raised to 900l/day) saw overall use reduced by more than 10%. The standard charge for water supply in Christchurch is based on the capital value and for an average household works out at $518.51/yr.



Demand Forecast and Abstraction compared to Consent, Christchurch

Operation: The water supply demand base load is generally obtained from the deeper aquifers at each site, often free flowing into a suction tank if there are artesian bores. Suction tanks at some sites also help balance the flow between bores in different aquifers, provide storage for short-term peaks, reduce surges on wells, and settle any sand that may come from the bores. Standby diesel generation is available at approximately 50% of the treatment plants in the case of power failure. Riccarton, Northwest and Parklands zones would rely solely on suction tanks and diesel-power pumps and generators for emergency supply as they don't have hill reservoirs for storage. These plants also have sufficient pumping capacity to meet instantaneous peaks. Zones that have the Port Hills immediately to the south (Central, Ferrymead and West) have their pressure controlled by the levels of the bulk-storage reservoirs on the hills that provide for emergencies and assist in meeting peak demand.

in 2004/05, approximately 30% of Christchurch/Ōtautahi's water supply was drawn from the shallower Aquifer 1 (Riccarton Gravels), in the 2022/23 period this had reduced to 11% and has subsequently reduced further with now only two treatment plants drawing water from aquifer one. These two sites are both located near the base of the Port Hills where access to a reliable volume of water from deeper aquifers is not possible, but water sources are needed here to provide supply to those living in hill suburbs. One site already includes UV treatment (Main Pumps), and the other is currently being upgraded to include UV (Tanner). Accessing aquifer 1 (Riccarton gravels) precludes establishment of a 'Class 1' water source under the Drinking Water Quality Assurance Rules as the depth to the shallowest screen is usually less than the specified 30m and therefore a protozoa treatment barrier needs to be installed.

Where are we going?

Woolston treatment plant – 56 Glenroy Street, Woolston

This is one of two treatment plants in the Ferrymead zone. The total population dependant on water from the Ferrymead zone is 22,701. As well as providing water to this immediate area the zone also provides water through to the Lyttelton Harbour Basin where there are 3 small zones (Lyttleton, Governors Bay and Diamond Harbour), this is through pipelines running through both the road and rail tunnels and in addition a line on the seabed that runs across the harbour. In 2024 this zone delivered 6.97% of the total water used by the Christchurch supply.

Woolston has two wells (wells 4 and 5) drawing water from aquifer 4 (129m and 124m deep). A shallower well (well 3 which is <30m) drilled in 1927 has been removed from service and overdrilling will be attempted targeting either aquifer 3 or 5. Well 5 has a submersible pump and well 4 is artesian, both feed into the suction tank and inside the

pump station building three surface pumps pump water, following chlorination, into the network.

Keyes Treatment plant – across from 374 Keyes Road, Rawhiti Domain, Aranui

Site within Rawhiti Domain (owned by CCC Parks and Rec dept). Three wells, drilled in 2011, 2012 and 2013, two access aquifer 2 and one aquifer 4. Development of this site was part of the rebuild following the Chch earthquake in 2011. All wells are artesian but two have pumps to provide additional flow when needed. In 2024 this site extracted 3.53% of the total water used in Christchurch.

Site includes a small suction tank (317m^3), partially buried and also a diesel generator. Water is pumped to network from the suction tank following chlorination.

Keyes Community Drinking Water Station

This supplies from Keyes well 2 (aquifer 4). Community Drinking Water Stations are required to follow the level 1 source and treatment rules under the DWQAR, the station therefore includes cartridge filtration and UV treatment but does not include chlorination. The community bring their own containers and fill with non chlorinated water. There is one other community drinking water station in Northwest Christchurch zone at Burnside Treatment Plant. Both stations do get well used. Up to 100 people a day have been recorded collecting water in their own containers.

Main Pumps Treatment plant

This is one of our oldest treatment plants and draws on 6 wells which all access the shallower aquifer 1. Deeper groundwater is no accessible at this location – but it is a crucial position for serving both the flat urban area of Christchurch and also pumping water to the series of reservoirs that serve the city's hill suburbs. The wells are spread across two adjacent sites and include examples of wells remaining in chambers but with some upgrades to give some protection from surface water intrusion. The oldest well, well 3, was drilled in 1924.

In 2024 7.70% of the water extracted for the Christchurch supply came from this plant making this the largest producer of water (a total of 3,845,069m^3 extracted).

Main Pumps wells are not able to achieve Class 1 (Protozoa barrier not required) status because all wells draw from depths <30m, and in addition do not meet Sanitary Borehead Requirements as per the DWQAR. The source water is therefore considered to be Class 2. UV reactors were installed in 2019 to meet compliance requirements set in the then Drinking Water Standards and now provide protozoa and bactrial barriers as per the DWQAR Class 2 requirements.

The six wells fill the suction tank, the well pumps are controlled by the suction tank level, and the surface pumps are staged based on network pressures. The discharge from the three surface pumps is dosed with chlorine and then passes through the UV disinfection system, (two UV units operating on a duty/standby basis). The three surface pumps and pipes from the suction tank are due for replacement. The deteriorated lining of old suction pipes and pump pipework are the potential source of rust particles that have been found inside the reactors due to movement of pipes during the pump cycle. Currently as a Class 2 source the plant is not compliant as it doesn't provide continuous source monitoring for conductivity and pH. A project is underway to address the matters and also enable improved isolation of each UV unit for maintenance.

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We are an influential and trusted team committed to proactively ensuring water sustainability

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