South East Water

Study of chlorate production in drinking water distribution system; impacts of temperature and recuperative chlorination

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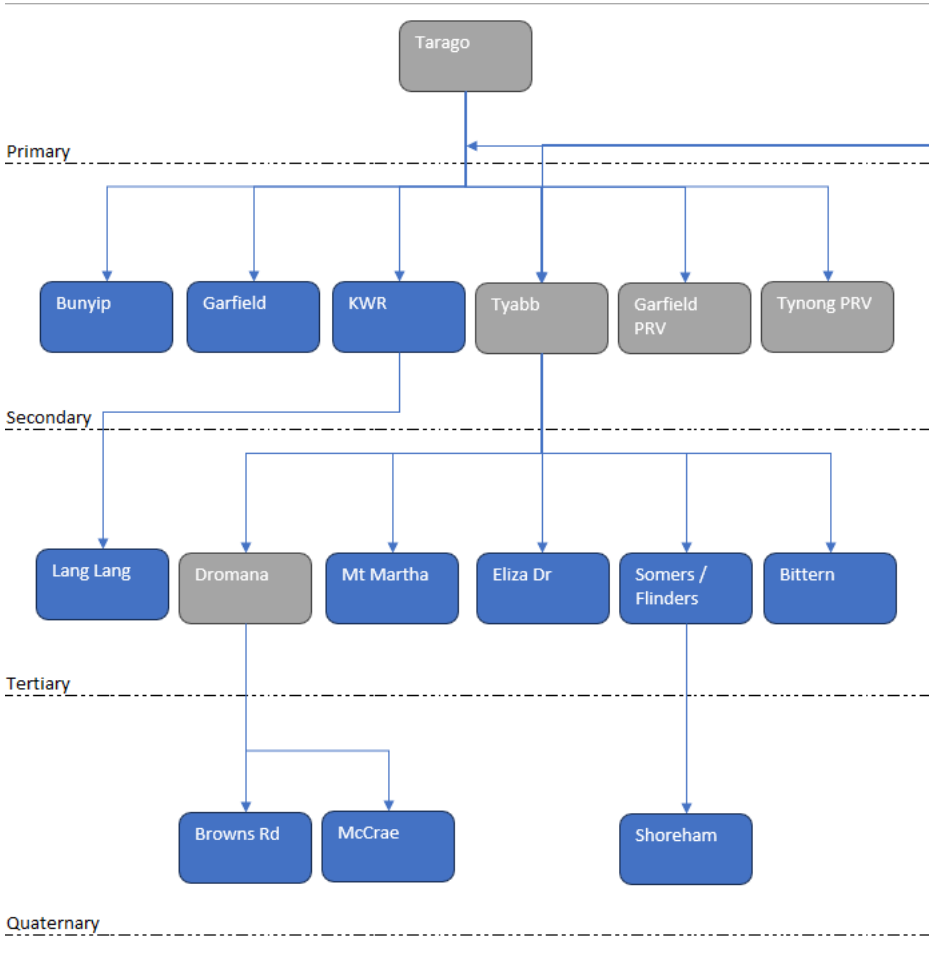
Drinking water distribution network

1,831,777 people

14,726 kl of mains

25 secondary chlorination plants

2 portable chlorinator



Disinfection by chlorination

Chlorination performed at the final stage of treatment and continues throughout the network.

Most popular disinfectants are chlorine, chloramine, ozone and chlorine dioxide.

SEW widely uses **sodium hypochlorite** due to its advantages:

✓Cost effective and easy process (only needs contact pools)

✓Relatively safer for storage and handling

Disadvantages:

- Taste and odour
- Short shelf life
- Disinfection byproducts

* 0.7 mg/l, if operationally unachievable

	ADWG (2011)	Australia (Recycled Water) - 2008	New Zealand - 2018	WHO - 2017	USEPA	Canada - 2020	EU - 2007
Chlorate (mg/l)	N/A	N/A	0.8	0.7	N/A	1	0.25*
Chlorite (mg/l)	0.8	N/A	0.8	0.7	1	1	0.25

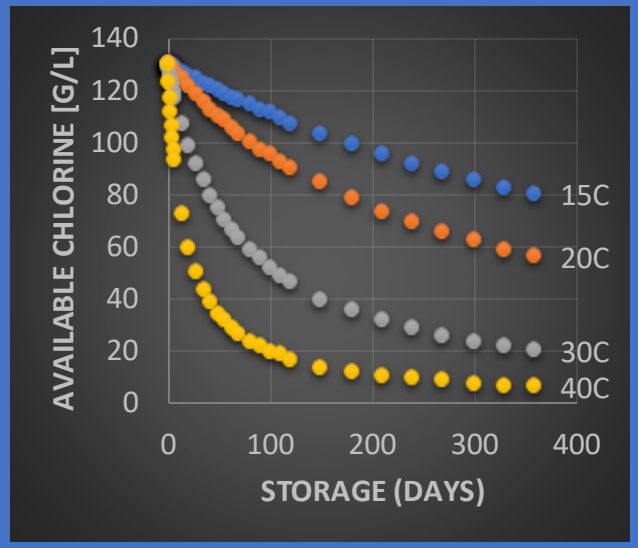
THMs → result of organic matters reacting with chlorine → Regulated.

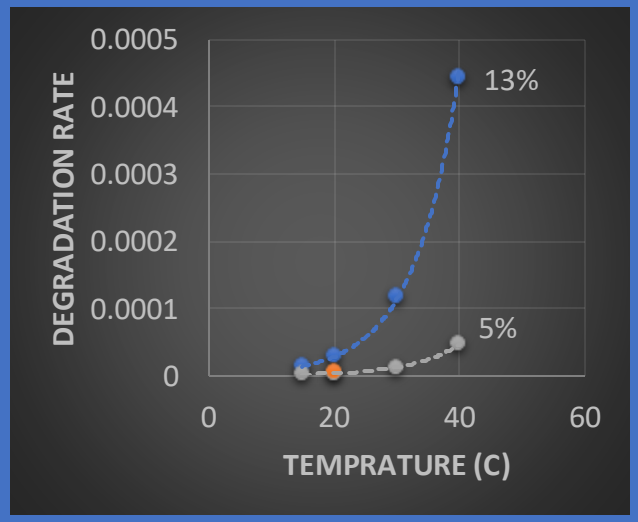
Chlorite → result of degradation of chlorine in storage → Regulated.

Chlorate → result of degradation of chlorine in storage → Not regulated yet.

- ❑ US EPA non-enforceable guideline of 0.21 mg/l
- ❑ WHO provisional guideline of 0.7 mg/l

Hypo degradation in storage





Chlorinator cabinet with s. hypo storage under the cabinet

Chlorinator building with s. hypo storage inside

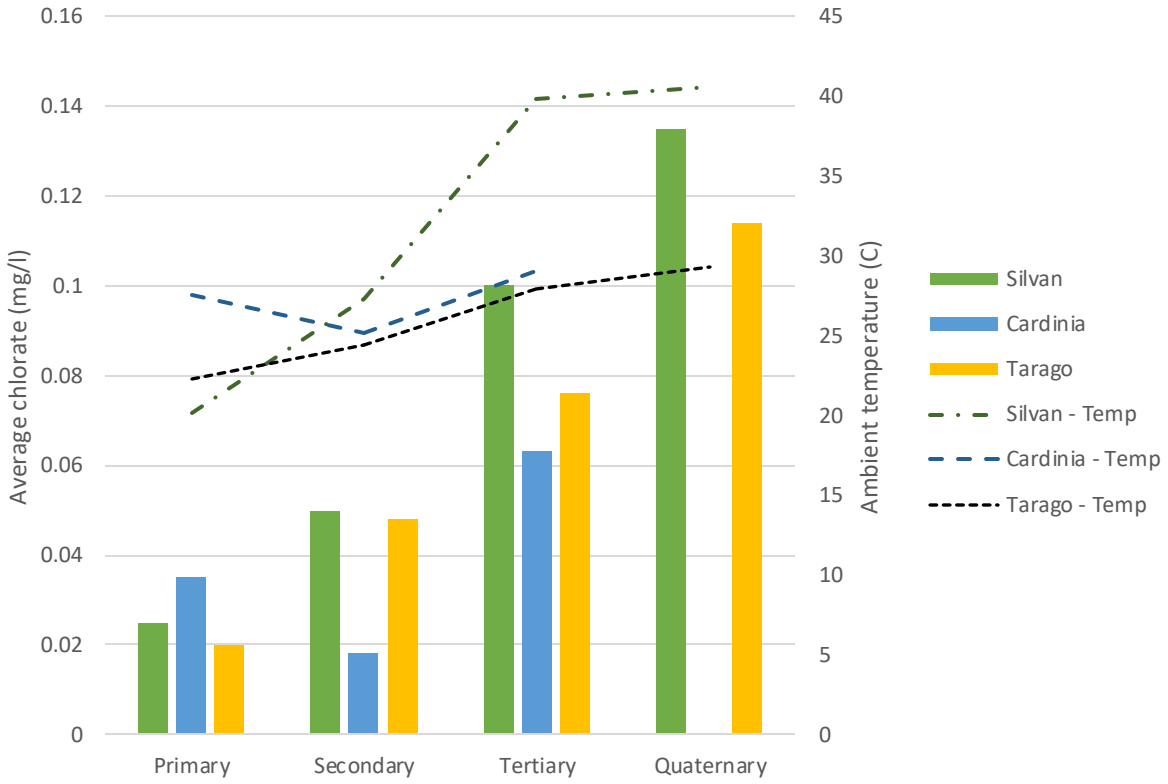
Chlorinator cabinet under the shade

Chlorate accumulation

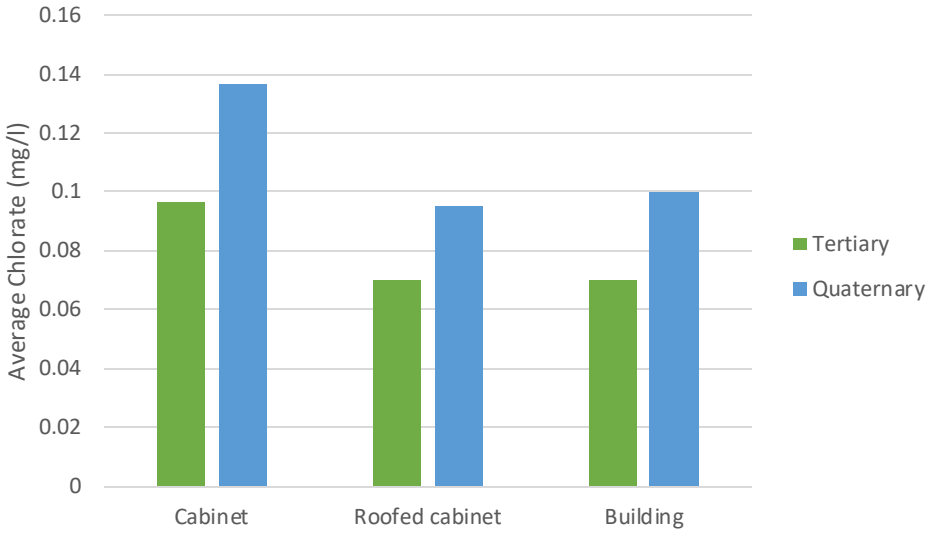
- 45 samples in total

✓Chlorate increases by chlorination stage

✓Max chlorate 0.19 mg/l are within proximity to the US EPA proposed 0.21 mg/l limit.

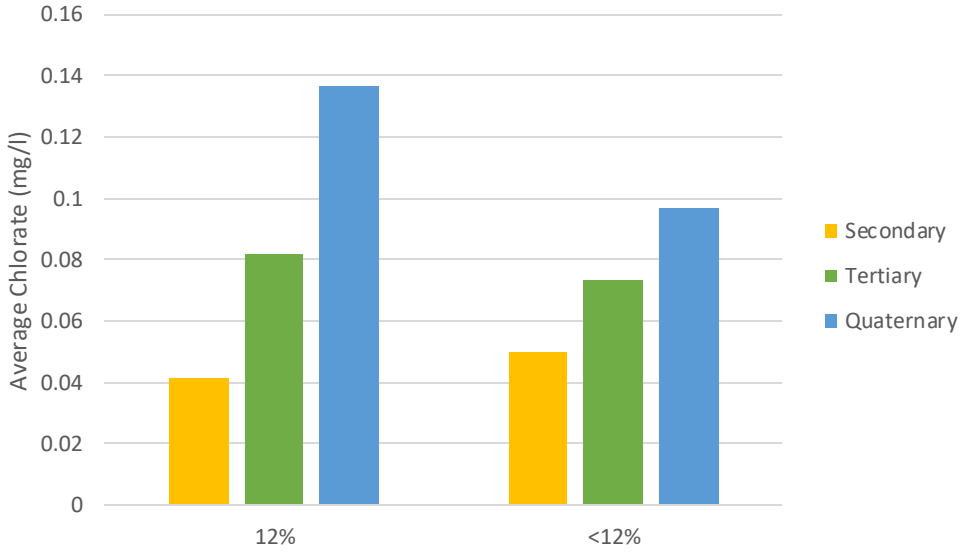


Hypo storage condition



- ✓ Less chlorate production for better storage weather proofing
- ✓ Installing shades or constructing buildings for chlorinators leads to a notable reduction in chlorate production.
- ✓ Extends the shelf life of hypo while decreasing consumption and associated costs.

- ✓ The higher the concentration the faster the degradation processes
- ✓ Storage can be modified to reduce the chlorate: Lowering the hypo age and strength and adding AC/cooling fan

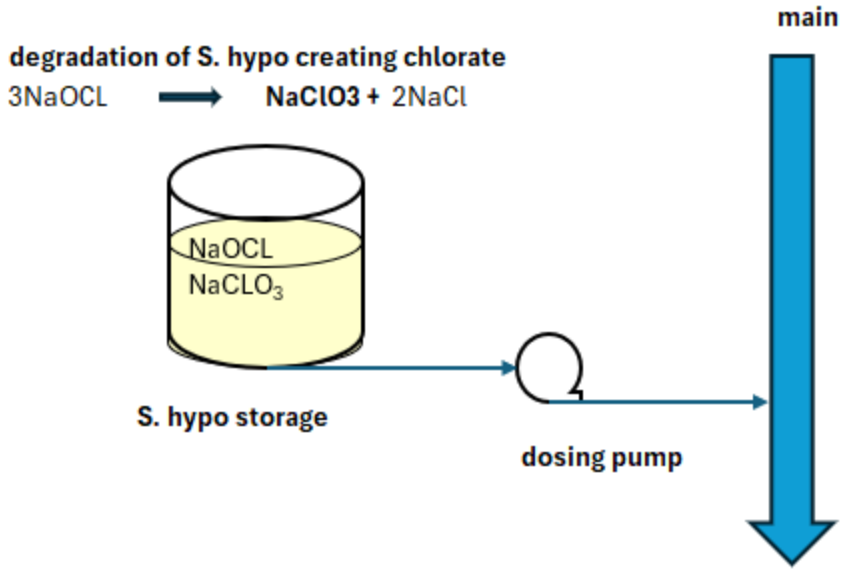


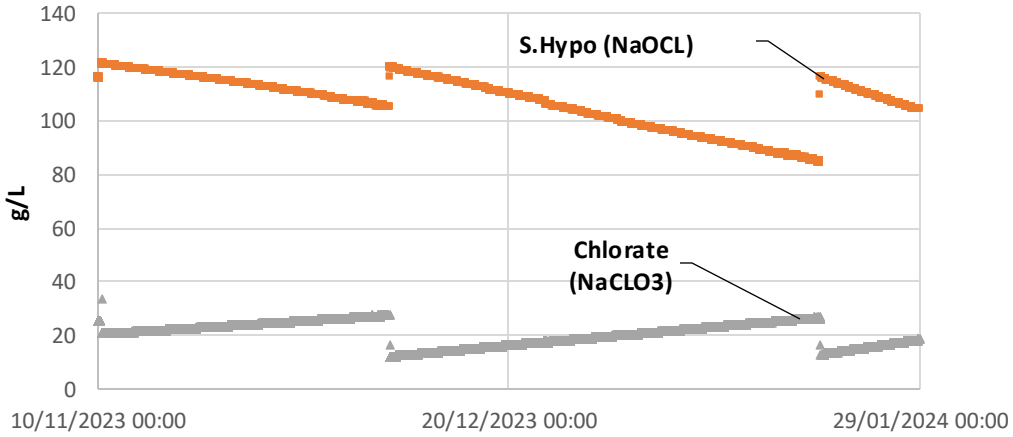
Modeling chlorate creation

S. Hypo degradation $\frac{d(vC_A)}{dt} = q_i C_{i,A} - q_o C_A - kC_A^2$

Chlorate creation $\frac{d(vC_B)}{dt} = q_i C_{i,B} - q_o C_B + kC_A^2$

C_A Concentration of S. hypo in storage
C_B Concentration of chlorate in storage
k S. hypo degradation reaction rate (calculated from the supplier data)
$C_{i,A}$ Initial concentration of S. hypo (lab analysis)
$C_{i,B}$ Initial concentration of chlorate (lab analysis)
q_i S. hypo flow rate to storage
q_o S. hypo flow rate to main
v Storage volume
X Final concentration in the main after dilution





Model prediction

- MW Tyabb chlorinator (Secondary dosing)
- SEW Somers-Flinders chlorinator (tertiary dosing)
- SEW Shoreham chlorinator (quaternarily dosing)

Improvements

Chlorinator upgrade project

- Future proofing the designs
- Climate change resilient
- Prioritising the chlorinator upgrade program

Monitoring

- 6-monthly lab-testing the S. hypo at the bulk delivery for chlorate
- Monthly testing the S. hypo strength in chlorinator storage by titration kit
- Add chlorate to our routine monitoring program