Our water history – on tap

Water supply in the Wellington region 1867-2006

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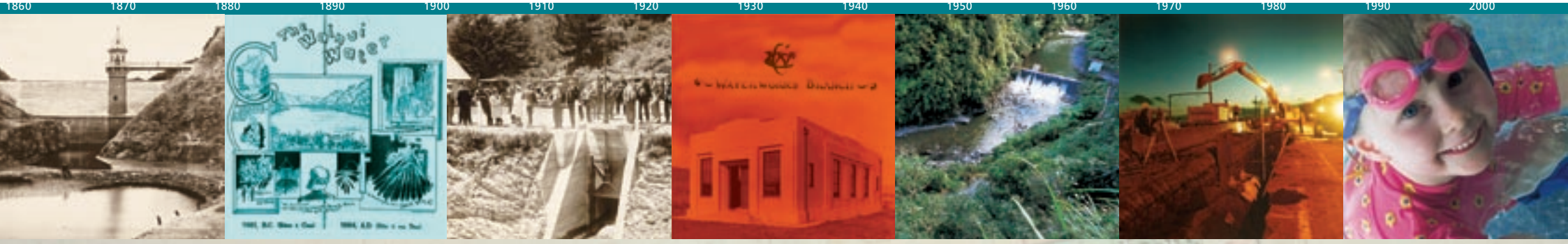
Quality for life



Contents

Foreword

We first published an account of Wellington's water supply history, spanning more than a century, 21 years ago. Neil McDougall – then operations engineer for bulk water supply – oversaw that work. His zeal to place on record an accurate history deserves our recognition. *History of Water Supply in the Wellington Region 1872 – 1985* was the starting point for this publication.

As Neil McDougall was the catalyst for that earlier text, so John Morrison – Greater Wellington's recently retired engineering consultancy manager – has been for this expanded account. John has given more than 30 years of distinguished service in regional water supply, spanning a period that has seen many major improvements. We felt it timely to make good use of his enthusiasm for this subject, his first-hand knowledge and his eye for detail in defining this text.

From this distance in time, it is difficult to appreciate fully the extreme hardships our first engineers and surveyors must have encountered – and overcome – in bringing water to Wellington's citizens. However, it is apparent from this account that while much has changed in water supply since 1867, vision, determination and no little engineering ability are constant themes in the development of the system we enjoy today.

In common with earlier custodians of Wellington's water, Greater Wellington faces the task of providing for a growing population. While the march of technology has made this task physically less demanding than it was for our forebears, the apparent primacy of the engineer and infrastructure over competing interests has waned, presenting new challenges.

The importance of a safe and reliable water supply cannot be overstated. It is timely to remember the achievements of our predecessors in planning for the long-term water needs of the region, which this publication so clearly illustrates. Our part is not only to appreciate what they achieved, but also to build on that legacy for future generations.

Ian Buchanan
Chairman
Greater Wellington Regional Council
September 2007

Introduction

Since the earliest days of European settlement in the Port Nicholson area (Te Whanganui a Tara[A]), the development of water supplies has greatly influenced the subsequent growth and administration of Wellington city and the wider region.

The history of water supply for the Wellington region is to a large degree centred on the geography of the area. There have always been abundant water sources available to meet the demands of an ever-increasing population. The major challenge, however, has been one of overcoming the region's mountainous terrain and natural hazards at a cost its population would bear.

Peter Cooke researched and wrote this history, under contract to Greater Wellington Regional Council. He has developed and extended the *History of Water Supply in the Wellington Region 1872 – 1985*, written by Sally Morrison on behalf of Wellington Regional Council and published in 1986. Peter holds a BA with Honours and is a professional historian, based in Wellington, who specialises in engineering and defence histories.

View of Wainuiomata reservoir, showing the earth dam and spillway in the foreground (1920s).
(S C Smith Collection, Alexander Turnbull Library, Wellington, NZ. Reference G-47765-1/2)

1860s-1920s

Early water

Surveying the Orongorongo River, February 1915

The mayor and councillors boarded three waggonnettes and, with the bad news fresh in their minds, headed for the works. The roads were still muddy from the rains and their journey by vehicle ended at Sinclair's sawmill. From here, guided by works staff, they picked their way along a valley floor strewn with branches and rocks and caked in silt. They might have ridden the little tramway line, but it had been engulfed by the flood. After what seemed miles of sloshing, but was only 20 minutes on foot, they arrived at a site of utter devastation. The dam into which so much hope and ratepayers' loan money had been poured was a wreck – scoured out behind and breached in its middle. While some minds turned to blame, the engineers immediately thought 'rebuild' – Wainuiomata's water must get through to Wellington.[1]

This event in 1883 probably inspired a later mayor to claim "the engineer made Wellington".[2] With its reclamations, and road and rail works, the city had been hewn from an unwilling shore, but the water story is no less one of vision and skill, of overcoming doubters and harnessing this "natural genius of place".[3] It is an engineering story that had started two decades earlier, when the new Town Board was presented with a growing population.[4] Relocating the General Government from Auckland to Wellington in 1865 added to the demand, but also brought the first major injections of capital.[5]

Since Wellington had been founded water had been "collected from house-tops into barrels and iron tanks, and also some shallow wells". At springs on Grant Road (Thorndon) behind the officers' cottages "a usual sight was a number of women, housewives and maids with large jugs, cans or pails, around the spring getting water which seemed to take a very long time to get, though the flow of the spring was very free, but no more than the gossip".[6] Streams piercing the hills also provided clean water, but the growth on their banks of homesteads, which used them as sewers, "cannot be otherwise than detrimental to the wholesomeness of the water" and was considered "very unsatisfactory".[7] Analysing the water, government scientist Dr James Hector referred to "the misery and suffering entailed especially of the children from the prevalence of intestinal worms" and concluded that "no water collected from within the crowded part of the city, either from wells or house tops, is safe or proper for human consumption".[8] Recent research in England had linked water to diseases, such as cholera, so the health aspect was known early.[9]

The town had "long been crying out for a water supply and various plans have been suggested [by 1867], more or less grand in design, and expensive in nature…. The chief difficulty is the financial one".[10] Wellington, as residents know, is a hilly city – the topography presents a challenge in laying utility services. However, hills had one advantage – gravity. Engineers could rely on a drop of almost two metres-in-the-kilometre bringing water to town.

Parliament received the city's first water supply, in 1868, from a spring on Tinakori Road. This detail from a plan of the 'Tinakori Water Supply' shows the spring (far left) close by the Premier's residence (Premier House), with pipes leading to nearby government buildings. (Wellington City Archives Reference 00456:W1159/7)

The first reticulation in the city was initiated by the Provincial Government, to supply shipping at Queen's Wharf. In 1867 Messrs John Beck and Carter tunnelled through the Hill Street ridge to a spring on Tinakori Road and planned to lay pipes to the wharf.[11] The spring was on a government property purchased in 1865 for the Premier, and the water was collected in an underground cistern by his front door.[12] The city, however, picked up the work laying pipes to the government's reservoir built on Hill Street beside the Meteorological Office.[13] By mid-1868 this supply was in use, and the Colonial Secretary tried to sell 136,000 surplus litres per day to the city. A sales pitch by Jerningham Wakefield could not close the deal.[14] The reason was not money, even though the Town Board was impecunious, but that the government's reservoir leaked badly and the supply was inadequate.[15] After declining this supply, the Town Board laid the government's pipes beyond the Parliamentary 'demesne' to Browns Wharf, off Molesworth Street, where lighters from an increasing number of warships refilled their tanks. The board again used its hard-labour convicts, with overseeing 'gunmen', for this work.[16]

Detail from an 1869 plan of the Government Domain, including water reservoir.
(Archives NZ, Reference AAFV 997, WT9A)

Meanwhile, Wellington's first town surveyor/engineer, Richard Skeet, had developed a waterworks scheme.[17] This was to supply the southern wards of the town from Te Aro (or Waimapihi) Stream in Polhill's Gully (upper Aro Valley), with the Thorndon Ward being supplied from the Kaiwharawhara Stream tapped near Baker's cutting. Together the cost would be £41,575 (a huge amount, beyond the town's budget), though no plans were prepared.[18] At the first mention of the Kaiwharawhara, the board said it would "not undertake or execute any work beyond the outer boundary of the Town Belt" but would leave this to the Provincial and, if necessary, General Government to survey.[19] Other engineers generally agreed with the scheme, George Aicken adding that the water could be drawn via a 1.6-hectare, six-metre deep reservoir for double the current population of 6,000-7,000.[20] A letter to the editor urged the Town Board to adopt the works as they were of "incalculable benefit to the town… [and would] have nothing to do with party politics".[21]

A consulting engineer, Robert Marchant, prepared another scheme for the city in April 1868.[22] Marchant's scheme, which he promoted through a pamphlet with lithographed drawings, would pipe the water down the Kaiwharawhara valley until being tunnelled through the Northland Hill to Tinakori Road.[23] Including plans for a 136 million-litre dam, this was the first proposal submitted to the board "approaching completeness," according to his namesake and new town surveyor/engineer Nicholas Marchant.[24] To pay for the scheme, Robert Marchant proposed Dunedin's solution. The Dunedin Waterworks Act 1864 assigned power to the Dunedin Waterworks Co Ltd to build the waterworks and rate the users: its two dams on Ross Creek were built in 1865-1867.[25] When, in August, Wellington's ratepayers found that the Town Board had "entered into" the expensive scheme with Robert Marchant, their indignation boiled over. Why spend on waterworks when "every occupier of his cottage had a well?" Concern also over 'jobbing'– councillors benefiting financially from public works – delayed the Town Board's advancement into a borough (under the Municipal Corporations Act) by a few months.[26] The availability of the Hill Street supply also discouraged the scheme being adopted. Wellington's Waterworks Company was, however, established and its shares secretly issued, but it played no part in the scheme adopted.[27]

In mid-1869 Beck re-entered the picture with a waterworks scheme. John and William Beck wanted to tap Te Aro Stream to form an 11.4-million-litre reservoir, and asked to open the streets to lay reticulation pipes, which they had ordered.[28] The board "gave the same permission as to the Gas Company" – so long as the interests of other riparian users "were protected".[29] Brewers and bottlers using Te Aro Stream "threatened… several actions" if their water was interfered with.[30] In October 1870 the board declined Beck permission, possibly after he had started the headworks.[31] It did, however, agree to buy his pipes (for £1,265.9.5).[32]

Wellington's new city council (WCC) asked Nicholas Marchant to progress the waterworks. He summarised and borrowed elements from Skeet's scheme, Aicken's scheme, RM Marchant's scheme and finally the Becks' scheme.[33] Having collected data on the Kaiwharawhara since February 1870, he calculated a flow of 1.4 million litres per day, enough for 10,000 people. He reported on 28 March 1871 that the Kaiwharawhara was "the only source worthy" of tapping (having also assessed the Ohiro, Te Aro and Karori streams). The point by Baker's Hill was the place to build the 160-million-litre dam because it "little exceeds two chains in width at the top and [has a] depth of 60 feet".[34] He intended to allow the average summer flow to continue down the stream, but still compensate the "riparian proprietors" affected. Indirectly referring to RM Marchant's proposed route, Nicholas Marchant would "avoid the stream's sinuosities" by sending the supply through a 365-metre-long tunnel under Baker's Hill to a distribution basin at the top of Aro Valley. A drop of 46 metres in elevation from dam to basin would "break the head of water [reduce its pressure]" for its journey down to Willis Street and reticulation thereafter in 200-millimetre and 150-millimetre pipes. His tunnel, basin and 21.7 kilometres of piping would cost £17,358.[35] Notice of the Wellington Waterworks Bill in June 1871 defined the 92 hectares intended to be taken and listed the several owners and two gold mining companies the council had to buy out before proceeding.[36] The Municipal Corporations Waterworks Bill, under discussion by now (and passed in 1872), would vest the water rights in the corporation rather than the Crown.

Polhill Gully reservoir, at the head of Aro Valley, circa 1900. This concrete distribution basin fed by the Kaiwharawhara Stream was the source of Wellington's first public water supply, in 1874. This distinction has often been credited to Karori's lower reservoir, which was not completed until 1878.
(Alexander Turnbull Library, Wellington, NZ. Reference G-8021-1/2)

Karori water

The Karori waterworks on the Kaiwharawhara Stream was started in 1871. On 12 December that year the council created a permanent waterworks committee and instructed Nicholas Marchant to start. He asked John Blackett CE to consult, and the works are as much his as Marchant's. Meeting first on 2 February 1872, the permanent committee opened the tenders for the tunnel through Baker's Hill, selecting Ebenezer Short to undertake the work. Blasting began on 5 February from both ends, the two drives meeting on 24 October.[37] Meanwhile, valuers had been assessing the claims by landowners whose land the council needed, keeping the city solicitor, WLT Travers, busy.[38] Early in 1873 tenders were received for the Aro Valley distribution basin (on what is now the corner of Raroa and Mount Pleasant roads), to receive water from the tunnel. The Becks tendered, but the Saunders and O'Malley tender, the cheapest at £3,749, was accepted. The water mains contract was let in April and a working overseer appointed.[39] By now, shortage of money reined in the project. A full dam across the Kaiwharawhara had been intended, but "Financial reasons … rendered it necessary to abandon the large reservoir for the present, and it was then determined to increase the size of that in Polhill's Gully" from 2.3 million litres to over 4.5 million litres.[40] The concrete basin was itself a big engineering job, being in a valley nestled on a steep hillside (a 'snuggery'). Marchant had the contractors essentially dam the valley, involving works 27 metres high and foundations six metres below the floor of the basin. A wet winter and vast slump of earth slowed the works, adding £1,100 costs.[41] Boat-shaped, the 'dam' was nine metres deep and 36.5 metres long, pointing into the hill and the tunnel. The tunnel was not lined (except for a small section where it tapped a spring, which was lined in brick), and the water was carried in cast iron pipes.[42] To cause a flow into the tunnel a small weir was built across the Kaiwharawhara Stream early in 1874.

Some 22 kilometres of pipes had been laid by Collie & Co, including on reclaimed harbour-front land and The Terrace (neither originally contemplated), and were initially filled with water from the Te Aro Stream, tapped at 38 metres altitude. This water was available from November 1873.[43] With the basin nearing completion, the engineer promised, "the want of an abundance of water will be a thing of the past".[44] On Saturday 2 May 1874, with some fanfare, "the full force from the [Aro Valley] reservoir was flushed through the mains to their extreme range as far as the lower end of Tinakori Road, and the pipes with one exception proved equal to the pressure. The basin itself was emptied…."[45]

Karori reservoir's gothic-style valve tower

The first Karori dam (built 1876-1878), shortly after its completion.
(Alexander Turnbull Library, Wellington, NZ. Reference F-20096-1/2)

Marchant and Blackett both received bonuses, but the sensitive issue of sending out accounts for the connections made to people's homes, and determining the water rate, came in for more discussion.[46]

The dam on the Kaiwharawhara Stream, however, had not been built. With the price of iron and labour higher than expected, the first loan (of £25,000) had run out, and another Act was required for another loan. The new Act was passed in August 1874, authorising borrowings to "extend the pipes and construct a reservoir on the main stream".[47] Marchant started planning this waterworks extension in September. Finalising his drawings, he called tenders in 1875, but was not able to contract J Saunders for this work (at £17,195) until October 1876.[48] Already the summer demand for water had outstripped the flow and, as he got under way in November, Saunders was asked to erect temporary works to boost the supply. The dam, a central puddled-clay core similar to Ross Creek (Dunedin), and to a height of 21.6 metres, had a top water level 141 metres above sea level. It overlaid the original weir, burying the tunnel entrance. The shoulder upstream of the core was formed from layers of stones, each coarser than the previous, with the final one faced in concrete for wave protection.[49] During construction, the engineer "altered the relative positions of the front [upstream] wall and the puddle wall in the centre of the dam, bringing them about 29 feet (nine metres) nearer together… to suit the ground".[50] Other modifications were made to the plans as they went: reducing the height of the dam; shortening the front slope to 3:1, thus reducing the quantity of earthworks inside and length of the pipe culvert underneath; changing the outlet to a culvert type; and launching the valvetower bridge from the side rather than the more-distant crest of the dam. Marchant supervised the "final closing of the dam" in January 1878, and had the "streambed cleared and the storage of water commenced" at daybreak on 25 January.[51] A Waterwork Investigation Committee adjudicated on the contractor's extra costs of £2,305.14.0.[52]

The Karori supply was quickly to prove inadequate. Rainfall records had been available for a few years only, and the dry summers of the late 1870s were unexpected. In addition, the city's population was rising rapidly, having jumped in four years from 10,000 to 18,000.[53] Finally, a more plentiful supply had meant a corresponding increase in consumption; half the supply was being used in industry.

The first Karori dam was completed in January 1878, and is shown here about to be filled. A lone man sits on the Baker's Hill gold mining weir, which had supplied water to a stamper battery.
(Zoe Martin – Carter Collection, Alexander Turnbull Library, Wellington, NZ. Reference PA1-f-171-75)

Wainuiomata water

In 1878, despite having just spent £80,000 on a water supply, there were severe water shortages in the city.[54] The water flow was stopped at night. The public complained. Extraordinary usage was metered at the rate of one shilling per 4,500 litres and fines introduced for wastage.[55]

Fires hastened the search for a more reliable water source. Overnight on 22 October 1877 the Princess Hotel, home to the new Premier Sir George Grey, burned down, killing widow Johnson and her five children.[56] This and the tinder-dry nature of Parliament buildings led to investigations and talk of "water supply failure". The Te Aro Stream supply was again turned on, and the Government even considered the Tinakori Creek supply in the Botanic Garden for fire fighting.[57] In 1878 the railway station caught fire.[58] There was no water in the pipes to prevent the blaze. Fires made the city engineer fraught: "At the sound of the fire bell, I always leave my house and when I get there [to the fire] the turncock goes back [along the route of the distribution main] and closes off all the valves to give maximum pressure. This can take half an hour."[59]

To find another source, the new City Engineer James Baird (former Wellington provincial engineer) worked with William Clark CE.[60] While Wellington rainfall was around 1,200 millimetres per annum, Wainuiomata averaged 1,900 millimetres.[61] They visited the Wainuiomata River in Sinclair Valley, 27 kilometres away, on 17 May 1878, guided by Duncan Sinclair. They rode the little logging loco to Horseshoe Bend above John Dick's Point.[62] In subsequent visits Baird measured the flow and took levels, and after discounting all other rivers recommended a dam there, with a pipeline bringing water to Wellington.[63] The WCC asked the Government to reserve the watershed in July and started buying it (a total of 3,400 hectares). The council resolved to go ahead with the development, despite the cost, after an affirming ratepayer poll on 20 August 1879.[64] After ordering £68,684 of pipes from Glasgow, tenders were let for two pipe tunnels in 1880.[65] Clearing the site began in October.[66] WF Oakes started the water-race job in July 1881 and John Blackett consulted over the pipe bridge required over the Hutt estuary. In 1883 GH Bayliss was contracted to build the main dam wall (for £3,997), and the work was sufficiently advanced in September for the water mains to be charged.[67]

As designed, the small dam had a concrete-face wall, with earth filling and a spillway on the left bank. It was as much a pond for settling silt as a reservoir for storage. The impounded water flowed through a concrete headrace, 1.9 kilometres long, to a pressure-reducing well.

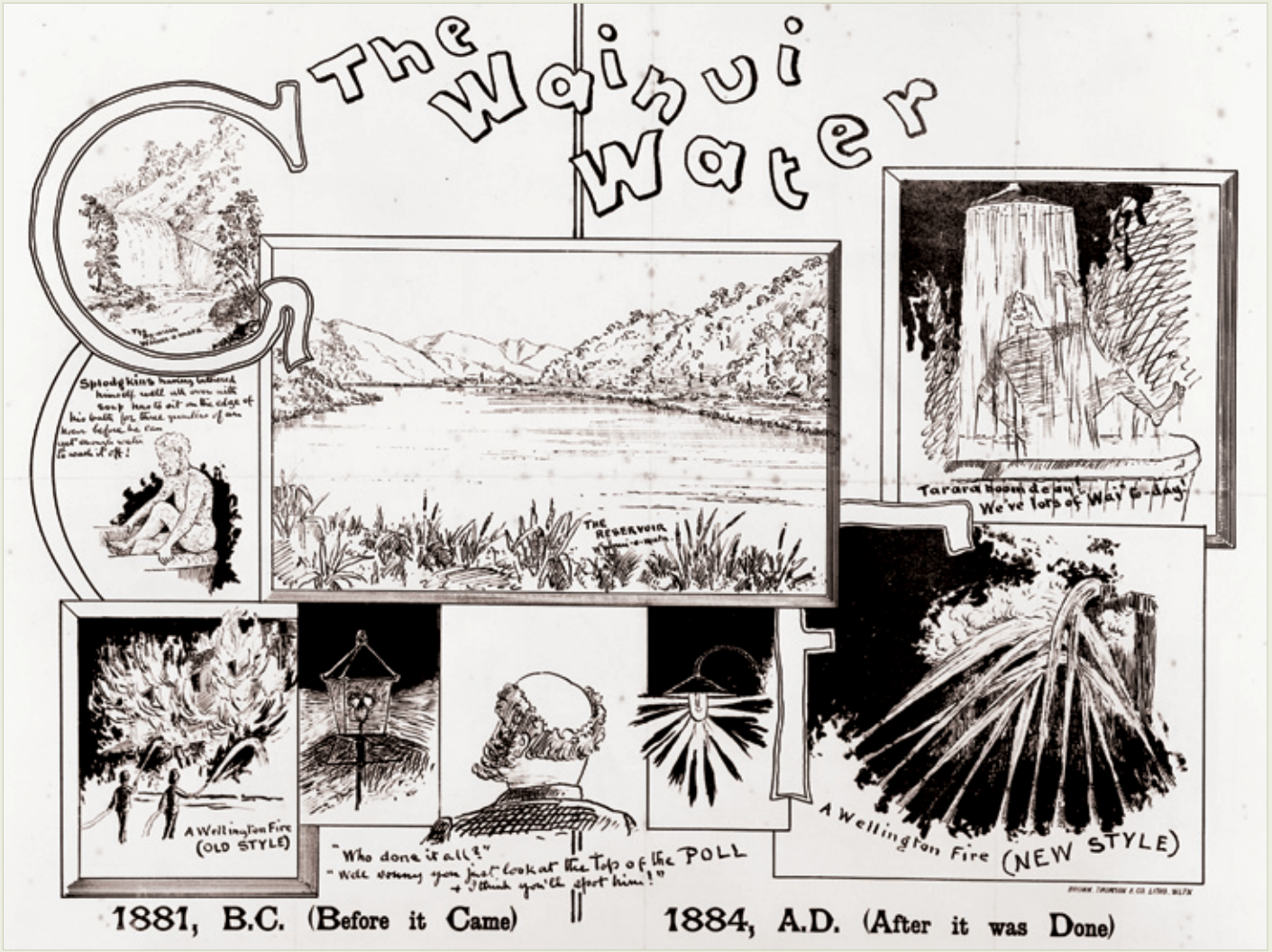
The first Wainuiomata dam in 1884, after it was breached by floodwaters. This failure and the subsequent controversy around its repair and the scheme's leakiness occupied Wellington's engineers and politicians for years to come. (Martin Album, Alexander Turnbull Library, Wellington, NZ. Reference PA1-f-036-13-2. Image cropped slightly)

Here it dropped 18 metres to enter a 750-millimetre cast-iron pipeline. This pipeline passed through two tunnels, under Dick's Hill (200 metres) and the Waiwhetu hills (1.1 kilometres), to reach Gracefield. A further 13 kilometres of 600-millimetre piping was laid along the Petone Esplanade and Hutt Road to Thorndon Quay.[68] The project was difficult and frustrating throughout. The journey for wagons delivering the pipes over the Hill Road was arduous, and in 1881 a tunnel cave-in slowed work.

What the council couldn't plan for were a series of strong summer or 'rata' floods, which seriously damaged the dam. On the night of 19 October 1883, after a fortnight's heavy rain, flood waters scoured out the earth filling behind the concrete-face wall and opened a "large gap" in it and the rock core below. Repairs to this nine-metre gash were hindered by another flood on 4 November 1883.[69] Each time the pipes were charged, they burst as far as Petone (six times in four months). As if this was not enough, a third flood hit the works in January 1884 – on the day the city planned to ceremoniously turn on Wainuiomata's water. A "severe, tremendous storm" set in suddenly on the 21st as the town prepared for its 44th Anniversary Day regatta and Druids fete. That afternoon the *Evening Post* revealed "the new dam is being rather anxiously watched". By this time the dam was complete and had been handed over to the council, full of water. Sure enough, overnight floodwaters rose to 3.3 metres above the dam crest, causing damage that took months to repair. This "washed away the dam" (though Baird would deny it) and all the bridges downstream.[70] Baird delayed his departure from the city engineer's job to oversee repairs, which cost £3,426.[71] While he repaired the dam, Joseph Saunders flumed the water from the river to the race, allowing the pipes to again be charged: water flowed to Wellington from 10 May.[72] The Wainuiomata waterworks were completed later in the year, and the dam soon planted in trees (a practice now frowned upon) to help stabilise its earth filling.[73]

When these mains were turned off temporarily in 1887 for repairs to the badly leaking water-race, another disastrous fire occurred, in Panama Street, for which the flow from Karori was inadequate. The public backlash led to the Waterworks Investigation Committee being revised,

and a bitter public spat ensued between Baird and the new City Engineer, Bernard Loughrey, over the scheme as a whole and the water-race in particular. Loughrey put aside "professional etiquette" to criticise Baird. Other consultants weighed in. The media lampooned the leakiness and frequent inspection visits, which often included a wet lunch.[74] The committee found that Baird could have supervised more (despite Oakes saying "he had been watched as if he were a pickpocket"), but there was "no grave defect in any part" of the Wainuiomata scheme.[75] It was, after all, supplying 176 litres per head per day for domestic use, but to some people the crystal clarity of Wainui water made Karori water by contrast "inferior in quality".[76] Replace the race with piping, the committee said, and for future supplies Wellington should look to the next valley over, the Orongorongo River. Bringing Wainuiomata's water to Wellington cost £130,000.



"Tarara boom deay! We've lots of 'Wai' to-day!" This 1884 lithograph reflects the great optimism surrounding the imminent arrival of Wainui water to Wellington. (Alexander Turnbull Library, Wellington, NZ. Reference B-034-020)

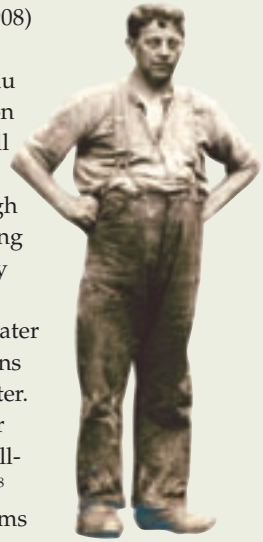
Around the region

As Wellington grew, so did the local authorities in the region. In 1876 provincial government was abolished, and under the Counties Act, Hutt County was established in 1877. It covered the whole future Wellington region – with the exception of Wellington city. County revenue came largely from licensing, rates, and the much-hated tolls on roads and bridges. This revenue was barely sufficient to maintain and improve these services, let alone extend to the provision of public waterworks. Most councils nonetheless searched for public water supplies. The Hutt and Petone town boards commissioned reports on possible water schemes in the mid-1880s.[77]

Petone residents relied on private artesian wells, tapped from 1883. This underground water, or river-fed aquifer, leapt out of the ground at Petone (whereas up the valley it had to be pumped by windmill or hand). This supply was also fed into underground tanks on some street corners for fire-fighting purposes. Wellington offered Petone a supply in 1884 (at one shilling per 4,500 litres), but rather than buy this costly Wainuiomata water Petone applied to be a co-user.[78] The application was declined, and the necessity to establish its own water supply led to the formation of the Petone Borough Council in 1888. Petone's first plan was to draw a supply from the spring on Mr Fitzherbert's Hutt Road property. Nicholas Marchant said this would be inadequate and recommended Belmont Stream or Takapu Creek.[79] Cost precluded this, so in 1899 Petone and Lower Hutt boroughs jointly investigated a Belmont supply. Lower Hutt Borough nominally dropped out but quietly purchased the Belmont Stream water rights from the owner, Speedy, while Petone was in negotiation. This kept relations cool between the two boroughs for a number of years.[80] In June 1901, following a fire that destroyed the Victoria Hotel, Petone again applied to connect into the Wainuiomata main for fire-fighting purposes, but was again rejected owing to water shortages in Wellington.[81] The borough settled on the only other stream available, Korokoro, but this brought it into conflict with the woollen mill there, which had riparian rights over the supply. A solution, which split the council and saw the resignation of five councillors, was for the borough to build two dams, one for public supply and a second smaller dam for the mill. Both were built in 1903 by borough engineer Samuel Jickell.[82] The borough's dam had a capacity of 36 million litres, but stream flow was inadequate in summer and had to be supplemented by bores and pumps in Tennyson Street. This episode was very costly, as the mill successfully defended its rights to the water in court.[83]

The Lower Hutt Borough started works in January 1906 for fresh and wastewater reticulation. For a population of just 3,000, they were expensive. The borough's first engineer, Henry Rix-Trott, diverted the Belmont Stream in the western hills, piped the water 600 metres to a new reservoir at Normandale and built a pumphouse to add artesian water drawn from Williams Grove. By the time the work was finished in 1908, costs had blown out to nearly £20 per resident. The ratepayers revolted by throwing out the mayor, most councillors and Rix-Trott.[84] The system, however, successfully supplied 136,000 litres a day and the reservoir had to be considerably enlarged only four years later.[85]

Other local authorities (formed 1906-1908) established rudimentary supplies.[86] Johnsonville drew a supply from Ohariu Valley in 1912. A small dam was built on Ohariu Stream with a pumphouse to fill a high reservoir near the ridge-top (the pipeline down to the town went through a tunnel). This dam survived a damaging flood in 1918 and was supplemented by two others at the top of Elliott Street in 1920.[87] Eastbourne in 1911 engaged a water diviner and investigated tapping Gollans Stream, but neither produced town water. Some residents privately dammed their backyard creeks, Bartolo Russo even selling water to his Rona Bay neighbours.[88] Residents in other suburbs cut by streams used hydraulic rams to pump water to their own tanks. The Porirua Mental Hospital in 1893 dammed Mitchell Stream coming off Colonial Knob for a water supply (adding another tributary in 1912).[89] Upper Hutt's supply was started in April 1914 with a weir on Clarke's Stream and pipes crossing the Hutt River at Birchville. The Defence Department established a separate reticulated supply for Trentham camp (town-sized in itself) in 1915, with reservoirs on Cuckoo Valley Creek.[90] Paekakariki's town supply, designed by G Laing-Meason, was initiated in 1922 from McKay's Creek, on land owned by former Hutt County Council chairman Arthur McKay.[91]



Labourer

This plan of the Kaiwharawhara Stream watershed, dated 1901, shows the catchment land to be purchased (blue) in relation to the planned upper dam and reservoir.

Extending water

Wellington city grew phenomenally: by the 1890s it was the country's biggest settlement. Shiploads of immigrants boosted the city's population to 43,000.[92] New boroughs ringed the city – Melrose in 1888 (including what are now Kelburn, Brooklyn, Vogeltown, Island Bay, Lyall Bay, Kilbirnie, Hataitai and Roseneath), Onslow in 1890 (Ngaio, Khandallah, Kaiwharawhara and Wadestown), Karori in 1891 and, in 1904, Miramar (the remaining eastern suburbs).[93] Melrose applied to tap into the Wainuiomata supply (as Petone had), before parts of both it and Karori were deemed to be within the city's water supply area in 1895. Following the report of a Special Boundaries Committee in 1898, parts of Onslow, Seatoun and Karori that lay within the Wellington watershed were also brought under city control.[94]

The remains of the incline tramway used in the construction of Karori's upper dam can still be seen in the Karori Wildlife Sanctuary.

Initial confidence in the abundance of the new Wainuiomata supply led to over-use, including by water engines, fountains and even hydraulic lifts.[95] By now electricity was being generated from the piped supply.[96] Where use by church organs, swimming pools and garden hosing had been occasionally restricted, the 1890s saw them prohibited and the supply conserved for domestic use. A plumber was appointed as water inspector to curb excessive waste.[97] Already the first pipes laid now carried a lesser flow, encrustation reducing their usable diameter.[98]

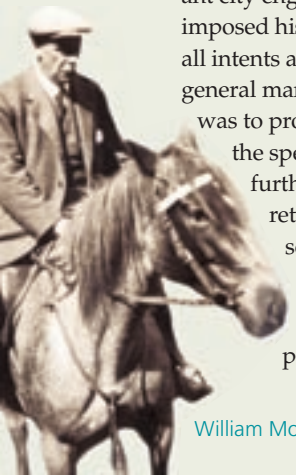
By 1900 the city instructed its new City Engineer, Richard Rounthwaite, to advise on "the best means of increasing the supply… in view of the inconvenience householders are being put to through the shortness of water".[99] Rounthwaite recommended new dams in the upper Wainuiomata (with new mains) and above the Karori dam, as well as investigating the South Karori Stream. Test bores were sunk at the Wainuiomata site. A second Karori storage dam had first been mooted in 1880, by Nicholas Marchant.[100] Rounthwaite also recommended replacing Wainuiomata's old water-race with piping.[101] This work was completed in

1902-1903 and included the installation of the new Venturi meters to more accurately measure the water delivered.[102]

City hygiene was being addressed, with a main-trunk sewerage system completed in 1899 (a main from Dixon Street to the outfall at Moa Point, tunnelled under intervening hills) and other measures.[103] Fears that water shortages would exacerbate poor sanitation prompted the council to set up a Special Waterworks Committee in 1902. The committee endorsed Rounthwaite's proposals for additional storage, as well as acquiring the Karori catchment (which was still used by a "thoroughly dirty… dairy farm and sheep run"[104]). Costed at £162,000, however, these proposals were rejected by ratepayers.[105]

William Morton became city engineer in 1904. He had been in public works in Australia for two decades, 16 years alone with Melbourne city (where he was assistant city engineer).[106] The 38-year-old soon imposed his dominant personality: "to all intents and purposes he was the city's general manager".[107] His two-decade tenure was to prove very influential. He adopted the special committee's findings, and further recommended that water be reticulated to the recently absorbed borough of Melrose and elsewhere throughout the city.[108]

Probably through Morton's persuasiveness, and with Melrose voters in favour, ratepayers now approved the waterworks loan for the upper Wainuiomata and Karori dams, piping and catchment purchase in 1905.[109] In mid-1906 tenders were called for both dams and the city purchased the Karori catchment, mostly from AB Fitchett.[110]



William Morton

The upper Karori dam was started first. A gravity dam, 21 metres high with a curved concrete wall, was completed by Mitchell & King in March 1908.[111] It impounded 284 million litres[112], with the water level 35 metres higher than that of the old reservoir.

At the same time, reticulation by gravity was started in the new low-level suburbs. For hilltop suburbs, high-level zones were created using new pumping stations: for Brooklyn in 1907; Northland/Kelburn in 1908; and Roseneath, Melrose and Wadestown in 1911.[113] These were made possible with the recent advent of the 500-volt DC power network for the trams (previously steam engines had pumped water).[114] The pump stations had to be built close to tram routes, but they provided water to previously impractical heights (Brooklyn's service reservoir was 223 metres above sea level, Wadestown's 241 metres and Karori's 257 metres).[115]

With the upper Karori dam finished, the council turned its attention to Wainuiomata. A site not far upstream of the first Wainui dam was chosen, beside a hillock called Solomons Knob. The river had to be

Contractors for the Karori upper dam, Mitchell & King, gather for the opening ceremony in 1908.
(W F Tibbutt Collection, Alexander Turnbull Library, Wellington, NZ. Reference PAColl-0419)

Wellington's high peaks were used for several service reservoirs, to which water had to be pumped, but which then gave a good gravitational flow to residents. This is Wadestown's reservoir, 241 metres above sea level, built in 1911 and smartly fenced.

The second Wainui dam (Morton Dam) under construction beside Solomons Knob in Sinclair Valley (circa 1911). (S C Smith Collection, Alexander Turnbull Library, Wellington, NZ. Reference G-20074-1/1)

diverted and new roads and bridges built before dam building could start. Martin, Hurrell & Snaddon were contracted (for £46,424) in November 1908. They started the following January and finished in November 1911.[116] The buttress dam in reinforced concrete (of cellular section) was 164 metres in length and 12.5 metres high, and impounded 485 million litres. A fortnight after completion, the council named it Morton Dam in appreciation of the stalwart city engineer (who three years later consulted on sites for Auckland's dams).[117] Melrose residents got their water supply as a 1911 Christmas present.[118]

Morton also recommended duplicating the 600-millimetre main from Gracefield to Wellington. Since laid, this pipeline had leaked and burst, often alongside earth tremors, particularly on the Wellington fault along the Hutt Road.[119] In March 1907 a major flood of the Hutt River destroyed part of the pipe bridge, breaking the Wainuiomata main. The Waterworks Department took 21 days to repair it, working around the clock.[120] A new pipe bridge over the Hutt River estuary was built in 1909 to improve security of the supply. Morton's duplicate 525-millimetre main, connecting to the city's reticulation at Thorndon Quay, was started in 1910. This new main reached Thorndon in 1912 and increased the supply of water from Wainuiomata by 1,075 million litres in its first year.[121] A further connection was also planned to a nine-million-litre distribution reservoir to be built at Bell Road, above the Nairn Street Reserve, to regulate the pressure throughout the city. The new 525-millimetre main arrived there, via Lambton Quay, The Terrace and Nairn Street in 1913. In a rare case of poor planning, the Bell Road reservoir was built a bit too high so that, in summer and with the head loss in the pipe, the water could not rise to it. Instead it was filled, sometimes with difficulty, from Karori.[122]

The 1909 pipe bridge on the Hutt River carried water from Wainuiomata to Wellington for 45 years. (A P Godber Collection, Alexander Turnbull Library, Wellington, NZ. Reference G-453-1/2-APG)

Morton Dam was named after William Morton, the city engineer who oversaw its construction. It was a concrete buttress dam and its cellular mode of construction was 'state of the art' at the time. The spillway was removed when the dam was decommissioned in 1988.

Orongorongo water

Looking at the Orongorongo River as a future source, the Special Waterworks Committee had in 1887 pronounced its waters "as clear as crystal" – but suggested they leave it "to future generations".[123] With Morton Dam nearly finished, Morton proposed that the Government be asked to set aside the Orongorongo catchment as a waterworks reserve. Morton felt its time had come in 1915 and took the mayor there in February, after which the WCC authorised him to pipe Orongorongo water to the dam.[124] Preoccupation with the war hampered this, but the years 1915-1917 were the three driest consecutive years on record – the Wainui dams completely dried out for three days over Easter 1917. *The Dominion* sensationalised this under the headline 'Our Shrinking Water Supply' – and kept the Orongorongo proposal alive.[125] In 1919 Morton refreshed his proposals. At first he proposed that Orongorongo water be supplied into a new large storage reservoir in the lower Wainuiomata valley. This scheme was modified in 1920 because of the unexpected depth required for the dam foundations. He settled on conveying the new supply directly to the lower Karori reservoir, 34 kilometres away, by adding a third pipe.[126] This time the council favoured the Orongorongo as their next source of supply.

Council waterworks staff investigated the inaccessible but pristine Orongorongo River in February 1915. Morton and Morice are sitting (left to right) with Messrs Drummond, Hindmarsh and Luke behind them (left to right).

As a run-of-the-river scheme no dam was involved (merely a weir and intake), and gravity would get the water to its destination. With the absorption of new boroughs Onslow and Karori placing further strain on existing supplies, Wellington ratepayers approved the loan to borrow £561,943 on 15 September 1920.[127]

The Orongorongo project, overseen by Waterworks and Drainage Engineer JM Morice, was major: in all 13 contracts were let, over half for preparing the approaches to the tunnelling sites and pipeline route. Water was to be drawn from a weir, piped through two tunnels to Wainuiomata, then to Karori through new pipes laid alongside the existing two. The 3.7-metre-high weir on the Orongorongo was at the Huia Creek confluence, at 260 metres above sea level.

The headworks and tunnels were built by cooperative labour under a contract between the labour gang, led by the once-militant miner-unionist Robert Semple, and the WCC. The major problem for the headworks was access. For transporting light materials, Semple's team cut a 6.5-kilometre packhorse track over the 580-metre-high bushy ridge between the two valleys. Heavier loads were trucked 45 kilometres to the mouth of the Orongorongo Stream from where horse teams dragged them on sledges 22 kilometres up the bed of the snaking river to the tunnel site. This involved crossing many fords and rough shingle beds, and cutting side roads where the riverbed was too narrow. About 600 tonnes of steel water mains, cement, timber and compressing plant were carried in this way.[128]

At each end of the long tunnel, the council erected a camp with "two power houses with water turbines for driving air compressors for working the rock drilling machines". The WCC also supplied the drilling machines, tools and explosives.[129] The camps were connected by telephone, the insulators and wires slung from trees. The long narrow tunnel, started in October 1921, was the biggest engineering part of the project. At 3.2 kilometres, it was the "second longest in New Zealand", WCC boasted in its 1926-27 Yearbook, "and the largest work of any kind any municipality in Australasia has undertaken in connection with its water supply". Parties started digging from each end, the 525-millimetre pipe (and the 610-millimetre tramway) being laid as it proceeded: the headings met on 23 February 1924.[130] At the headworks in the Orongorongo valley, the shorter second tunnel, 800-metre pipe track and 18-metre truss bridge were completed in 1922: the weir and intake chamber in May 1924.[131] Concreting the long tunnel lining (for about 40 percent of its length) was completed in March 1926. Because of the weir's elevation, the water had enough pressure for the pipeline to be laid over the Waiwhetu hill and not through it.

The western portal of the tunnel to link the Wainuiomata and Orongorongo water catchments, seen here during construction. The 3.2-kilometre tunnel took 28 months to complete, with tunnelling parties working from both ends.

On 23 December 1926, the 'practical men of Wellington' gathered at Karori's lower dam to officially turn on the Orongorongo water supply scheme. Karori was the terminus for all incoming water to Wellington.

When the last pipe was laid for the 'O-K main', as the Orongorongo-to-Karori main became known, the supply was turned on at a ceremony at the Karori reservoir on 23 December 1926.[132] Unlike earlier jobs, New Zealand-made bituminous-lined, steel lock-bar pipes were used (the lock-bar holding the pipes together like a zipper).[133] Three branch lines were connected to reservoirs at Karori, Onslow and Kelburn (which filled when the terminal valve at Karori was shut). The new supply, together with existing sources, was capable of providing 335 litres per head per day for a population of well over 130,000 people. This was anticipated to meet all requirements for at least 15 years.[134]

A caretaker's cottage was built in the Orongorongo valley, but the isolation was not easy. The wife of the first caretaker, Frank Ryan (after whom Ryan's Creek is named), wrote to the council in 1930. "This is a very bad place for a woman to live in," she said, asking for a jigger for her husband or one she could work herself "for getting our necessities through the tunnel. The telephone is very unreliable." The council attended to footbridges over the two creeks on the Wainui side, and fixed the phone, but mentioned no jigger.[135] In what has been a remarkably safe industry, with its dam building, trenching and tunnelling, a death in Orongorongo tunnel provides stark contrast. A staff member going through the tunnel in 1967 failed to stop his jigger at the Orongorongo end and crashed over the turntable into the river, which was swollen at the time. His drowning led to more visible signs warning jigger drivers of the approaching terminus.[136] Some of the topography now owes its identity to this project, with names like Semple's Track, Semple's Tunnel, and Telephone Creek.[137] Before being finished, the high cost led to criticism of the project. At a Newtown political meeting of Labour supporters before the 1925 municipal election (in which Semple was standing), "Severe criticism was directed at the Orongorongo tunnel scheme, which, it was stated, was costing a considerable sum of money each year in interest, but was giving no service in return".[138]

Orongorongo project living quarters

1920s-1940s
First Cooperation

City councillors and Water Works staff inspect a main being mortar lined in Newtown.

Wellington City and Suburban Water Supply Board

By the time the Orongorongo scheme was finished in 1926, the seven authorities of the region saw some advantage in cooperation with Wellington over water. Wellington's Mayor, Sir John Luke, joked about the silliness of each little borough having distinct watersheds, saying that Onslow's catchment was in Johnsonville district and Johnsonville's in Onslow.[139] Indeed Hutt County was in conflict with Upper Hutt Borough, with the latter withdrawing its offer of water for Heretaunga.[140] There was talk of an "extended metropolitan area" in relation to water, and New Zealand's four cities even compared water charges.[141]

Engineers calculated that Wellington's daily water needs were 34 million litres, but the supply in dry weather was only 20 million litres and the storage dams (though good for 66 days' supply) were silting up.[142] A new supply would be needed if other boroughs were to be supplied as well. The result was the Wellington City & Suburban Water Supply Act 1927.[143] The Act vested in WCC the watersheds of the Akatarawa, Whakatikei, Hutt and Pakuratahi rivers (around 27,200 hectares). This land was to be used for water supply, forestry and recreational purposes to benefit the member authorities. A board of control was established, with membership by the mayors of Wellington City, Lower Hutt, Upper Hutt and Petone boroughs, four Wellington City councillors, and one councillor each from Hutt County and Eastbourne.[144] Wellington's Mayor Troup was the first chairman, with Bob Semple (a Labour city councillor) a member.[145]

The Water Supply Board marked a tentative beginning to regional cooperation over water – it became involved with most of the supply schemes over the next 45 years. The board's affairs were managed by the WCC town clerk, the city engineer and the forestry officer. With the region's rapid population growth and subsequent changes in administrative boundaries, it was later to include representatives from Makara County and Johnsonville Town Board (1947), Tawa Flat Town District (1952) and Porirua Borough (1962).

The board's first meeting early in 1928 thanked the Government for the catchment gift, and initiated a comprehensive investigation of streams under its control.[146] Wellington's new City Engineer, GA Hart, submitted a report the following July. Stating that Wainuiomata had no scope (and Orongorongo little) for further development, he recommended a Hutt River scheme with a small development of the Whakatikei. This would provide "10 million gallons (45 million litres) per day, estimated to meet all requirements of the City of Wellington and the Suburban Areas for not less than 15, and possibly 20 years".[147] The DSIR's Geological Survey Branch assessed potential dam sites in the upper river reaches.[148] The estimated cost was £566,000, to be divided pro rata, and the report was adopted by the board.[149]

Lower Hutt and Petone, however, were both unwilling to pay this sort of money. After half a century of seeing Wellington's water passing under their noses on the foreshore, without benefiting from it, they were not about to buy in now. Petone wavered first, and Lower Hutt supported it on the assurance of its borough engineer, AG Bush, that the Hutt aquifer could economically be expanded to meet all their needs.[150] (The Director of Health, Dr Watt, had by then quelled fears that aquifer water caused goitre.[151]) So, on 18 August 1930, Petone and Lower Hutt withdrew from the Water Supply Board (despite the Hutt representative saying that his council should "stay on and carry its share of the burden".)[152]

Petone started renewing its water mains in September 1929 and the following year sank more wells beside the Tennyson Street pumping station.[153] In 1932 it extended its scheme to the district of Korokoro.[154] Growing demand in Lower Hutt had seen the borough add many new wells and pumps in 1926. But after leaving the Water Supply Board, Lower Hutt was required to extend its supply to Eastbourne Borough. Eastbourne had turned to Lower Hutt for its supply after

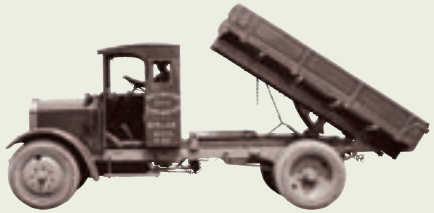
'Day' labourers excavating the site for the Eastbourne reservoir, located at Point Howard (circa 1930). (Alexander Turnbull Library, Wellington, NZ. Reference F-162468-1/2)

the Health Department demanded action in 1928 over poor water quality. Water from Lower Hutt artesian bores was piped to a storage tank built at Point Howard.[155] In 1937 Lower Hutt built a pumping station at Birch Street and sank two new wells. More wells and pumps were added during the war.[156] In a large programme of works in 1946-1947, a well field and pumping station was commissioned at Elizabeth Street, Hutt Park, along with 525-millimetre mains and a 4.5-million-litre reservoir above Naenae.[157]

Elsewhere, Upper Hutt built the Akatarawa dam (Birchville) in 1930-1931, and this supply was later augmented by wells at the end of Miro Street, Trentham camp and the racecourse grounds.[158] In many areas of Hutt County no public water supplies had been provided. Paekakariki had started local reticulated supply in 1922 and Paraparaumu in 1929, but otherwise, roof tanks and wells were still the only source.[159] In Paremata and Plimmerton, water was delivered by tanker until the 1950s.[160] Unable to expand its supply from Morton Dam, Wainuiomata Riding tapped two streams by Hair Street in the 1940s. From 1955, Skerrits Creek was used. When Hutt County took over Wainuiomata's supply in 1957, it was linked to the dam.[161]

"In recent years, in one form or another," the city engineer said in 1938, "overtures have reached either the City Corporation or the [Water Supply] Board to consider supply of water to: Paraparaumu, Paekakariki, Plimmerton, Titahi Bay, Porirua, Tawa Flat, Johnsonville, Upper Hutt, Hutt County, and Eastbourne." The Board's consideration of the watersheds and trunk routes needed to supply these widely dispersed areas was to prove useful practice for the future.[162]

With the withdrawal of Petone and Lower Hutt from the Water Supply Board, Wellington faced huge costs for the proposed Hutt River scheme.[163] It still owed £874,383 on waterworks loans going back 49 years, and was installing a chlorination plant at Karori, having finally accepted claims long made by users that its water occasionally tasted and smelled 'off'.[164] Two new pump stations, at Onslow and Karori, were also being installed to make up for the head loss in the O-K main. Wellington's share of votes on the board rose (even if the mayor had trouble getting his two councillors, who were also MPs, to attend), but so did its ratio of cost (based on population), from 77 to 93 percent.[165] With the loss of contributions from Petone



The concrete arch Birchville dam served Upper Hutt for 23 years from 1931, until superseded by the Kaitoke scheme. (Photo Jessica Dewsnap)

and Lower Hutt, the city engineer reviewed his proposals.[166] Hart's report of 13 July 1930, after again considering another dam in Wainuiomata, recommended artesian water sources in the lower Hutt Valley as "a temporary expedient. Recourse to the conservation areas of the Hutt River and some of its tributaries is sooner or later inevitable."[167]

Gear Island supply

Not everyone favoured Wellington's use of the Hutt aquifer. "In Wellington the opposition took the form of condemning the proposal on the score that the water was polluted, uncertain in quantity and definitely goitre producing. In the Hutt Valley citizens became alarmed at what they conceived to be a raid upon their local supplies, and their objections crystallized finally into an appeal to Parliament. One by one the objections both internal and external were voted out…"[168] The scheme was approved as a supplementary supply for Wellington City in times of drought or emergency.

Wellington drilled preliminary bores on a strip of Hutt River Board land at Gear Island, Petone, in October 1931. After dry periods in 1932-1933, the land was taken under the Public Works Act.[169] In the meantime Wellington wrangled with the Petone and Lower Hutt borough councils and the Hutt River Board over its rights to this water source. Only after three years was an agreement reached, which allowed Wellington a maximum draw-off of 22.5 million litres per day, to be reviewed after 10 years. They could extend the drilled area if less than 22.5 million litres per day was obtained.

Drilling the production wells and building a low-pressure pumping station started in February 1935. This pumped the water

into the Wainui mains to Thorndon. A break-pressure tank was constructed in the hills along the Hutt Road to avoid over-pressuring the mains, and a second pumping station built on Thorndon Quay (below Tinakori Road) to boost the water into the city reticulation. The original cost of the scheme was £18,510. The supply was first substantially used on 3 March 1939, after a three-month dry spell.[170] A high-pressure pump was added to Gear Island in 1946 to pump into the O-K main and in 1953 the station was extended and two further high-pressure pumps installed. This increased the draw-off to 22.5 million litres per day.[171] The Gear Island supply was only utilised on a few occasions and, for the most part, for short periods.[172]

In 1935 the lower Karori dam was linked directly into the city's distribution system by a 450-millimetre steel auxiliary main, after an automatic break-pressure tank was built behind the old distribution basin on Raroa Road. This basin, the first major water supply work built in Wellington, was taken out of service (and filled in by 1964).[173] As well as serving "the high-value business areas of the city", the auxiliary main allowed Wainuiomata water to be shut off briefly for maintenance without interrupting supply.[174] A construction programme increased the capacity of service reservoirs around Wellington; by 1938 there were 19.[175]

An exploratory bore at Gear Island. Artesian water had long been used in Petone when Wellington City tapped this source in the 1930s.

With a hint of stripped classical and deco simplicity, the architectural Gear Island pumping station was built in 1935. It is still in use, albeit with the windows filled in.

These water supplies soon proved inadequate in the face of intense urbanisation. Wellington was again forced to augment its supply. The South Karori Stream had long been considered, and in 1944 a temporary scheme to tap it was started. An upper tributary in Long Gully (called Silver Stream), with a 490-hectare catchment, flowed only 590 metres from the upper Kaiwharawhara Stream. A 125-metre-high saddle separated them, so the simple solution was to pump the water over the saddle into the Karori catchment. It was possible only because a power supply was available nearby, having been extended in 1942 to Wright's Hill for the 9.2-inch (234-millimetre) counter-bombardment battery. Once the pipeline had been snaked over the saddle, pumping was started on 17 September 1945.[176] The Long Gully water supply was dismantled in April 1957 when Kaitoke came on stream.

BUSHLAND WATER SOURCE IS LARGE CONTRIBUTOR TO A THIRSTY CAPITAL CITY

WELLINGTON LOOKS TO HER FUTURE NEEDS FOR AMPLE AND PURE WATER

New Zealand Free Lance, December 3, 1952.

1940s-1970s

Regional water

Water supply pipeline, Wainuiomata (circa 1952).
(New Zealand Free Lance Collection, Alexander Turnbull Library, Wellington, NZ. Reference PAColl-8983-25. Image colourised)

The Hutt River scheme

The Water Supply Board was well aware by the mid-1930s of the need for a new source. Wellington had "very seldom for any length of time been able to sit back and congratulate herself upon an entirely adequate water supply".[177] Constant expansion, plus the first Labour Government's intended housing schemes in the Hutt and Porirua basin, would further increase pressure on existing supplies.

The Hutt River's headwaters were investigated in 1906 as a site for a hydro-electric dam, but Mangahao, behind Shannon, was favoured. In 1919 the city engineer suggested the Hutt River be developed after the Orongorongo.[178]

The untapped Akatarawa and Whakatikei catchments were also surveyed and portions of the Little Akatarawa watershed acquired in 1928 and 1936.[179] Also purchased (in 1939) were 63 hectares at Kaitoke, for the Hutt River headworks.[180] While the surveying stopped in 1940, the situation was reviewed two years later by Waterworks engineer Edgar McKillop, supported by the government's geological surveyor John Henderson.[181]

Bob Semple, Minister of Works and past-master in waterworks projects, drove the effort for a new scheme. In February 1943, Semple asked for information on potential water schemes to supply 15,000 houses in the Porirua basin. In supplying the information, the board sensed the offer of government money and "omit[ed] references to the economics of construction", that it "cannot be justified on economic grounds".[182] The Hutt option was now, as Scheme X, contrasted with a cheaper scheme (Y – enhanced artesian and Little Akatarawa waters). Semple visited the Kaitoke site in April with City Engineer KE Luke, who detailed the river scheme in his 1943 report.[183] "Rigid economies" were already required in higher parts of the city during dry weather periods, and Luke warned that without recourse to the Hutt gravity scheme, "even with such economies, it is unlikely that rationing in some form or other can be wholly avoided".[184] Additional intake weirs had already been added to the Orongorongo valley's Big and Little Huia streams and Telephone Creek and, when the O-K main's carrying capacity dropped 25 percent through encrustation, another intake was approved for upper George Creek on the Wainuiomata side of the range.[185] Enthusiasm for artesian waters had waned with recent incidents in Foxton and Lower Hutt of cross-pollution, in which 'negative pressure' in leaking wells sucked in polluted ground water from nearby septic tanks.[186]

Government water

The Government endorsed the board's proposal and agreed to fund the Hutt River scheme (the cost being £1.1 million excluding service reservoirs and branch lines), but then "to hand over the works on completion to the Wellington City Council, to operate on behalf of the [Water Supply] Board's members".[187] In reaching this agreement, the members horse-traded their allocated proportions of water: Wellington saying it should not agree to any volume less than 25 million litres per day, otherwise it represented "no gain".[188]

A number of factors led Luke to alter the pipeline route, which from the 1929 report would have gone straight down the Hutt Valley, to join existing mains at Petone.[189] The ultimate destination (because of the Government's housing scheme) was now Porirua, far to the northwest. The pipeline now also had to skirt the non-members of the board in the lower Hutt Valley (an attempt to woo them back in 1948 had failed).[190] Lower Hutt and Petone's withdrawal from the board in 1930 had "seriously handicapped" its planning for any comprehensive water supply scheme (particularly choosing trunk routes) ever since.[191] Avoiding the Wellington fault line was also sensible, but wartime provided another reason not to lay the pipes along the Hutt foreshore: they could "be disrupted by earthquake or enemy action".[192]

The route chosen was to go through the upper Hutt Valley to Haywards Hill, then over to Judgeford (in 900-millimetre pipes). After the line branched off for Porirua and Plimmerton, a 750-millimetre pipe was to head south through more tunnels, past Tawa, Johnsonville and Wilton to the Karori reservoir.[193] The Ministry was to lay the pipeline to Wellington's boundary with Johnsonville at Maldive Street, whereupon Wellington Waterworks (which became a separate branch in the City Engineer's Department in 1949) supervised the remaining pipe-laying.[194]

Laying of the Porirua branch line off the Kaitoke-to-Karori water main. (The Dominion Post, Wellington, NZ)

Stewart and Lloyds' steel pipes from Britain being loaded on a truck at Wellington wharf for delivery to Kaitoke, 1950

The Ministry of Works, with Edgar McKillop now Permanent Head, carried out design and construction work to the general requirements of the Water Supply Board and subject to the joint approval of the Ministry's engineer-in-chief and (acting for the board) WCC city engineer. Detailed engineering studies started in February 1944, with the ministry building 14 kilometres of access roads to Kaitoke from June 1945 – and later to parts of the hilly, swampy pipe route. An experimental weir established earlier on Farm Creek only just survived a flood on 28 October.[195] The land for the headworks at Kaitoke had already been purchased by exchange in 1939.[196]

Progress on the scheme was impeded by war-related shortages. New Zealand's wartime manpower shortage continued into the 1950s. Steel was in short supply. Work until January 1950 was therefore limited to road and tunnel construction. The outbreak of the Korean War again made the delivery of steel "uncertain".[197] While steel pipes were eventually imported from Britain, steel plate was also brought in for fabricating into pipes (more than half of the main pipeline was made in New Zealand this way).[198]

Kaitoke water

The heart of the headworks is an intake weir, essentially a low, concrete, gravity dam 40 metres wide and eight metres high. This raises the normal water level by four metres to allow a flow into the tunnel conduit. Construction work on the weir was hampered by confined working space; the site is subject to flash floods and there is no room for a bypass tunnel.[199]

The intake is 200 metres above sea level. The water passes through a short tunnel then crosses the river on a flume bridge (aqueduct). It then enters settling chambers to remove sand and silt, and passes through automatic rotary strainers to remove twigs and leaves. The flow of water is measured, and since 1965 has been chlorinated and fluoridated (this function taken over by the Te Marua treatment plant by 1990). From the strainer building, the water enters a 2.8-kilometre tunnel and emerges in a chamber in the hills above Te Marua.[200] From here it is piped to Karori.

Construction work included six tunnels (totalling nearly five kilometres), 54 kilometres of main pipeline, and approximately 12 kilometres of branch lines. In all, 10 reservoirs were built for the original project and two pumping stations erected, at Johnsonville and Karori, for back-pumping to Upper Hutt. Back-pumping allowed water to be shut off at Kaitoke after storms made it too turbid or coloured, and pumped back up the pipeline from Karori to serve users en route. A turbidimeter – for measuring dirt particles in the water – was installed at the headworks in 1958.

As built, the scheme's capacity was 50 million litres per day, but the headworks were designed for later doubling this figure and duplicating the pipeline.[201] Wellington won its 25 million litres per day. The rest was apportioned to the other board members: Upper Hutt, Makara County (replaced by Porirua in 1962) and Hutt County.[202]

The Kaitoke scheme (as it is now generally called) was completed in 1957 and was operated briefly by the Ministry of Works before being handed over to the Water Supply Board on 1 April. It proved very successful as a cheap gravity scheme.

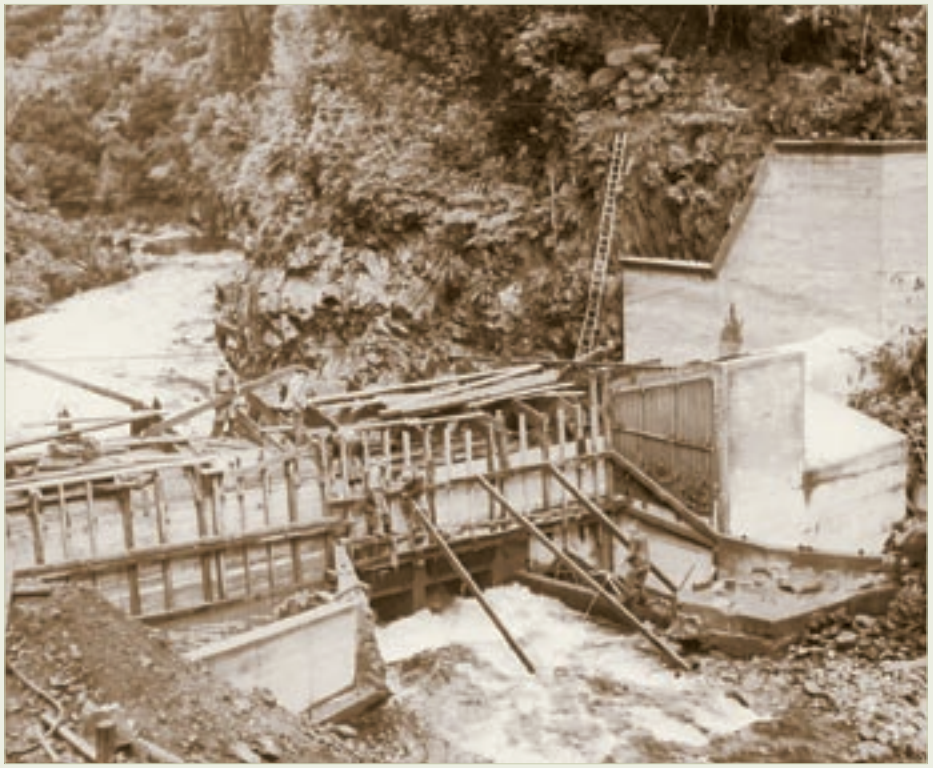
Water from the scheme arrived in stages to the consumers. First to receive it was Upper Hutt in 1954, followed by Trentham. From there, receiving supplies for the first time were Pinehaven, Stokes Valley, Haywards, Plimmerton, Porirua, Tawa and Newlands (in 1959). With the coming of Kaitoke water, many of these areas abandoned their unsatisfactory earlier supplies.[203] Communities further away, such as Paremata, had to endure "a hot dry Christmas" or two before the Kaitoke pipe reached them.[204] Kaitoke first showed

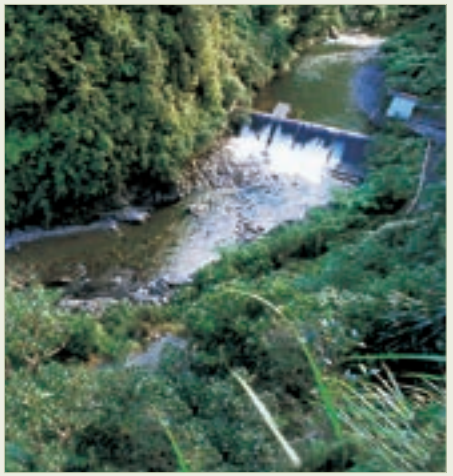
its major value when a storm on Boxing Day 1962 shut down the Wainuiomata and Orongorongo supplies.

By 1956 the cost of steel plate had trebled, wages had doubled over the 10-year period, and various extensions had been made to the existing project. The original 1943 cost estimate fell far short of the actual costs of £3.4 million.[205] When Auckland's mayor, JH Luxford, heard that the Government was subsidising 43 percent of this he 'boiled over', saying it was an "unjustified preferential treatment for Wellington".[206]

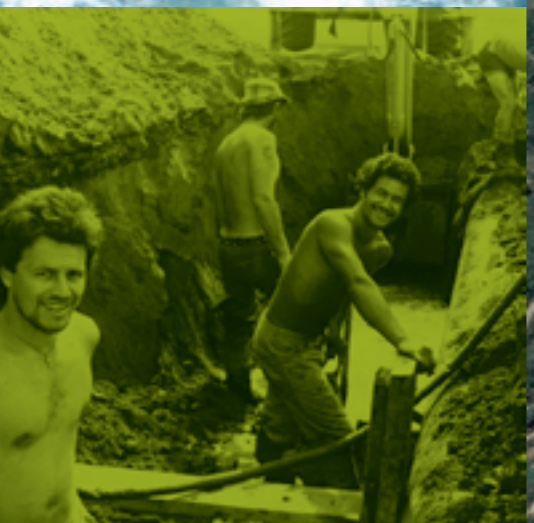
Petone Borough and Lower Hutt City remained reliant on their artesian sources. Petone discontinued its surface water supply from the Korokoro Stream when its quality proved to be unsatisfactory, replacing it with new wells and a pumping station built in Buick Street in 1963.[207]

Kaitoke supplied enough additional water throughout the region for the next 15 years. Consumer demand increased due to steady population growth, increased water usage for gardening, and with domestic novelties such as automatic washing machines and swimming pools.[208] Augmenting Wellington's distribution system, the O-K main was connected to the pipe feeding Bell Road via a break-pressure tank, in 1953.[209] New service reservoirs were constantly needed. Among these was the eight-million-litre Carmichael reservoir in Newtown (1960), named in honour of Wellington's recently-retired water engineer. It serviced Island Bay, Lyall Bay and Miramar. Others were Emerald Hill (Upper Hutt), Hayward substation (both 1.1 million litres) and Porirua East (4.5 million litres), all constructed in 1966, plus a new 4.5-million-litre reservoir for Tawa Borough, completed in 1971.[210] The new Hutt estuary bridge was completed in 1964, with 675-millimetre and 525-millimetre pipes to carry water from Wainui and the Orongorongos respectively over the Hutt River mouth. After 51 years in service, the old pipe bridge was demolished the following year. The back-pumping capacity at Karori was increased in 1968 from 22.5 to 40 million litres per day. This alleviated the limitations of the Kaitoke scheme when the Hutt River was low or dirty. Described as Kaitoke stage two, a booster pumping station and second 18-million-litre reservoir were constructed at Haywards. Completed in 1971 at a cost of $600,000, it doubled the system's capacity to 100 million litres per day[211].





The water intake at Kaitoke on the Hutt River, seen here under construction (September 1952, left) and complete (above). Building the intake proved challenging, as it is situated in a narrow gorge that is subject to flash floods and the river could not be diverted away from the construction site.



1970s-2000s

Greater Wellington water

Te Marua water treatment plant (foreground) and the Stuart Macaskill storage lakes, 1999

Regional Water Board

The Kaitoke scheme was the first to address the region's water sources and needs in a truly integrated way. It was conceived to supply many municipalities, and set the scene for collaborative thinking on water, which has characterised every decade since.

A Wellington city engineer once said that "as time progresses considerations of mutual interest in regard to water supply will inevitably draw the authorities within these areas into closer relationship".[212] That was after the 1930 schism: in 1959 his equivalent went even further, recommending that "all sources of water supply within the region should be controlled by one authority".[213] In the same year, the Hutt Valley Underground Water Authority (HVUWA) was set up to safeguard the Hutt aquifer by controlling "the tapping, use and pollution of underground water".[214] Control of water at this time was by three bodies: the HVUWA, the Water Supply Board, and the Hutt River Board. Importantly, the HVUWA argued that a "single regional [water] authority was essential".[215]

Reform was afoot in Britain, where 'water wars' saw 1,226 water boards amalgamated to around 350. The Commission of Enquiry into Reorganisation of Local Government in the Hutt Valley in 1963 noted this, and advocated integrating all water supplies under a single authority. The biggest user, WCC, agreed.[216]

By 1963, the Wellington City and Suburban Water Supply Board owned the Kaitoke scheme and controlled catchments totalling 52,500 hectares, but not being a rating body it had no independent income and did not represent Lower Hutt and Petone. Not until 1967 did reform kick in, with the Water and Soil Conservation Act. This Act established "control of all water resources in the country", and anticipated eight water boards (in reality augmented catchment boards) as its local agents.

With the Act passed, regional water boards started forming.[217] Legislation establishing the Wellington Regional Water Board (WRWB) was passed on 1 December 1972. The WRWB absorbed the old Water Supply Board, HVUWA and Hutt River Board, moving into the latter's premises in Lower Hutt. Its operational area extended from Waikanae in the north and the Orongorongo range in the east, and included 10 local authorities and 340,000 people in 1,550 square kilometres. The WRWB began operations on 1 March 1973, taking over Wellington Waterworks Division staff on 1 September 1974.[218] At the same time WCC contracted the WRWB to run its retail operation and maintain its reticulation on an agency basis (this arrangement continued with Wellington Regional Council from 1980 until November 2001).[219]

The road tunnel project to link Wainuiomata with the Hutt Valley was abandoned in the 1930s (shown here), but produced dividends when in 1981 it was finished in a smaller bore for water pipes. (Alexander Turnbull Library, Wellington, NZ. Reference F-65767-1/2)

As well as bulk water supply, the WRWB was responsible for forestry, water resources management, soil conservation, rivers control, and recreation. It adopted a major WCC report from 1971, by JS Roberts, which identified the need to rehabilitate large sections of the existing system, increase the quality of water and introduce new sources for a rapidly expanding population. The board's chief engineer Ron Bishop also recommended (in 1974) expanding the Kaitoke scheme and providing new storage at Te Marua.

The board set about a major programme of system renewal and expansion works, but its existence was to be fairly short-lived (1973-1980). The functions of the WRWB and the Wellington Regional Planning Authority were combined under the Wellington Regional Council (WRC), a new local authority created in 1980.

The regional council (restyled Greater Wellington in 2003) continues to operate a 'wholesale' water supply under the WRWB Act 1972. It supplies water to four retailing councils: Wellington, Porirua, Hutt City and Upper Hutt, levying each for its share of the total supply.

Renewal

From 1973 the first major task for the newly established water board was renewing old pipes – but doing so in a way that significantly upgraded their capacity. With each project the engineers had to keep the water flowing: "It is a '24/7, 365 business'," design engineer John Morrison says. "We don't have the opportunity to take it offline".[220] The 90-year-old 600-millimetre cast-iron mains from Wainuiomata came first. The plan was to replace 15.5 kilometres of the main, from the Waiwhetu tunnel to Thorndon, with a 1,050-millimetre steel pipe. This took four years from 1975. The original pipe had been laid along the Hutt Road following the old coastline, and knowledge of its exact route was vague (in the 1930s a water diviner had even failed to locate it).[221] The new pipe had to cross the old 26 times, requiring deviations and a tunnel under Rocky Point. The traffic issue was best handled by doing much of the work at night. The project was commissioned with a ceremony at Thorndon pumping station on 12 June 1979.[222]

Next was replacement of the increasingly leaky 750-millimetre pipe through the Waiwhetu hill. The original 1880s brick-lined pipe tunnel was too small for a replacement pipe. A logical alternative presented itself in the form of the part-finished road tunnel from Tunnel Grove just a few hundred metres south. It had been started in January 1932 by the Wainuiomata Development Company, but was killed off by the Depression. About a third of it had been driven (from the Hutt side), and its only function had been to store explosives during World War Two. The WRWB bought the tunnel in 1975 with plans to complete it with a smaller drive. Codelfa Construction New Zealand Ltd broke through to Waiu Street in September 1980. A 1,100-millimetre steel pipe was laid through the tunnel. Such was the excitement in Wainuiomata over the original road tunnel that, when it was completed for water only, *Valley News* cried "alas".[223]

While these two sections of original Wainuiomata-Wellington pipeline were replaced, the 750-millimetre-diameter century-old pipeline running through Wainuiomata itself was deemed to be still usable, so was cleaned and concrete-lined in 1987-1989. From Moores Valley Road to the dam, both the 1902-1903 750-millimetre and the 1926 525-millimetre O-K main were replaced with a 1,050-millimetre pipe in 1992-1993.

Another big renewal job was the O-K main between the Orongorongo intake and Wainuiomata water treatment plant, which was replaced between 1997 and 2004. The pipe through the 3.2-kilometre tunnel was replaced first. In parts the tunnel wall had to be shaved to allow both the new pipe and replacement rail tracks to fit. The pipe from the Orongorongo weir to the tunnel's eastern portal was replaced two years later. The terrain made access and pipe-laying as challenging as it had been in the 1920s, but this time lightweight pipes and materials were flown in by helicopter. The final stage was the western-portal-to-Wainuiomata treatment plant, completed in 2004.

In further refurbishment of the O-K main, the section from Moores Valley to the eastern portal of the Waiwhetu hill tunnel was lined in concrete in 1995. In 2000-2001 the Thorndon-to-Karori section was concrete-lined, and the Randwick-to-Rahui section

The 'ten-fifty' project in the late 1970s greatly increased the supply capacity of the pipeline from Wainuiomata to Wellington.

The signboard at Ngauranga warning motorists of possible disruption during the laying of the new water main along the Hutt Road. (Dominion Post Collection, Alexander Turnbull Library, Wellington, NZ. Reference EP/1978/0031/10A)

– now part of a dedicated supply from Waterloo to Petone – rehabilitated by inserting an inner polyethylene pipe of smaller diameter.[224]

The work of maintaining Wellington's distribution system involved much renewal of old pipes, as well as laying trunk, feeder and rider mains and service connections to new subdivisions. The serious condition of much of the Wellington's early reticulation piping had been reported as early as 1945. At that time there were still over 11 kilometres of original piping (seven decades old) and 290 kilometres of cast-iron mains that needed concrete lining.[225] The weakness of 19th-century pipes was emphasised in May 1985 when an 1884 200-millimetre main burst spectacularly at the intersection of Lambton Quay, Featherston and Hunter Streets. A major development for Wellington was laying a new trunk main from Thorndon to a reservoir planned for the south of the city. While an 800-millimetre main was being laid from 1983, Macalister Park was chosen as the reservoir site, with work under way there in 1990. Finished in 1993, the 20-million-litre reservoir acts as a control point for water from Waterloo and Wainuiomata; it is effectively an extension of the bulk supply system.

Expansion

The reports of Roberts (1971) and Bishop (1974) set the scene for expanding the water network, but did so based on population growth estimates that proved to be too high. In 1967 the Wellington Regional Planning Authority published growth predictions based on the 1966 Census. These saw Wellington's population of 286,000 increase to 917,000 by 2001. Water consumption was also predicted by JS Roberts to double in the 20 years from 1971. Dry summers in 1969-1971 saw the first restrictions imposed on water use since Kaitoke had been commissioned. Although the population predictions were scaled down by 1980, they were still higher than Wellington's actual growth, and led to ambitious plans for new water sources over the next quarter century, most of which were not required.

Some expansion, however, was needed. The Hutt Park pumping station was upgraded by the Regional Water Board after 1975. The Gear Island plant was reconstructed in 1976-1977, with three new wells in the Shandon Golf Course to replace its open 'flowing' wells, which posed a contamination risk. Variable-speed pumps were also installed to better manage supply pressure to Wellington along the now-fragile, 600-millimetre, cast-iron main. Aeration and chemical treatment were introduced to remove acidity, while water from this source was fluoridated for the first time.

Studies of the aquifer (by Donaldson & Campbell) suggested much more water could be drawn if the wells were placed further up the valley where there was less risk of saltwater intrusion. This led to the biggest development yet of the source. After encouraging findings from test wells in the Waterloo area, land was bought from New Zealand Railways, and a major storage, treatment and distribution plant was begun in 1977 next to the Waterloo station. Six service wells were sunk along Knights Road, rising mains were laid to Naenae and Gracefield reservoirs and a connection made to the Wainuiomata-Wellington system at Randwick. The plant opened in 1981, after which the Hutt Park pumping station was decommissioned. Two further wells were sunk in 1988, coming into use the following year. In October 1999, closure of the Buick Street plant (Petone) and limiting Gear Island's use further concentrated abstraction from the aquifer away from Petone foreshore. Pumping capacity to Wellington was subsequently shifted from the flood-prone Randwick site to Waterloo. Waterloo is now a major part of the supply system, delivering about 40 percent of the region's water.[226]

The major development of the system in the last quarter century has been in terms of storage. Morton Dam and the upper Karori dam were increasingly considered at risk of failing in a large earthquake. Morton Dam was also silted up. The drawback of the

Waterloo water treatment plant and pumping station – next to the Waterloo railway station in Lower Hutt – became the main point of water abstraction from the Lower Hutt aquifer when opened in 1981 (photo December 1986).

The smaller of Te Marua's twin lakes ready for filling. The radiating inlet pipes at the base of the tower help circulate the stored water.

intake systems at Kaitoke and Orongorongo was that there was no storage, so they had to be shut off if the water was too turbid or coloured (happening on average about two days a month). Rather than build another dam, two lakes were planned 'off-river' at Te Marua to be fed by gravity from the Kaitoke intake.[227] Treatment and a pumping station would follow.

In 1974, the WRWB negotiated with housing developers Te Marua Ltd to buy its whole property for the lakes. Upper Hutt stood to lose rates income from this and "saw it as a land grab", according to its former representative Stuart Macaskill. The issue of recreation on the proposed lakes was also divisive; some nearby residents wanting boating and swimming access while the Ministry of Health and Commission for the Environment said that water quality demanded none.[228]

After these issues were settled, work started in October 1980 on the two lakes, to hold 3,220 million litres – equivalent to about three weeks' average supply. The consulting engineers were Tonkin & Taylor Ltd, for whom contractors Green & McCahill worked. The project was hit by ballooning inflation in the 1980s, when costs estimated in 1974, for instance, had to be multiplied by 361 percent.[229] Water from Lake 2 flowed first to consumers in January 1986. However, leakiness seemed to dominate public perception of the lakes and led to five years of remedial work. The contractor was paid for this considerable extra work by the engineers' insurers, but only on the steps of the High Court.[230] The lakes were named after Stuart Macaskill in 2002, honouring the long-term water board member and regional council chairman.[231]

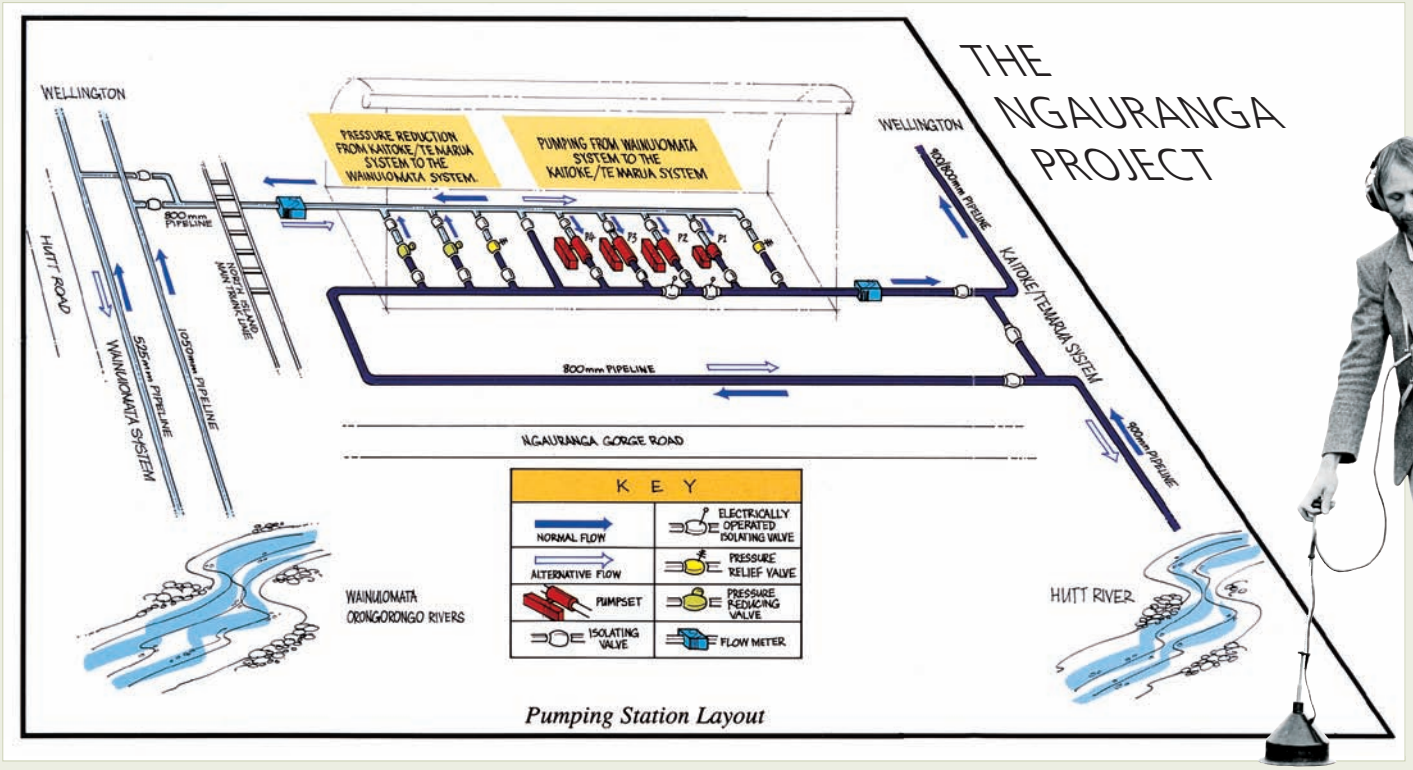
Before the lakes were completed, work began on a pumping station at Te Marua. This housed 10 pumps, to move water from lake to treatment plant or between the lakes, or boost the gravity flow of treated water from Te Marua to Karori. It was commissioned in December 1985. The Te Marua water storage and treatment project was completed in 1987 with commissioning of the treatment plant.

The 'moonscape' of the Te Marua twin lakes construction site, September 1983.

A major systemic enhancement has involved interconnecting parts of the system. As originally built, the Wainuiomata and Orongorongo systems were not linked. An interlinking of sorts, of Orongorongo/Gear Island and Wainuiomata waters, came in 1953 with a 450-millimetre pipe connecting the O-K main in Glenmore Street with the Bell Road feeder on The Terrace. A fuller interlinking was introduced in 1981-1982 with the reconstruction of the Thorndon pumping station. Unused for many years, this station's new equipment was able to pump water from the 1,050-millimetre pipe up to

the lower reservoir at Karori (useful during back-pumping up the Kaitoke main). At about the same time the newly completed Waterloo pumping station and associated distribution changes allowed cross-connection at Randwick, in either direction between the Hutt aquifer and the Wainuiomata systems.

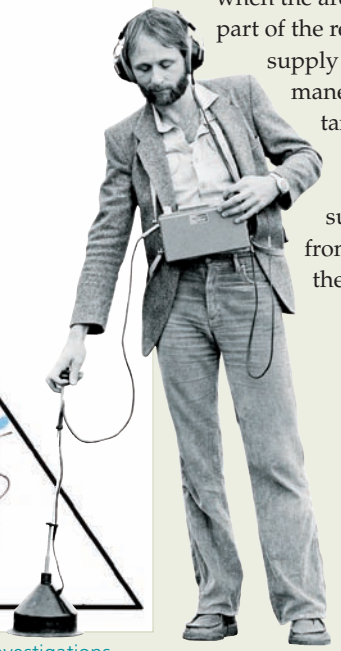
The most significant interconnection was the Ngauranga project – a pumping station, 20-million-litre covered reservoir and pipeline down Ngauranga Gorge – which linked the Wainui/Waterloo and Hutt supply systems. This project developed because of growing concern about the water quality and earthquake safety of the open storage at Karori, and allowed those reservoirs to be decommissioned. The Ngauranga pumps replaced those at Karori for back-pumping towards Upper Hutt, while the reservoir compensated for the loss of storage at Karori. Ngauranga had to balance different pressures from the two systems and be able to pump in several directions. It was opened on 23 June 1992.



The Ngauranga pumping station and pipeline (opened June 1992) allowed water to be passed between the 'Kaitoki-to-Karori' and 'Wainui-to-Wellington' pipelines, which provided a major improvement to the security of regional water supply

Around the region

Horowhenua and Hutt county councils formed a joint committee in 1971 to solve Kapiti's water problem, and designed a treatment plant at Waikanae. The WRWB oversaw construction from June 1975. Drawing water from an intake on the Waikanae River, the plant also piped water to Otaihanga and Paraparaumu. The plant was opened on 20 March 1977 while reticulation was finalised.[232] Kapiti took over management of the plant on 1 April 1982, when the area was not included as part of the regional council's water supply role. The prospect of a permanent water supply (as against tanker loads) might have led Pukerua Bay to join Porirua City in April 1973, but a supply (of Kaitoke water, from Paremata) was extended there only in mid-1980.[233]



Gary O'Meara – pipe location investigations.
(Dominion Post collection, Alexander Turnbull Library, Wellington, NZ. Ref: ep/1980/1702/12. Detail)

Quality and safety

With water, quality is everything. The earliest approach to quality was simply to choose a clean source. The Kaiwharawhara Stream served this purpose until deemed "not satisfactory" in 1929, when a chlorination plant was begun at Karori.[234] While considered better in quality, the high-country catchments brought lots of twigs and leaves, especially after storms. A coarse strainer was built at Morton Dam in 1952, though this did nothing to stop discoloured water reaching consumers.[235] Shared use of catchment land in the early years of water supply, for activities such as farming, gold-mining and deer-breeding, became taboo by 1900.[236]

The Boxing Day flood in 1962 had an unexpected effect on quality management. Heavy rains in the Wainuiomata and Orongorongo valleys damaged the intake weirs and carried mud and silt into the city before the valve was shut. As a result a chlorination plant was built for both supplies in 1963, with strainers installed on the O-K main in 1967 and the Wainuiomata pipe in 1968.[237]

Modern medical thinking sees water as an avenue for augmenting health. Fluoridation is a good but controversial example. A commission of inquiry in 1957 endorsed fluoride for improving dental health, after which Lower Hutt added it to the Hutt Park supply. Petone, however, preferred to draw water perceived as more pure from the Buick Street pumping station. Fluoridation and chlorination of the Kaitoke supply began in March 1965, with the Water Supply Board favouring fluoridation for all. When the Buick Street pumping station was finally retired in 1999, the WRC moved to provide Petone with a fluoridated supply from Wainuiomata. There was such an outcry from residents that the supply of aquifer water was restored and fluoride was discontinued again for Petone – the plants at Waterloo and Gear Island modified to allow for the aberration.[238] For the regional council this was about public health and efficient use of resources, but for the residents of Petone it was all about democracy.

Construction of the region's biggest water treatment plant, at Te Marua, was started after the lakes were finished, on a hill to the north. This introduced a chemical coagulation process and filtration of Hutt River water, "a major step forward in the maintenance of water quality standards and the removal of bacteria".[239] Two clarifiers and six filters enabled turbid raw water to be treated, while chlorination and fluoridation were transferred from Kaitoke. With a rated capacity of 140-million-litres a day, Te Marua was fully commissioned in 1990.[240]

The final chapter in treatment came with the plant next to Morton Dam at Wainuiomata, with a rated capacity of 60 million litres, which was completed in 1993.

Wellington City Council Laboratory staff take water from Karori's lower dam for testing, December 1952. Water from all sources was tested once a week. (New Zealand Free Lance Collection, Alexander Turnbull Library, Wellington, NZ. Reference F-92870-1/2)

The Boxing Day flood in 1962 resulted in muddy water being supplied to Wellington before the pipe could be shut off.

This treats water from both the Wainuiomata and Orongorongo catchments using the dissolved air flotation process, in which the 'colour', sediment and microorganisms in the water are coagulated with chemicals, lifted by millions of tiny air bubbles to the top of the filters and floated off. With the supply pressure from the Orongorongo intakes now reduced by treating the water at Wainui, the pipeline over the Waiwhetu hill was abandoned, with water from both catchments coming through the Wainui tunnel.

Automation has allowed manually-operated mechanical systems to be retired. At first a telephone system let the Karori custodian dial up automatic level indicators for each reservoir. Now, computer control systems are integral to the management of water treatment and supply, and laptops and wireless technology can be used to remotely monitor and control key points in the system.

The water custodian at Karori checks water levels at his other reservoirs, circa 1952. Computer technology has since revolutionised management and control of water supply. (New Zealand Free Lance Collection, Alexander Turnbull Library, Wellington, NZ. Reference PAColl-8983-26)

Standards expected of water quality have also risen. New Zealand adopted World Health Organisation standards for drinking water in 1960, but formal Drinking Water Standards for New Zealand were introduced only in 1984. These have been revised every five years since 1995, providing increasingly demanding standards for managing the health risks associated with water supplies.[241]

Microscope slide of a creature taken from tap water in Karori in 1951, prior to water treatment.

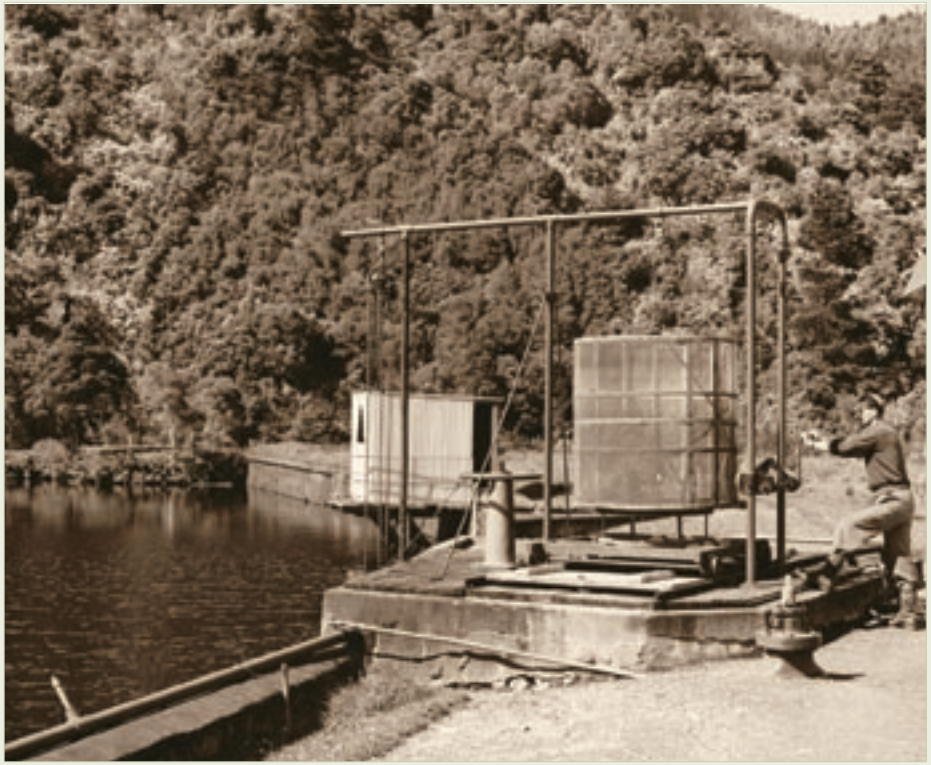
Wellington's water rates very highly. Its surface water collection areas have long been set aside exclusively for that purpose, to lower the risk of contamination. More recently, improved water treatment and catchment management processes have allowed some controlled public access into these areas without jeopardising water quality.

The Waiwhetu aquifer beneath Lower Hutt is also of high value to the region. The aquifer is sealed from surface contamination in the lower Hutt Valley by an impermeable layer of clay and the water takes over 12 months to 'flow' underground to the wells at Waterloo, making it secure from microbiological contamination. Occasional scares have served to confirm how fortunate the region is and how well its water is managed. A pollution alert in January 1991, when high coliforms were detected from the Waterloo treatment plant, had residents boiling their water for three weeks. The source (a seagull had died in a tank at the plant) illustrated the vulnerability of water supplies if they were not chlorinated. A Giardia alert in August 1998 closed the Wainuiomata treatment plant for several weeks, but only a single cyst was found and no cases of illness were reported.[242]

Mitigating the effects of natural hazards has also received greater attention in recent times. The Te Marua lakes were built very close to the Wellington fault line so, at the time of construction, seismic monitoring devices were buried deep to measure movement. Ongoing seismic mitigation includes moving services near fault lines to more solid ground and strengthening or duplicating critical assets. Even so, Greater Wellington has joined with the region's city councils to encourage preparedness in every home, because a big shake could cut all water supplies for several days.[243]

Morton Dam had been assessed as being at risk of failing in an earthquake and silt build-up had substantially reduced its value as a storage reservoir. It was decommissioned on 29 October 1988. Two new intake weirs were built, on the Wainuiomata River and lower George Creek, to retain supplies from the Wainuiomata catchment.[244]

In 1979 consultants suggested the upper Karori dam could also fail in an earthquake, taking out the lower dam by domino effect. With resulting headlines like 'Karori Dam Ready to Spew Disaster – Little Can Be Done', mitigation work followed in the streets below, including the purchase of four houses on Curtis Street to remove them.[245] Fear of the Karori dams bursting had earlier led the national emergency management headquarters in the Beehive basement to be bunded against floodwaters. With the Ngauranga scheme in operation, the chief engineer recommended both Karori dams be decommissioned, which they were in 1997. After 124 years of doing so, 'the Kaiwarra' ceased to supply water to Wellington. Now no longer the heart of Wellington's water system, the Karori waterworks reserve was gifted back to WCC for the wildlife sanctuary in July 2004.[246]



Cleaning the mesh filter at Wainuiomata lower dam, circa 1952. (New Zealand Free Lance Collection, Alexander Turnbull Library, Wellington, NZ. Reference PAColl-8983-27)

Future water

On the future organisation of water, the WRC in the late 1990s suggested full integration of bulk supply and reticulation for Hutt City, Porirua, Upper Hutt and Wellington on a trust model, but the time was not right for pooled ownership of municipal assets. WCC and HCC advanced this model for integration by forming a non-profit management company, Capacity, to retail water and manage their two water and drainage infrastructures.[247] While tensions continue between local and regional government, there is a mood apparent for sustainable management of urban waters, with potable and waste being seen holistically as part of one cycle.[248]

With modelled growth in water use set to surpass the present system's sustainable yield within a few years, options for new sources are again being considered, including storage dams that could supply approximately 60,000 additional residents (at present levels of use). A new dam is not a certainty: smaller-scale source options and demand management may defer new storage for years, by which time some other solution, such as desalination, may be affordable and acceptable.[249]

The amount of water on our planet is finite. Water has become a commodity and wars have been fought over it. In the Chinese city of Harbin, three million people had their water shut off for five days in November 2005 after a chemical plant exploded upstream. New Zealand has considered exporting water from Deep Cove and, when this was looked at in 1985, the Government identified the Hutt aquifer as a potential export source, if piped to tankers from Point Howard. While it did "not have the market image of 'pure Fiordland mountain water' its quality was certainly acceptable."[250]

To bring Wellington's urban population its water, engineers have tapped into sources progressively further afield and harnessed increasingly sophisticated technology, until today, on average, around 150 million litres of water a day are supplied to 370,000 people from up to 55 kilometres away through some very difficult country and several thousand kilometres of service pipes. We can take for granted neither this engineering feat nor the product delivered.

The Wainuiomata water treatment plant, with its state-of-the-art treatment process, was opened in 1993. The decommissioned Morton Dam can be seen in the foreground.








Footnotes

A Although the transliteration of Port Nicholson became 'Poneke', there is general recognition that Wellington harbour was known as 'Te Whanganui a Tara' prior to European settlement and this name is still widely recognised

1 Based on *Evening Post*, 22, 23 and 25 October 1883

2 Attributed to Sir John Luke (Mayor 1913-21) and William Morton (City Engineer from 1904-23), John Mulgan, *The City of the Strait*, 1940, p204

3 John M Thomson, *A Distant Music – The Life and Times of Alfred Hill 1870-1960*, Auckland, 1980, p12

4 The Wellington Town Board appointed a Board of Works on 14 June 1864 to oversee these municipal works. Wellington Town Board Minute Book 1, 14 June 1864, 00165:0:1, p58, Wellington City Archives

5 John E Martin, *The House*, Wellington, 2005, p41

6 Ebenezer Maxwell, 'Wade's Town in the 1860s', in *Recollections and Reflections of an Old New Zealander*, Reed, 1935, in *The Onslow Historian*, 11/1, 1981, p22

7 Both quotes Nicholas Marchant, H-3, 1871, *Appendices to the Journal of the House of Representatives*

8 'Reports and Proceedings of the City Corporation on a Water Supply to the City', 1871. Dr Hector's Report to WCC Committee, 0030:1:1, Wellington City Archives

9 Wellington Waterworks Engineer JS Carmichael, 29 July 1958, identified Dr John Snow and Louis Pasteur. 'Historical material – Water Supply', file 6/10/1, vol 1, WRC

10 *Wellington Independent*, editorial, 19 February 1867

11 *Wellington Independent*, editorial, 19 February 1867. This ridge, over which Hill and Parliament streets travel, was largely removed for the Wellington Motorway in the 1970s; Plan 'Tinakori Water Supply', W.1159/7, Longitudinal Section, 1887. Beck supplied water to the wharf for seven years, in agreement with the Provincial Government. See also *Cyclopedia of NZ*, Wellington, 1897, p763; WCC Board of Works meeting, 15 March 1867, 00165:0:2, p154, Wellington City Archives; WCC Minute Book 3, 22 December 1871, p156

12 Plan 'Tinakori Water Supply', W.1159/7-8, 1887, at 122 (now 260) Tinakori Road. A reservoir was built on Hill Street, just above the Parliament, in 1867-68; *Wellington Independent*, editorial, 19 February 1867

13 Wellington Town Board, Board of Works meeting, 17 April 1868, reported in *Wellington Independent*, 18 April 1868, p5; Rod Cook, *Parliament, The Land and Buildings from 1840*, Parliamentary Services, 1988, p42

14 *Wellington Independent*, 17 October 1868, p5. The Government asked £60 pa, and 49 householders and nine publicans agreed to pay £123 pa (£2 and £3 respectively) for the water; *Wellington Independent*, 5 December 1868, p4

15 Within six years the Hill Street reservoir was being filled by WCC instead of drawing from the Tinakori Road spring [WCC 30 April 1874, 00166:0:1, pp365, 370; Nicholas Marchant to Question 16, Minutes of Evidence, 29 October 1877, 'Government Buildings Water Supply Committee (Report of)' Legislative Council, 1877, no 15; WCC Committee Book 6, 3 April 1883, p69]. This reticulation still in use in 1961 [Annotation to Plan WDO 3906, 13 July 1956]

16 City Surveyor's Annual Report to 30 June 1869, Board of Works Minutes, 00165:0:2, pp424, 514, Wellington City Archives; *Wellington Independent*, 17 July 1869, p5; Warship visits were increasing – with the Duke of Edinburgh arriving on HMS *Galatea* in April 1869, USS *Kearsage* visiting in September 1869 and a RN squadron visit announced in November. These were in addition to regular warship visits from Sydney. TD Taylor, *NZ's Naval Story*, Reed, 1948, pp118, 243

17 Wellington Town Board meeting, 3 May 1867; *Wellington Independent*, 4 May 1867, p4; Richard Mixer Skeet (1832-94) was Wellington's first Surveyor/Engineer, 12 September 1864 – 16 September 1867. See *Wellington Independent*, 1 October 1864, p2

18 N Marchant, Report to Subcommittee Meeting, 13 October 1870, WCC Minutes, 00164:0:1, p6, Wellington City Archives. Baker's cutting is where Raroa Crescent goes over the hill above the current Karori Tunnel. 'Kaiwharawhara' was rendered as 'Kaiwarra' by early settlers

19 Board of Works meeting, 14 April 1867; *Wellington Independent*, 16 May 1967, p5c

20 *Wellington Independent*, 16 May 1867, p5b; Aicken costed it at £26,000, excluding £3-£4 to hook up each house. George Aicken, City Engineer, 1822?-82, a public works engineer and former Canterbury Provincial Engineer, served a year as Wellington Town Commissioner in the Thorndon Ward, October 1867 – May 1868

21 Pseudonym 'Water Supply', *Wellington Independent*, 16 May 1867, p5

22 Robert M Marchant (1820-1902), was 'irascible and eccentric'. He had led a mob of labourers in the 1851 Battle of Mickleton Tunnel in Gloucestershire against the railways company (for which his second cousin the railways engineer IK Brunel worked), over a pay dispute. After coming to NZ around 1863, Robert Marchant left an indifferent reputation from his railway projects in Southland, before failing in a similar proposal in Wellington (the railway from Wellington to Upper Hutt). Andrew and Melanie Kelly, *Brunel 200 South West*, on www.swmlac.org.uk/docs; Furkert, 1953, p219. Nicholas Marchant's Report to Subcommittee Meeting, 13 October 1870, WCC Minutes, 00164:0:1, p8

23 Wellington Town Board, 20 December 1867; Wellington Town Board, Board of Works, 17 April 1868; *Wellington Independent*, 18 April 1968, p5; 28 April 1868, p4

24 Nicholas Marchant, City Engineer (1836-1907), served as Wellington City Surveyor/Engineer from October 1867 – March 1878, and as well as forming roads, culverting streams and digging drains is principally associated with the Karori water supply. He went into private practice (as an architect and engineer), clients including the Borough of Marton. *NZ Mail*, 31 January 1880, p19c; *Evening Post* advertisement, 4 December 1883, p2. The Marchants appear not to have been related

25 RE Offer, *Walls for Water. Pioneer Dam Building in NZ*, Dunmore, 1997, p27

26 *Wellington Independent*, 15 and 20 August 1868

27 *Wellington Independent*, 19 September 1968, p7; 'The Wellington Water Works Company Limited' was registered on 1 May 1868 for the purpose of "procuring a sufficient supply of water for the City of Wellington", *NZ Gazette*, no 22, 7 May 1868, p200; see also *NZ Mail*, 9 February 1878

28 Wellington Town Board meetings, 10 July and 10 September 1869; Marchant's Report, WCC meeting, 13 October 1870, 00164:0:1, p15; Board of Works meeting, 11 February 1870, 00165:0:2, p473

29 *Wellington Independent*, 12 February 1870, p5; WCC Water Supply Subcommittee, 3 October 1870, 00164:0:1, p2 Wellington Gas Co was formed in 1870 and, after importing its equipment and pipes, built the city's first coal-converting gas works in Courtenay Place in 1871

30 Water Supply Subcommittee, WCC, 14 October 1870, 00164:0:1, p30; Quote from WCC meeting, 21 October 1870, 00164:0:1, p35. These included the brewer Bannatyne and a soda water manufacturer on Cuba Street

31 WCC meeting, 20 October 1870, p33; Marchant's Report, WCC meeting, 10 October 1870, 00164:0:1, p16; City Engineer GA Hart speculated that Beck may have begun the headworks, Speech to the Wellington Philosophical Society, 17 September 1930, file 6/10/1, vol 1, p16, WRC

32 WCC meeting, 8 November 1870, p38; WCC meeting 11 November 1870, p40; WCC meeting, 23 December 1872, 00164:0:1, p87, payment made 1 January 1873

33 Report of 10 October read to WCC Subcommittee meeting, 13 October 1870, 00164:0:1, p4, Wellington City Archives; WCC, 6 January 1871, p49

34 Marchant to WCC, 28 March 1871, H3 1871, *Appendices to the Journals of the House of Representatives*

35 City Surveyor's Report, 1871, 0030:1:1, Wellington City Archives

36 *NZ Gazette*, no 35, 24 June 1871, p313. This led to the Wellington Waterworks Act 1871 (with amendments in 1874 and 76), authorising the works and a £25,000 loan for them. It appears only 110 acres was taken at this time. 'Plan of Watershed of the Kaiwarawara [sic] Stream to be taken under the Public Works Act by the Wellington City Corporation'. [Plan No.] 15414 [originally 187/16], Thomas Ward Licensed Surveyor, 3 December 1901, WRC

37 WCC Waterworks Committee meetings, 2 February 1872, p50; 14 February 1872, 00164:0:1, p52, Wellington City Archives. Short quoted 35s-11-5/6d per 100yds; Judith Burch, *The Karori Reservoir Area, A History*, 1997, p33

38 WCC Waterworks Committee meetings, 6 May 1872, 00164:0:1, p62, Wellington City Archives

39 WCC Waterworks Committee meetings, 18 January 1873, p91; 24 April 1873, 00164:0:1, p103, Wellington City Archives

40 *NZ Mail*, 17 January 1874, 28 February 1874. These accounts of the Aro Valley basin have, in many secondary histories of the Karori waterworks (including the 1995 *Karori Reservoir Heritage Assessment*), been mistakenly thought to refer to the Karori dam. Virtually all correspondence about the Karori dam, and most plans, have not survived, and even details of the city's reticulation pre-1908 are lacking (AK Bristow note, 'Water Supply' volume of WCC notes).

41 *NZ Mail*, 28 February 1874

42 Nicholas Marchant to Question 36, Legislative Council, 1877, No 15

43 *NZ Mail*, 17 January 1874. Tapped somewhere by Polhill Gully Reserve or Holloway Road?; *Wellington Independent*, 24 November 1873, p2e. This was used to water the dusty streets, for which seawater was otherwise used; Burch, 1997, p34

44 *NZ Mail*, 17 January 1874.

45 *Wellington Independent*, 4 May 1874, p2f

46 Marchant received £500, Blackett 100 Guineas, voted by the Water Works Committee on 21 May 1874, WCC Committee Minute Book 1, 00164:0:1, p129, Wellington City Archives

47 MP Edward Pearce, second reading Wellington Waterworks Loan Bill 1874, which authorised another £25,000, 29 July 1874, *NZ Parliamentary Debates* Vol XVI, p305. In the Legislative Council, Member George Waterhouse said the first £25,000 had been used "economically to introduce water into the city but… had not been enough to enable them to erect reservoirs of sufficient dimensions to ensure adequate supply of water at all seasons of the year." *NZ Parliamentary Debates*, Vol XVI, p546

48 WCC Waterworks Committee meetings, 9 September 1874, WCC Committee Minute Book 1, 00164:0:1, p138; WCC meeting, 13 May 1875, WCC Minute Book 3, 00166:0:1; WCC meeting, 26 October 1876, 00166:0:1, Wellington City Archives

49 Offer, 1997, p34

50 Blackett Report on the Wellington Waterworks Extension Contract, 30 January 1878, to the first Wellington Waterworks Investigation Committee, *NZ Mail*, 9 February 1878, p15

51 *NZ Times*, 25 January 1878, p3b; *Evening Post*, 25 January 1878, p2f

52 Blackett's in *NZ Mail*, 9 February 1878, p15

53 Census figures 1874 and 1878

54 *Cyclopedia of NZ*, Wellington, 1897, p274. The Reserve Bank CPI Calculator says this is $12m today

55 WCC Minute Book 4, p223, 15 February 1877; *NZ Times*, 5 April 1878

56 Margaret Alington, Wellington Regional Committee of NZ Historic Places Trust, *Newsletter*, vol 1 no 1, October 1975, p5

57 WCC Minute Book 4, 25 October 1877, p328; WCC Minute Book 4, 25 October 1877, p332; Legislative Council 1877, no 15

58 WRC, file 6/10/1, vol 1

59 Nicholas Marchant to Question 41, Legislative Council, 1877, no 15

60 WCC Meeting Minutes, 18 April 1878

61 *Floods in NZ 1920-53*, Soil Conservation & Rivers Control Council, 1957, p133

62 Hugh Sinclair had operated the loco since February 1880. 'Skunk or Wainuiomata?', *NZ Railway Observer*, Summer 1999-2000, p142

63 Sinclair's Reminiscences, *The Dominion*, 9 January 1914, p6b

64 WCC Minutes, 25 July 1878, and Book 5, 10 May 1881, p455; The poll returned 1,099 votes for the Wainuiomata development, and 398 against, *The Dominion*, 9 January 1914, p6b.

65 Messrs R Laidlaw & Son cast the pipes (in their Alliance Foundry, Milton Street) which bear the letters 'R L & S', WCC Minute Book 5, 29 January 1880, p258; WCC Minute Book 5, 30 October 1879, p223; WCC Minute Book 5, June 1880, pp317, 310; 16 September 1880, p358

66 WCC Minute Book 6, p110 22 June 1882. J&D Sinclair received £8 per acre; WCC Committee Minutes, 28 June 1880, p67; WCC Minute Book 5, 30 Sept 1880, p363

67 WCC Minute Book 6, 15 March 1883, p190; WCC Minute Book 6, 11 October 1883, p259
68 'Notes on the History of the City of Wellington' uncredited, ca1955, file 6/10/1, vol 1, WRC; The short tunnel was called Coleman's Tunnel, Loughrey to Committee, 19 April 1887, file 6/10/1, vol 1, WRC. The route of the water-race is above the present Reservoir Road. The well is high above where Whitcher Road becomes Reservoir Road, overlooking Richard Prouse Park
69 *Evening Post,* 22 October 1883, p2, 23 October 1883, 25 October 1883, 6 November 1883, 4 December 1883
70 Loughrey to Waterworks Investigation Committee, 19 April 1887, p6, 7, file 6/10/1, vol 1, WRC
71 James D Baird CE (1840-1908) was due to finish his term as City Engineer at the end of 1883, being toasted at a public dinner on 22 December, but remained as Acting City Engineer throughout January 1884. In private practice with Thomas Ward until 1892, but was declared bankrupt in 1889. He died as Menzies Board Engineer, Western Australia. *NZ Mail,* 28 December 1883, p8c; 31 May 1889, p29c; WCC Minute Book 6, 13 March 1884, p320; Furkert, 1953, p102
72 *The Dominion*, 9 Jan 1914, p6b
73 WCC Minute Book 6, 6 November 1884, p456; ATL Photo G4089 1/2, Halse Coll, shows trees planted by March 1888
74 CW Richmond's satirical 'The Wainui Waterworks, by our artist who has NOT visited them'. The *Evening Press,* 1887, ATL B-034-021; In four visits in 1883 councillors drank £9-12-0 of alcohol, *Evening Post*, 4 December 1883
75 'Report of the Committee Upon the Water Supply', n.d [ca May 1887], file 6/10/1, vol 1, WRC. The committee commissioned HP Higginson to consult; the newspapers commissioned Nicholas Marchant (see *NZ Mail,* 4 March 1887, Supplement p2c)
76 This difference in perception had been established by 1887, see Baird & Ward reply to Higginson, 4 April 1887, in 'Report of the Committee Upon the Water Supply', n.d [1887], file 6/10/1, vol 1, WRC
77 Petone Town Board had been formed in 1882 and James Baird advised it on water supply on 12 May 1885 [Furkert, 1953, p102]; the Hutt Town Board formed in 1881 and Nicholas Marchant assessed Lower Hutt's options in 1887 [*NZ Mail*, 8 April 1887, p21e; 10 June 1887 p24d]. In reporting on Marchant's commission, the newspaper called him "one of the ablest hydraulic engineers in NZ."
78 WCC meeting, 4 December 1884, WCC Minute Book 6, p465
79 *NZ Mail*, 10 June 1887, p23d. Petone's first plan was probably conceived by William Fitzherbert, Hutt County Council's first engineer, 1877-85, who acted for Petone Town Board. Could he have been recommending his own property (if that on Western Hutt Road) as the source of Petone's water? See Daley, 1977, p214, *Cyclopedia of NZ*, Wellington 1897, p834
80 Susan Butterworth, *Petone, A History,* 1988, p132
81 RS Rounthwaite, 'City Engineers Report For Three Years Ending 31 March 1902', file 6/10/1, vol 1, p66, WRC
82 Offer, pp44, 47
83 *First 100 Years – Petone (Pito One) Progress & Prosperity,* Petone Borough Council, 1940, p261; *The Dominion*, 28 July 1930, p6a; The whole matter had to be settled with the Petone Corporation Waterworks Act 1905
84 Miller, David P, *Once Upon a Village, a History of Lower Hutt 1819-1965.* NZ University Press/Lower Hutt City Council, 1972, pp109-10, 121-23. Son of JWA Marchant, Fred Marchant was also no relation to Nicholas Marchant [Charles Lawn, *Pioneer Land Surveyors of NZ*, 1977, p182]
85 [Lance Hall?] *Lower Hutt Past & Present*, Lower Hutt Borough Council, 1941, p86
86 AN Grigg, Engineer to Hutt Valley Underground Water Authority, 'Technical Sub-Committee Report on the Administration of Water Supply & Distribution in the Wellington Region'. Hutt Valley Underground Water Authority, 1967, file 6/10/1, vol 4, WRC
87 Bob Meyer, 'Johnsonville's Water Works', pp5-7. Unsourced article, n.d, Scott Farrell Collection
88 Ann Beaglehole with Alison Carew, *Eastbourne - A History of the Eastern Bays of Wellington Harbour*, Eastbourne Historical Society, 2001, pp87, 123; *The Dominion*, 31 July 1930, 14c.
89 Offer, 1997, p38
90 Institution of Professional Engineers NZ, Heritage Database website www. ipenz.org.nz/heritage; 'Trentham Military Camp, Water Supply', Public Works Series 1, file 23/103/4, Archives NZ
91 'Paekakariki Military Camp, Water Supply. Compensation Claim, LS Smith', Public Works Series 1, file 23/698/1/14, Archives NZ; Daley, 1977, p105
92 GM Betts, *Betts on Wellington*, 1970, p37, population as at 1894
93 Daley, 1977, App III, p216
94 GM Betts, 'A study of Wellington City Council and the part its elected representatives and staff, together with the citizens of Wellington, play in the decision making process'. VUW thesis, Wellington, 1969, 3-vols
95 DA Roberts, 'The Water Supply of Wellington', ca1942/43, file 6/10/1, vol 1, WRC
96 *Cyclopedia of NZ*, Wellington, 1897, p749
97 Richard Rounthwaite, City Engineer to Mayor, 14 May 1900, file 6/10/1, vol 1, WRC
98 Special Waterworks Committee 'Re Water Supply Based on City Engineer's Report, 10 July 1901', file 6/10/1, vol 1, p10, WRC
99 Rounthwaite, file 6/10/1, vol 1, p10, WRC
100 *NZ Mail*, 31 January 1880, p19c
101 Rounthwaite. City Engineer to WCC, 10 November 1900, file 6/10/1, vol 1, WRC
102 Rounthwaite, City Engineers Report For Three Years Ending 31 March 1902, file 6/10/1, vol 1, WRC
103 Rounthwaite, 31 March 1902, file 6/10/1, vol 1, WRC
104 Special Waterworks Committee, '10 July 1901', file 6/10/1, vol 1, p6, WRC
105 Rounthwaite to Mayor, 14 May 1900, file 6/10/1, vol 1, WRC
106 William H Morton (1866?-1923). He headed off 66 other applicants for the £700 p.a job. He was also instrumental in the development of Wellington tramways. *NZ Mail,* 17 February 1904, p76b
107 *The Dominion*, editorial, 18 August 1926, p8b. In 1926 the Town Clerk became CEO
108 Roberts, ca1942/43, file 6/10/1, vol 1, WRC
109 Poll of Ratepayers was on 12 April 1905. While the poll approved a loan of £190,000, in fact £235,000 was borrowed in 1905 for waterworks, of which £17,000 was 'surplused' and allowed in 1909 to be spent on other urgent water works (reticulation and pipe-bridging). Wellington City Water Supply Loan Diversion Act 1909, NZ Statures 1909, No 3, 3 December 1909. *Evening Post,* 11 April, p4; 13 April 1905, p5
110 *NZ Mail*, 4 July 1906, p62c; *NZ Gazette*, No 32, 7 June 1906, p1425; Plan No 15414, 3 December 1901. In total over 516 acres was taken at this time
111 An earlier tenderer, MH Bennett (£23,594-1-10) appears not to have proceeded after being initially accepted. WCC Minute Book 18, 6 September 1906, p482; Mitchell & King's price was £23,990, *WCC Annual Report* 1906/07, p21; 1907/08, p26
112 GA Hart, 'The Water Supply of Wellington, Past, Present and Future with Notes Upon the Law of Water.' Paper to Wellington Philosophical Society, Technological Section, n.d [17 Sept 1930], file 6/10/1, vol 2, p12, WRC
113 GA Hart [17 Sept 1930], file 6/10/1, vol 2, WRC
114 WCC accepted a tender for a steam-engined pumping station on 14 March 1901. WCC Minute Book 14, pp433-434.
115 *WCC Year Book* 1926-27, p135.
116 WCC Minute Book 20, 13 October 1908, p255; 5 November 1908, p276; WCC Minute Book 23, 2 November 1911, p60; Contract 538, 'Wainuiomata Reservoir', n.d. List of Contracts, file 6/10/1, vol 1, WRC
117 WCC Minute Book 23, 16 November 1911, p74; Offer, 1997, p68
118 WCC Minute Book 23, 19 December 1911, p110, Melrose's water will be "turned on in a few days"
119 Roberts, 1942/43, file 6/10/1, vol 1, WRC
120 WCC *Annual Report*, 1906/07
121 Pipes and a river crossing cost £49,016-17-6. List of Contracts, file 6/10/1, vol 1, WRC
122 DA Roberts, 'The Water Supply of Wellington', Typescript, *Journal of Royal Sanitation Institute*, n.d. [ca 1942/43], p4; WCC *Year Book*, 1927-28; WCC: Extracts on Water Supply from Annual Reports 1947-1956 (Works Dept File No 50/504/5); Morton 1919 Report, p5; Waterworks engineers measure water levels by hydraulic gradient – the height or 'Head' of the Top Water Level above a certain point, such as Mean Sea Level (9.71m of Head represents 1 Bar of pressure - one 'atmosphere'). Headloss is the reduction in that pressure caused by friction inside the pipe (made worse by encrustation). Old City Datum, used until 1953, set a position 37.96ft *below* MSL to ensure that all pipes, be they water or drainage, didn't have 'negative head' (flowing uphill)
123 Special Waterworks Committee Report, May 1887, p6
124 *The Dominion*, 6 February 1915, p8c. The Mayor visited Orongorongo in March, *The Dominion,* 22 March 1915, p7
125 *The Dominion,* 17 March 1917, p4; Notes for rainfall and storage levels in 'Brief of Large New Storage Reservoir Wainuiomata…', file 6/10/1, vol 2, WRC
126 Morton to Mayor, 17 March 1919, file 6/10/1, vol 2, WRC; Memo to Town Clerk re Orongorongo and Karori Supplies, 8 March 1920, file 6/10/1, vol 3, WRC
127 WCC Minute Book 29, 16 September 1920; Notes by AK Bristow, file 6/10/1, vol 2, WRC. The voting paper for this poll was a yard long
128 GA Hart, [17 Sept 1930], file 6/10/1, vol 2, WRC
129 WCC Minute Book 33, 28 February 1924, p245; WCC *Year Book* 1926-27
130 Quote in WCC *Year Book* 1926-27; Semple had the contract to dig both tunnels, for £72,663-6-3, List of WCC Contracts, file 6/10/1, vol 1, WRC
131 Dyer and Meyer, 1987, p64
132 WCC *Year Book* 1927-28
133 Tender of Spiral & Lockbar Steel Pipe Co, Wanganui, of £134,310 accepted. WCC Minute Book 33, 29 January 1924, p200. The lockbar pipes were laid only from the western portal to Wellington
134 Ron Bishop, 'Bulk Supply Report', 8 September 1969, file 6/10/1, vol 1, WRC; Morton Memo to Town Clerk, 8 March 1920, file 6/10/1, vol 3, WRC
135 Mrs Ryan to McKillop, Waterworks Engineer, 3 August 1930, 'City Water Supply – Wainui-Orongorongo', 00009:795:40/1, pt 1, Wellington City Archives; Mrs Ryan is reputed in local lore to have succumbed to the isolation
136 Patrick H Woodgate-Jackson, died 11 Aug 1967. *Evening Post*, 14 August 1967, p1. There was also an accidental shooting of a hunter Doug Muir in the catchment, in the early 1970s, and a subcontractor's death at Te Marua. Barry Castle personal communication, 30 November 2005
137 Semple's Track referred to in a 1931 letter by (illegal) trampers in the area, in *Orongorongo Valley History*, Orongorongo Club (Inc) Newsletter, n.d. Semple Tunnel referred to by the Honourable Secretary, Hutt Valley Trampers Club in a letter to the Town Clerk, WCC, 14 March 1933, both Scott Farrell Collection; *NZ Freelance*, 3 December 1952
138 *Evening Post,* 16 April 1925
139 WCC Minute Book 29, p183, 2 April 1919. Probably stated at Onslow's merger with WCC on 1 April 1919
140 Daley, 1977, p43
141 *The Dominion,* 20 April 1918, p12; 15 August 1919, p8; Auckland City initiated the information sharing, in 1931. WCC also shared its waterworks knowledge with Christchurch, Palmerston North, Rotorua, Taumarunui, Te Aroha and Whakatane councils. 'City Water Supply – Wainui-Orongorongo', 00009:795:40/1, pt 1, Wellington City Archives
142 Report to City Engineer, 29 June 1927 on 'Water Supply to Eastern Harbour Districts', file 6/10/1, vol 2, WRC
143 Carmichael, 29 July 1958, file 6/10/1, vol 3, WRC
144 WCC *Year Book* 1928-29. Neither Makara County nor Johnsonville Town Board was included
145 WCC *Year Book* 1929-30, p121
146 WCC Minute Book 37, 9 February 1928, p315
147 GA Hart, 'Report of the City Engineer to the Wellington City & Suburban Water Supply Board', 24 July 1929, file 6/10/1, vol 2, p15, WRC. The Whakatikei part was only for low-lying areas in the Hutt Valley
148 DSIR *Annual Report*, 1929, pp11-12
149 Hart, 24 July 1929, file 6/10/1, vol 2, WRC
150 *Evening Post*, 18 March 1930, p11a
151 Carmichael, 29 July 1958, file 6/10/1, vol 3, WRC

152 *The Dominion*, 19 August 1930, p13d. This Lower Hutt representative was Sir Alexander Roberts. The Chair, Wellington Councillor Morpeth said "You will come back some day." A Wellington City and Suburban Water Supply Board Amendment Act changed the board's representation
153 *The Dominion*, 31 July 1930, p14b
154 Petone Borough Council, 'Report on Korokoro Sewerage and on Water Supply in the Whole Borough', October 1976, p24
155 Beaglehole/Carew, 2001, pp140-43
156 'Lower Hutt City Water-Supply Improvement. Loan £160,530'. [1941] extract from report by Dr McLean, Ministry of Health, submitted as evidence into Inquiry into Underground Water, 1957, file 6/10/1, vol 3, WRC
157 Dr FM McLean, 'Lower Hutt City Water Supply Improvement' Extract, 1941, file 6/10/1, vol 3, WRC; *Lower Hutt Past & Present*, 1941, pp86-87. The Naenae tank job had been interrupted by the war; Miller, 1972, p160
158 'Report on the Water Supply in the Upper Hutt Valley', Hutt County Council and Upper Hutt City Council, March 1972. The contractor was MG Templeton, the consulting engineer HF Toogood
159 Daley, 1977, pp120, 123, 215
160 Grigg, 1967
161 Daley, 1977, p185; LS Donnelly Hutt County Engineer to Wainuiomata County Town Committee, with Consulting Engineer KS Odlin's Report, 30 August 1965, file 6/10/1, vol 5, WRC. The Skerrits Creek supply was shut off in 1965, after considering its treatment
162 City Engineer to Town Clerk [but dictated by ER McKillop], 20 September 1938, file 6/10/1, vol 3, WRC
163 By Asst Director ER McKillop, 'Underground Flow of the Hutt River as a Source of Water Supply', Paper to Wellington Philosophical Society, part 1
164 Town Clerk to Mayor, 12 November 1929, 'Re Recommendations of Special Committee of Water Boards Re Finance', file 6/10/1, vol 2, WRC; WCC *Year Book* 1930/31, p101
165 *Evening Post*, 18 March 1930, p11a; *The Dominion*, 19 August 1930, p13d
166 City Engineer's Report, 19 July 1930, file 6/10/1, vol 2, WRC; The Assistant City Engineer ER McKillop and the Government Geologist sank three test bores at a dam site 1 mile above the Morton Dam. McKillop to City Engineer, 5 July 1930, file 6/10/1, vol 2, WRC. Though this report predates Petone and Lower Hutt's departure from the Board, their intentions had long been known
167 Hart G.A, City Engineers Report, 14 July 1930, file 6/10/1, vol 2, pp15, 17, WRC
168 McKillop, 'Underground Flow…' paper
169 WCC Minute Book 42, 5 October 1931, p213; WCC Minute Book 44, 3 July 1933, p244
170 City Engineer to Town Clerk, 9 March 1939, 'City Water Supply – Wainui-Orongorongo', 00009:795:40/1, pt 2, Wellington City Archives; *The Dominion*, 16 March 1939
171 WCC *Year Book* 1941-46
172 Carmichael, 29 July 1958, file 6/10/1, vol 3, WRC
173 WCC *Year Book* 1934-36, p96; Plan of Break Pressure Tank, Raroa Road, SM1943, dated November 1934; DA Roberts, *Journal of the Royal Sanitation Institute*, vol 4 no 1, December 1939; It was emptied (by 1940) after a suicide in it. Bob Offer personal communication, 20 October 2005
174 WCC Minute Book 47, p37, 14 November 1935
175 WCC *Year Book* 1936-38, p77
176 WCC Minute Book 56, 24 April 1947, p4; WCC *Year Book*, 1947-50, p54
177 Mulgan, 1940, p212
178 Hendriksen EE, 'Wellington Metropolitan Water Supply: Hutt River Scheme', *NZ Engineering*, 15 January 1956, pp 2-15
179 WCC *Year Book* 1947-50, p57
180 WCC *Year Book* 1936-38
181 J Henderson, Director, DSIR Geological Survey Office to City Engineer, 19 July 1943, file 6/10/1, vol 3, WRC
182 Margin note written on McKillop's draft for City Engineer to Mayor, 22 February 1943, file 6/10/1, vol 3, WRC
183 KE Luke City Engineer, 'Report on Water Supply City of Wellington & Suburban Areas, NZ', 1 July 1943, file 6/10/1, vol 2, WRC
184 KE Luke, 1 July 1943, file 6/10/1, vol 3, WRC
185 Carmichael to City Engineer, 7 November 1940; 10 July 1945, 'Water Supply to City', file 6/10/1, vol 3, WRC
186 McLean, 1957, p2. The Lower Hutt incident, at the Marsden Street pumping station, was in April 1939.
187 GIB Thomas, City Engineer to Town Clerk, 2 September 1963, 'In connection with Commission of Enquiry into Reorganisation of Local Government in the Hutt Valley', file 61/10/1, vol 4, WRC; Assistant Secretary to the Treasury to Wellington City and Suburban Water Supply Board, 7 April 1944, WCC Minute Book 54, 27 July 1944, p196
188 WCC Minute Book 54, p196, 27 July 1944
189 Hendriksen, *NZ Engineering*, pp 2-15
190 WCC Minute Book 56, 11 Aug 1948, p462
191 City Engineer to Town Clerk [dictated by ER McKillop], 20 September 1938, file 6/10/1, vol 3, WRC
192 Hart, 1943, p11
193 'Report by sub-committee No. 8 on Utilities and Services', Wellington Regional Planning Authority, 1964
194 Hendriksen, *NZ Engineering*, pp 2-15
195 Unlabelled album, WRC photographic collection
196 WCC *Year Book* 1936-38
197 WCC *Year Book* 1950-52, p65
198 Hendriksen, *NZ Engineering*, pp2-15
199 ibid, pp2-15
200 *The Te Marua Water Storage and Treatment Project*, WRC brochure, February 1987, file 6/10/1, vol 4
201 Hendriksen, *NZ Engineering*, pp 2-15
202 WCC *Year Book* 1947-50
203 WCC: Annual Reports extracts, 1947-1956
204 Daley, 1977, p135, Paremata was connected in December 1957
205 Hendriksen, *NZ Engineering*, pp2-15
206 'Mayor Boiled Over Capital Water', *Auckland Star* headline, 9 October 1956
207 Petone Borough Council, 'Report on Korokoro Sewerage and on Water Supply in the Whole Borough', October 1976, p24
208 Bishop, RG, *Future Bulk Water Supply Development in the Wellington Region*, September 1980, Wellington Regional Waterworks Board
209 David Smith, 'Outline History of Water Supply Development,' unpublished thesis, n.d [ca 1998], p13
210 WCC: Annual Reports extracts, 1947-1956; Photo of Retirement Function, 22 October 1959, 00340:0:892, Wellington City Archives
211 *Haywards Pumping Station*, Wellington City and Suburban Waterworks Board brochure, n.d [1971]
212 Hart, [17 Sept 1930], file 6/10/1, vol 1, p16, WRC
213 JS Carmichael, 'Report to the City Engineer on Wellington Water Supply', 6 October 1959, p3
214 AN Grigg. 'Technical Subcommittee Report on Administration of Water Supply & Distribution in the Wellington Region', Hutt Valley Underground Water Authority, 1967, p8
215 Hutt Valley Underground Water Authority Technical Subcommittee draft report on 'Future Demand and Supply', dated 21 January 1967, file 6/10/1, volume 4, p9, WRC
216 Three quotes, City Engineer Thomas to Town Clerk, 2 September 1963, 58/45 'In connection with Commission of Enquiry into Reorganisation of Local Government in the Hutt Valley', file 6/10/1, vol 4, p5, WRC; UK figures from Hutt Valley Underground Water Authority Technical Subcommittee draft report on 'Future Demand and Supply', dated 21 January 1967, file 6/10/1, vol 4, p5, WRC
217 Young, David, *Our Islands, Our Selves*, Department of Conservation/Ministry for Culture and Heritage, 2004, p197. The Authority was administered by Ministry of Works and Development's Water & Soil Division and created a 'fiasco' by issuing water rights to the Ministry of Works and Development for the Clyde Dam. The situation of one division of the Greater Wellington prosecuting another for breaches of resource consents may be seen in similar light
218 *Annual Report of Chief Engineer*, Wellington Regional Waterworks Board, 1974, p2; *Waikanae-Paraparaumu Water Supply 20 March 1977*, Wellington Regional Waterworks brochure, David Smith MS, 1977, p32
219 The Water Group, *Report of Business Activity*, 2001, p12
220 John Morrison interview, 27 October 2005, John started with Wellington Regional Waterworks Board in June 1975, after 10 years' experience with WCC
221 The Wainui 24-inch burst eight times in 1978. *Annual Report of Chief Engineer*, 1978, p8; *Evening Post*, 1 September 1933
222 When the 1050mm pipe had been completed to Ngauranga it was "a day of some moment". *Annual Report of Chief Engineer*, WRC, 1979, p8; John Morrison interview. Cr S Duff turned the cock in 1979
223 Vicky Alexander, *Tales from the Swamp*, Ch 15, 35, Wainuiomata Historical Society, 2000; W1 23/659, Archives NZ; *Evening Post*, 29 November 1975; 6 March 1980; *Hutt News*, 9 September 1980; *Valley News*, October 1980
224 John Morrison interview, 16 November 2005
225 City Engineer [JSC] to Town Clerk, 8 August 1945, file 6/10/1, vol 3, WRC
226 Greater Wellington Water, *Report of Business Activity*, 2005, Draft
227 *Te Marua Project* brochure, WRC, February 1987; *Annual Report of Chief Engineer*, WRC, 1979, p7
228 RS Stevens to Administration, Finance & Water Supply Committee, 19 September 1983, Report 83.471, file 1/4/8, vol 10, WRC. Te Marua Ltd's compensation was settled in the High Court in 1981-83; Report to Administration, Finance & Water Supply Committee, 27 November 1981, file 1/4/8, vol 2, WRC; Stuart Macaskill interview, 26 October 2005
229 As at December 1981. Appendix to Report 82.8, 13 January 1982, Bayly to Administration, Finance & Water Supply Committee, on 'Te Marua Project – Additional Loan Authority'. Water Supply & Forestry Committee, file 1/4/7, vol 1, WRC
230 *Annual Report of the Chief Engineer*, 1986, p5; 1988, p2; WRC Annual Report, 1989, p7; Macaskill interview
231 *Upper Hutt Leader*, 11 September 2002; see also 28 November 2001
232 *Waikanae-Paraparaumu Water Supply 20 March 1977*, Wellington Regional Waterworks Board brochure, 1977
233 Daley, 1977, p149
234 Hart, 24 July 1929, file 6/10/1, vol 2, WRC
235 *Evening Post*, 4 November 1983
236 Notes on water supply taken from WCC Minute Books, compiled by AK Bristow, 1881-1900
237 Roberts, 1971; David Smith, MS, p27. Fine-mesh strainer on the OK Main, microstrainer on the Wainuiomata pipe
238 Betts, 1970, p121-24; *Bulk Water Supply, Annual Statistics*, 1994, WRC; *The Water Group. Report of Business Activity*, 1999, WRC, p8; *The Water Group. Report of Business Activity*, WRC, 2000, p19; *Petone's Water Supply*, WRC Brochure [1999]
239 The Te Marua Water Storage and Treatment Project, WRC, February 1987
240 1989 WRC *Annual Report*; *Bulk Water Supply Annual Report*, WRC, 1990
241 Draft GW *Water supply annual report*, 2005, Greater Wellington Regional Council (GW); *Water supply annual report*, 2004, p8, GW
242 *The Water Group. Report of Business Activity*, WRC, 1999, p9; 2000, p19
243 *Water supply annual report*, 2004, p9, GW; John Morrison interview, 16 November 2005; *Storing Emergency Water*, GW Brochure, October 2004, says store 45-60 litres per person
244 *The Morton Dam Decommissioning Open Day, Saturday October 29, 1988*, WRC Booklet; *Morton Dam*, Souvenir Booklet, WRC, 1988
245 *Evening Post*, 31 March 1979; 11 June 1979
246 *The Water Group. Report of Business Activity*, 1998, pp16, 20, WRC; 1999, p12; The original 1872 tunnel is still in service, from a cross-roads of tunnels under the carpark.
247 *Annual Report of Chief Engineer*, Wellington Regional Waterworks Board, 1974, p3; H_2OME. *The Water Group. Report of Business Activity*, October 2001, p12, WRC; Capacity was formed in April 2004, following an earlier Facilities Maintenance Contract between the two councils.
248 *The Water Group. Report of Business Activity*, October 2001, p5; 2000, p2, WRC
249 Murray Kennedy and Alastair McCarthy, 'Water Source Development Strategy', Report 05.359 to Utility Services Committee, 13 September 2005, WRC
250 Bayly to Administration, Finance & Water Supply Committee, 14 May 1985. Commenting on a draft Ministry of Works & Development Report 'Sources of Water for Export', file 1/4/8, vol 10, WRC

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Images

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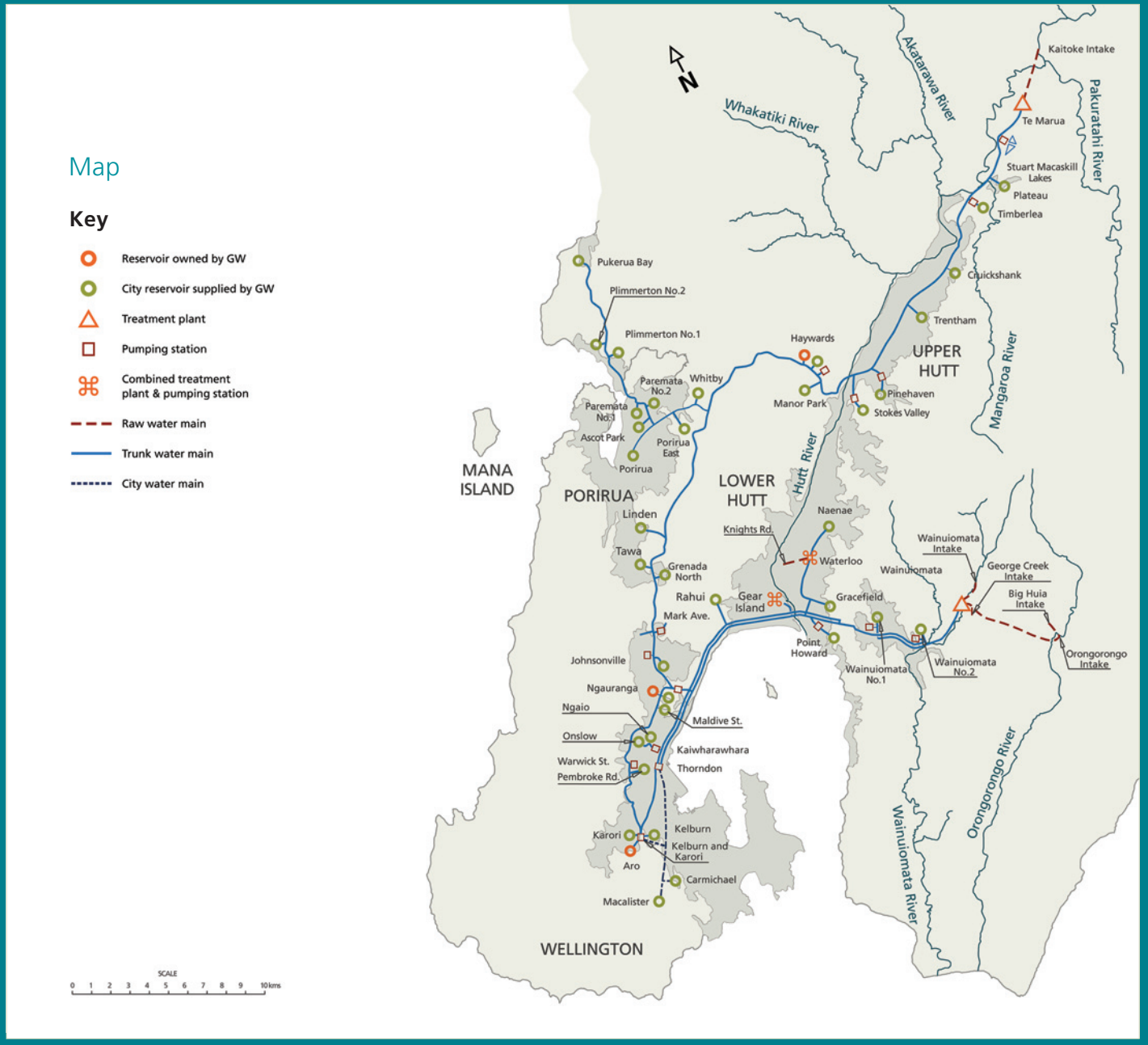
Units

All measurement units have been converted to metric, except where referred to in direct quotes. Metric conversions have been rounded. Imperial units were in use until metrication in 1974-1975.

Imperial to metric conversion rates (rounded)
One gallon (UK) equals 4.5 litres
One inch equals 25.4 millimetres
One foot equals 0.3 metres
One mile equals 1.6 kilometres
One acre equals 0.4 hectares
One ton equals 1.0 tonnes

Map



Greater Wellington Regional Council's wholesale water supply network, 2006.

Water, air, earth and energy – elements in Greater Wellington's logo combine to create and sustain life. Greater Wellington promotes Quality for Life by ensuring our environment is protected while meeting the economic, cultural and social needs of the community

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