TECHNICAL INFORMATION

Te Marua Water Treatment Plant

Key statistics

Plant flow: 20 ML/d to 140 ML/d, daily average flow 60 ML/d

Main treatment processes:

- Straining
- Coagulation and flocculation
- Sedimentation
- Filtration
- Chlorination
- pH adjustment
- Fluoridation

Treatment chemicals:

- Raw water dosing:
  - Carbon dioxide (CO_2)
  - Lime ($Ca(OH)_2$)
  - Aluminium sulphate ($Al_2(SO_4)_3 14H_2O$)
  - Polydadmac L3RC
  - Polyelectrolyte
- Filtered water dosing:
  - Sodium hydroxide (NaOH)
  - Chlorine gas (Cl_2)
  - Fluoride (Na_2SiF_6)

Typical operating costs:

River water:

- Power: 0.50 cents/cubic metre
- Chemical: 3.50 cents/cubic metre
- Sludge disposal: 0.30 cents/cubic metre

Lake water:

- Power: 3.11 cents/cubic metre
- Chemical: 3.50 cents/cubic metre
- Sludge disposal: 0.27 cents/cubic metre

40% of the Wellington urban region's water supply comes from Te Marua Water Treatment Plant

Raw water sources

Water for the treatment plant comes from the Hutt River at the Kaitoke Weir. The river is protected by the Hutt Water Collection Area, which consists of around 9000 ha of bush clad land at the southern end of the Tararua Ranges.

Greater Wellington may currently take up to 150 ML/d of water from the river. However the draw-off is often limited during summer to maintain a minimum flow downstream of the intake. Water flows by gravity through the strainer house and two tunnels to the treatment plant.

Water for the Te Marua Treatment Plant is also stored in the Stuart Macaskill Lakes. The lakes are used as a backup supply when the water from the river is too dirty and discoloured or the river flow is too low. Water from the lakes is pumped back up to the treatment plant from the pumping station below the plant. The lakes are filled when there is an excess of clean, clear water available from the river.

Kaitoke water intake weir

Typical raw water quality

Colour:	5-30 °Hazen, average 8°Hazen
DOC:	0.5-10.0 mg/L, average 2.0 mg/L
Turbidity:	0.1-2.0 NTU, average 0.5 NTU
pH:	7.0-8.0, average 7.4
E.coli:	0-80 cfu/100 mL, average 5 cfu/100 mL
Cryptosporidium:	0.1-14.0 oocysts/100 L, average 0.9 oocysts/100 L
Giardia:	0.1-9.0 cysts/100 L, average 1.1 cycst/100 L
Alkalinity:	10-25 mg/L as $CaCO_3$, average 20 mg/L as $CaCO_3$
Temperature:	8-19°C, average 13°C

Pre-treatment

The water is pre-treated at the strainer house through a sand trap followed by three mechanical strainers which remove leaves, twigs and silt. The mesh size is approximately 0.6 mm. The water then flows by gravity through a tunnel to the treatment plant.

Stream 1 and Stream 2

At the treatment plant the raw water can be split into two streams. Raw water in Stream 1 can be treated either by sedimentation/clarification and filtration (up to 80 ML/d) or by direct filtration only (up to 140 ML/d). Raw water in Stream 2 is treated by direct filtration only (up to 60 ML/d).

During normal operation only Stream 1 is used. The use of Stream 1 and 2 together enables the plant to run on both river and lake water at the same time. This is especially useful when low river flows limit the amount of water that can be taken from the river.

Rapid mix tanks

The addition of chemicals, coagulation and flocculation takes place in the rapid mix tanks. There are two sets of rapid mix tanks, one for each Stream.

Three flash mixers are provided on Stream 1 and two flash mixers and one static mixer on Stream 2. These are used to thoroughly mix the coagulant chemicals through the inlet water. The water also flows under and over a series of baffles to fully ensure complete mixing before entering the clarifiers or filters.

The treatment chemicals which are added in the rapid mix tanks are:

- Carbon Dioxide (CO_2)
- Lime ($Ca(OH)_2$)
- Aluminium Sulphate ($Al_2(SO_4)_3.14H_2O$)
- Polydadmac L3RC
- Polyelectrolyte

CO_2 and lime

Carbon dioxide (CO_2) and lime ($Ca(OH)_2$) are added to the raw water in the rapid mix tanks to achieve the optimum pH and alkalinity for coagulation and flocculation. They also reduce the corrosiveness of the water.

Carbon dioxide gas is added at a rate proportional to the flow to give an optimum concentration which is set by the plant operators. Lime is used to achieve a water pH of 6.7, with the amount added also proportional to the flow. The pH is measured three times to ensure an accurate reading.

Typical dose:

CO_2:	5-20 mg/L, average 15 mg/L
$(Ca(OH)_2)$:	5-25 mg/L, average 15 mg/L

Alum

The coagulant used at Te Marua to remove the organic matter and particles suspended in the water is Aluminium Sulphate (Alum). The coagulant causes the small particles suspended in the water to clump together forming flocs. The amount of alum added depends on the flow rate and the amount of material in the water. The pH of the raw water is adjusted by the addition of CO_2 and lime prior to the addition of alum so that the predominant mechanism of coagulation is charge neutralisation.

Typical dose:

As $(Al_2(SO_4)_3.14H_2O)$:	10-35 mg/L, average 15mg/L
As Al^{3+}:	0.9-3.0 mg/L, average 1.3mg/L

Polydadmac L3RC

Polydadmac is added as a secondary coagulant. It is a cationic polyelectrolyte which is particularly effective for the removal of fine suspended material which makes the water turbid. The use of polydadmac reduces the need for alum and therefore reduces the amount of CO_2 and lime required. However, alum coagulant is still required for removal of organics. Polydadmac is added to the rapid mix tanks at a rate that is set by the operators and is proportional to the flow through the plant.

Typical dose:

Polydadmac (as product):	0.5-1.5 mg/L, average 0.8 mg/L

Polyelectrolyte

The polyelectrolyte used at Te Marua is an anionic polymer which increases the strength of the flocs created during coagulation and flocculation. This increased strength prevents the flocs from breaking up within the filter and therefore makes them easier to remove.

Polyelectrolyte is added, at a fixed dose (mg/L) set by the operators, in the rapid mix tanks at least 5 minutes after the addition of Alum and Polydadmac.

Typical dose:

Polyelectrolyte (as product):	0.05-0.3 mg/L, average 0.2 mg/L

Clarifiers

No. Clarifiers:	2
Type:	Accentrifloc clarifiers
Surface area:	925 m^2 per clarifier
Capacity:	20-80 ML/d
Hydraulic loading rate:	1.8 m/hr at 80 ML/d
Typical clarifier sludge solids concentration:	0.2 % dried solids

There are two circular accentrifloc clarifiers at Te Marua. Flocculated water enters the clarifier through the centre. Mixers are provided to encourage coagulation in the clarifiers but these are not currently used. From the inlet the water is forced to flow downwards and out from under the skirt during which time flocculated particles settle to the bottom of the clarifier. Clarified water rises to the surface on the other side of the skirt and exits via the launders.

Sludge from the bottom of the clarifier is moved towards the centre of the clarifier by the sludge rake. The sludge is removed regularly by opening a flush valve on the bottom of the clarifier. The clarified sludge is sent to the sludge handling plant.

Filters

No. Filters: 6
Type: Twin bed, dual media rapid gravity filters
Media Type: Sand and anthracite on gravel bed

- Anthracite: 900 mm depth of 1.18-2.36 mm media
- Sand: 350 mm depth, 0.5-1.0mm media

Filter surface area: 100 m^2 per filter
Hydraulic loading rate:
9.7 m/h at 140 ML/d (all filters in service)
Typical filter run time: 24-36 hours
Backwash regime: Separate air and high rate water wash

- Air scour rate: 30 m/hr
- Air scour duration: 5 minutes
- Backwash water rate: 30 m/hr
- Backwash water duration: 5 minutes each side
- Backwash water volume: 4 bed volumes

The filters are divided into two banks of three (even and odd filters). Pre-treated water enters the filters through the inlet channel which runs the length of both filter banks. The inlet channel can be divided to allow the even and odd filters to be run on two separate streams. However, this function is not used during normal operation.

The turbidity of each individual filter is monitored continuously and maintained below 0.1NTU to ensure they are operating effectively to remove protozoa. If the turbidity of an individual filter exceeds the limits which have been set, flow through the filter can be reduced or in severe cases, a plant 'slam shut' will occur. A 'slam shut' involves closing the inlet to the treated water reservoir to protect the treated water supply, and then shutting down the plant.

These twin bed filters are split into a north and south side, with the backwash launder running down the middle. This enables the filter to be backwashed one side at a time.

Backwashing

Because the filters remove flocculated particles, over time they become clogged and less effective. At this stage they must be backwashed to remove the flocs and 'clean' the sand. Backwashing of the filters starts automatically if any of the following three events occurs:

- Turbidity spikes in the treated water
- Excessive run time or
- High bed headloss

The operators can also manually start a backwash of the filters.

When a filter backwash is required, the filter is taken off-line until there is sufficient water in the washwater reservoir and capacity in the washwater recovery plant for the dirty backwash water. Filters are washed on a first in/first out basis, although the operators can change the order in the queue.

The backwash is a separate air and high rate water wash. The sequence starts on the north side of the filter. Once the north air scour is complete, the wash starts on the north side and the air scour starts on the south side of the filter. Once the south wash has completed, the filter is refilled with water from the washwater reservoir.

The high level washwater reservoir is filled by pumping at a low rate from the treated water reservoir. The water flows by gravity for the backwashing process.

South air scour

North wash

Washwater recovery

Washwater settling tanks: 3 x 600 m^3
Settled sludge balance tanks: 2
Thickeners: 2 x 120 m^3
Thickened sludge balance tanks: 2
Centrifuge: 2
Supernatant lagoon: 1
Sludge lagoon: 1
Typical solids concentration:

- Unsettled washwater 0.05% dried solids
- Settled washwater 1.0% dried solids
- Thickened sludge 4% dried solids
- Centrifuge sludge 24% dried solids

Backwash water from the filters flows by gravity to the washwater settling tanks in the recovery plant where it is left to settle for around three hours.

Settled washwater sludge is then transferred to the thickeners where a polymer is added to speed up the sedimentation process. Supernatant (water) from the settling tanks is returned to the head of the plant.

Settled sludge from the thickeners is pumped to the centrifuge. More polymer is added to the sludge to strengthen the flocs so that they do not break apart in the centrifuge. The centrifuges are only operated manually when staff are present on site.

Supernatant from the thickeners is returned to the washwater settling tanks for further treatment. Any overflow of supernatant from the thickeners flows to the supernatant lagoon.

Centrifuge sludge is taken to the landfill, while the centrate (liquid) is pumped to the Upper Hutt City Council sewer. Any excess centrate flows to the sludge lagoon where it is held until it can be discharged.

The sludge lagoon is also used to collect any overflows from the washwater settling tanks and thickener so that contaminated water is not released into the environment.

Treated water

Filtered water is dosed with sodium hydroxide, chlorine and fluoride before entering the treated water reservoir. Dosing of these chemicals occurs in the reaction tank which is located immediately prior to the treated water reservoir. From the treated water reservoir, water is pumped to the water supply system using the boost pumps in the pumping station.

Sodium Hydroxide

Sodium hydroxide (caustic soda) is added to the filtered water to raise the pH level and to reduce its corrosiveness. The water leaving the treatment plant generally has a slight tendency to dissolve calcium carbonate.

The amount of caustic soda added depends on the flow rate of the treated water and its pH. The operators usually set the pH to be around 7.9.

Typical Dose:
Sodium hydroxide 5-30 mg/L, average 15 mg/L

Chlorine

Chlorine gas is used to disinfect the filtered water. The flow of chlorine is adjusted relative to the flow of treated water to achieve the required chlorine concentration when the water leaves the treated water tank. The chlorine dose is adjusted to produce a final concentration of approximately 0.7 mg/L.

The amount of chlorine in the water is monitored continuously. If the concentration exceeds pre-determined limits the plant is 'slam shut' to protect the treated water supply.

Typical Dose:
Chlorine 0.5-2.0 mg/L, average 1.0 mg/L

Fluoride

Fluoride is added to the water to provide dental health benefits to the consumer. The natural level of fluoride in the river water around Wellington is 0.1 mg/L. Following treatment, this is increased to 0.7-1.0 mg/L as recommended by the Ministry of Health.

Sodium silicofluoride (Na_2SiF_6) is made into a slurry and added to the treated water. The fluoride is added at a rate proportional to the flow of treated water.

The concentration of fluoride is monitored to ensure that the required dosing range is maintained.

Typical treated water quality

The quality of treated water from the Te Marua water treatment plant is very high, and exceeds all the standards set out by the Ministry of Health in the Drinking Water Standards for New Zealand 2005. This is reflected in the plant's attainment of the Ministry's A1 grading for the source and treatment management. The quality management system is certified to ISO standard 9001:2000 and the environmental management system holds ISO 14001:2004.

Treated water is monitored continuously for turbidity, pH, and chlorine to ensure the standards are met. In addition, treated water is monitored continuously for organics, aluminium and alkalinity.

Colour:	0.5-4.0 °Hazen, average 2°Hazen
DOC:	0.1-1.0 mg/L, average 0.4 mg/L
Turbidity:	0.02-0.5 NTU, average 0.04 NTU
pH:	7.0-8.5, average 7.9
Chlorine residual:	0.5-1.5 mg/L, average 0.7 mg/L

Comparing typical mean chemical values with two popular brands of bottled water

Parameter	Pump*	Kiwi Blue*	Te Marua
Calcium (total), mg/L	2.7	2.2	**13**
Chloride, mg/L	5.0	6.4	**7.7**
Magnesium (total), mg/L	1.0	1.3	**1.3**
pH	6.5	5-7	**7.9**
Sodium (total), mg/L	7.8	8.3	**13**
Solids (total dissolved), mg/L	110	110	**86**

* Mean values derived from Nutritional Information supplied on product

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Photo of Kaitoke weir by Jessica Dewsnap

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