Water Treatment for Small Supplies – Balancing Risks and Costs

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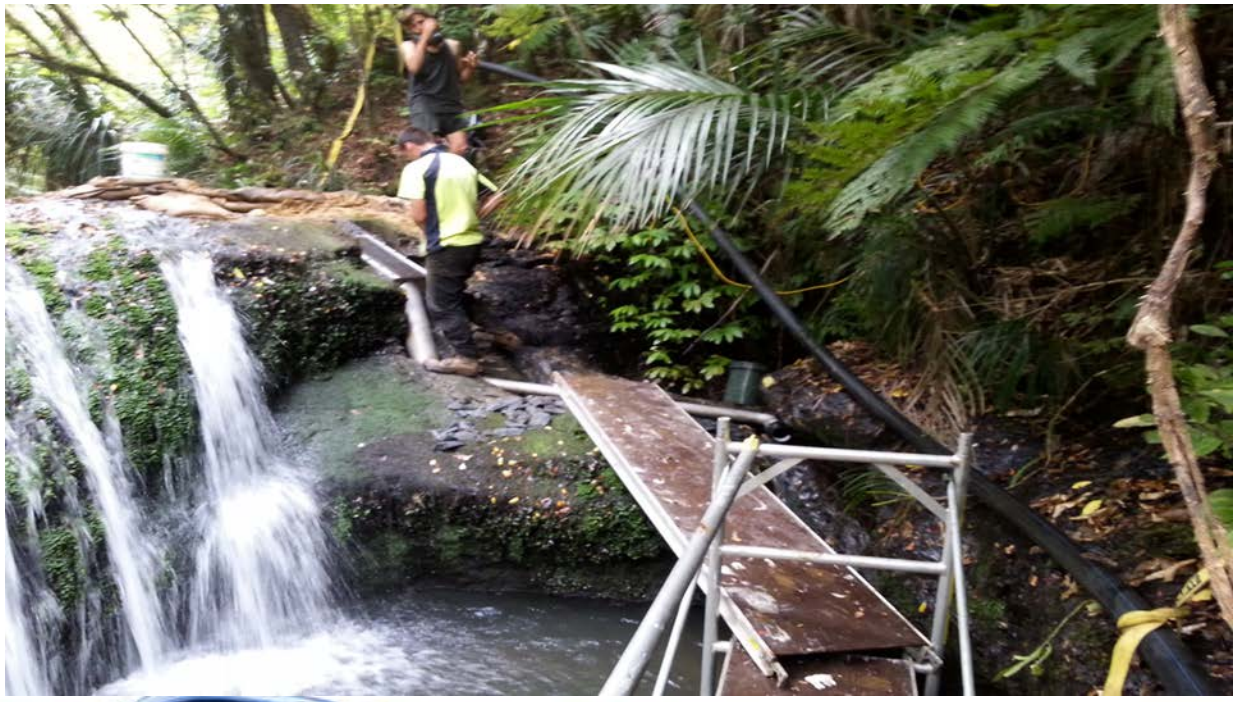
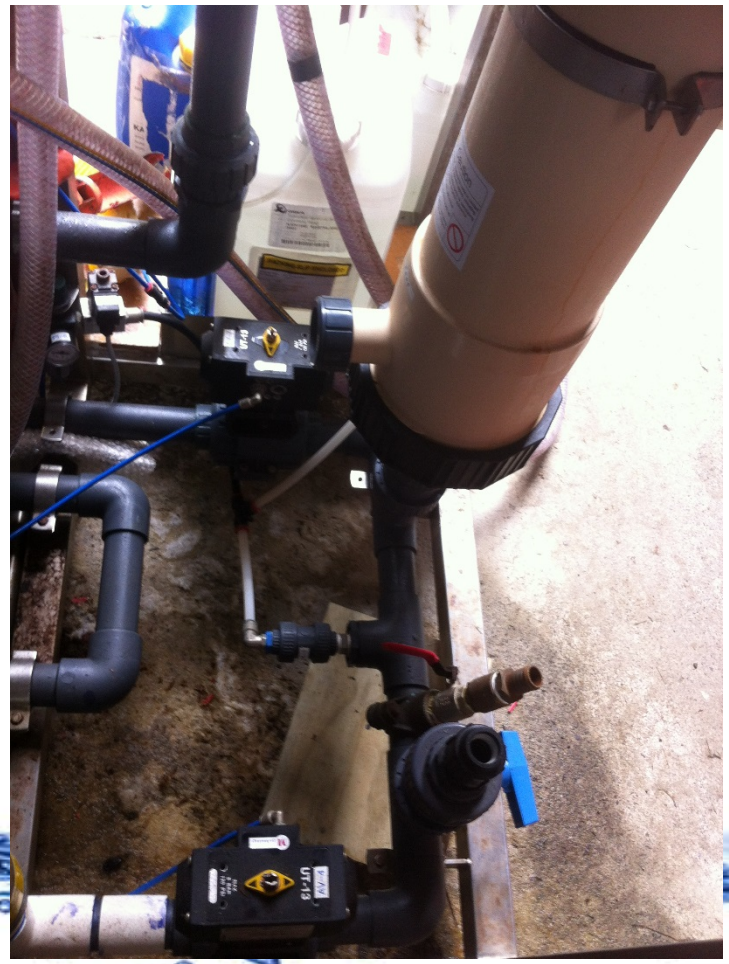
Introduction

- Small supplies - big challenges
- Compliance:
  - Minor supplies (501 – 5,000) - 60% not fully compliant
  - Small (101 – 500) – 70% not fully compliant
- Seven case studies
  - background
  - features
  - challenges and success factors
- Treatment technology
- Treatment challenges



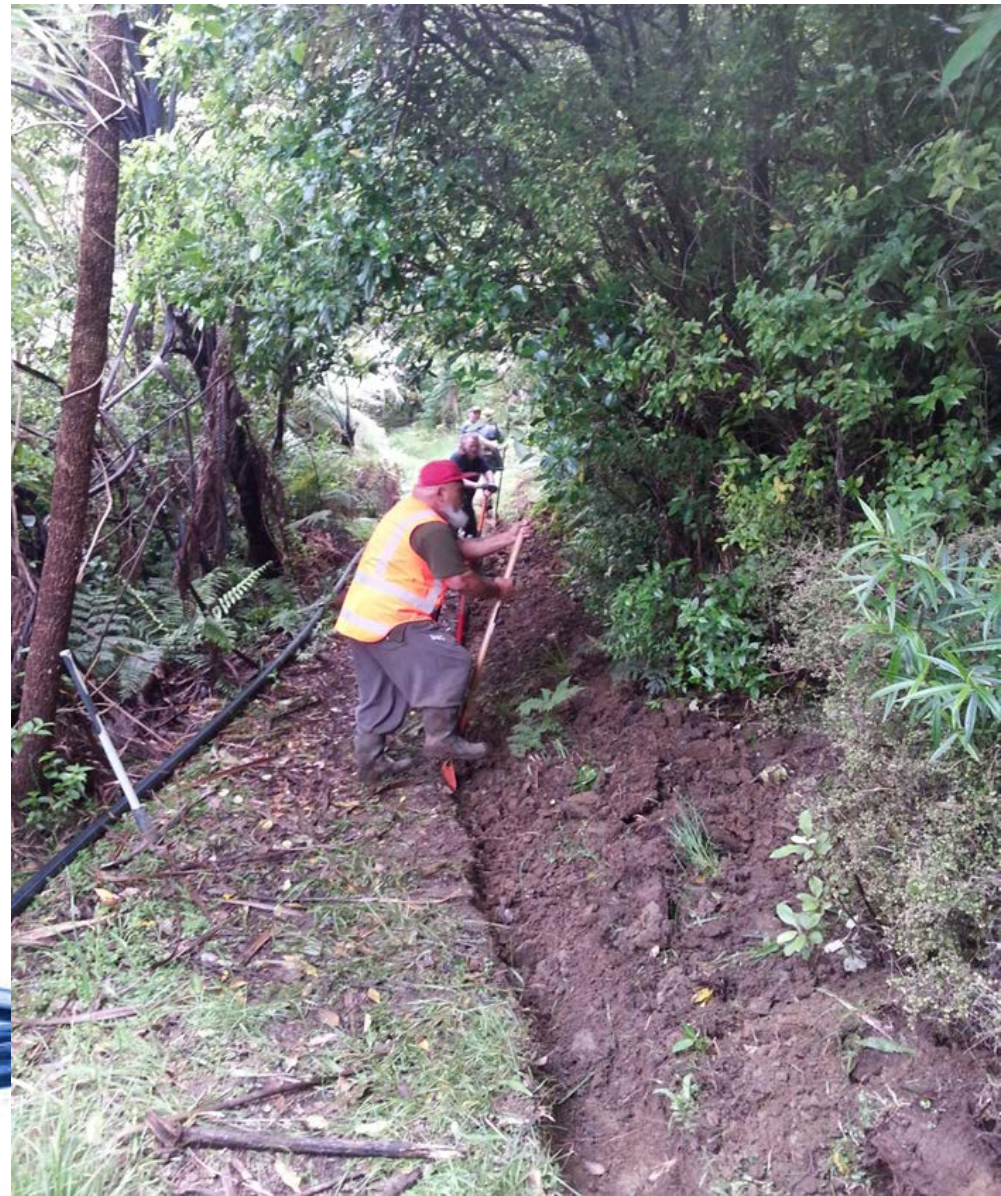
Whirinaki

- Background
  - Established under Nga Punawai o Hokianga, and completed in 2000
  - 64 households, expanded in 2017 to 89
  - Community
    - owned and operated (Whirinaki Water Board)
    - work largely by volunteers
- Features
  - Off grid (micro-hydro and PV)
  - Surface water, microfiltration, and UV disinfection
  - Original supply designed Cook Costello (plant D&C by Pall)
  - Upgrade designed by Board and CH2M Beca



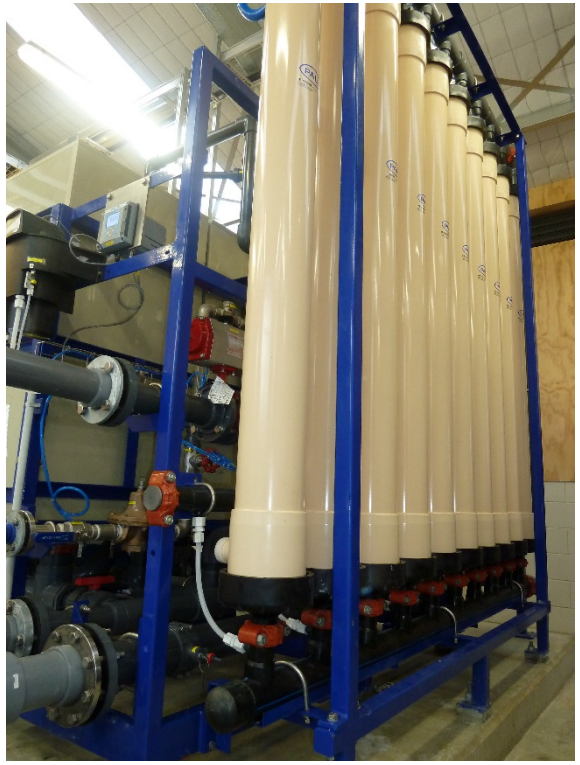
Whirinaki – Challenges and Success Factors

- Biggest challenges
  - remoteness
  - high deprivation
- Membrane filtration
  - high technology
  - copes well with variable raw water quality
- High quality source water
- Community
  - successful operation for 17 years
  - commitment to running supply
  - value is deeper than just safe water



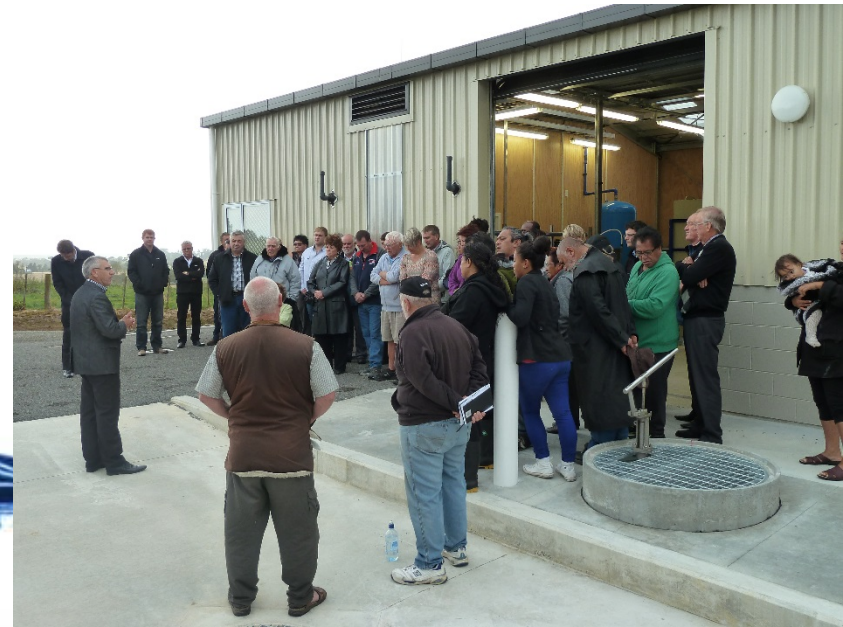
Shannon

- Background
  - Horowhenua District Council, operated by Downer
  - Population of 1,400
  - Basic chlorination-only plant
  - Surface water, typically 2 – 4 NTU, but can rise to >100 NTU
- Features
  - Design by CH2M Beca
  - Membrane filtration, pH correction, chlorination, completely automated
  - Delivery in two contracts – membrane (Pall) and balance of plant (Downer) - total of $2.6 million
- Discussion
  - Membrane well-suited (unattended and simple operation, copes with short high turbidity events)



Shannon - Challenges and Success Factors

- Capital Assistance Programme funding (72%)
- Membrane technology:
  - Unattended operation
  - Good fit for raw water
  - Avoided cost of clarifier
- Consistent performance (<0.1 NTU) despite many flood events
- Compliance in 15/16 for bacteria but not for protozoa

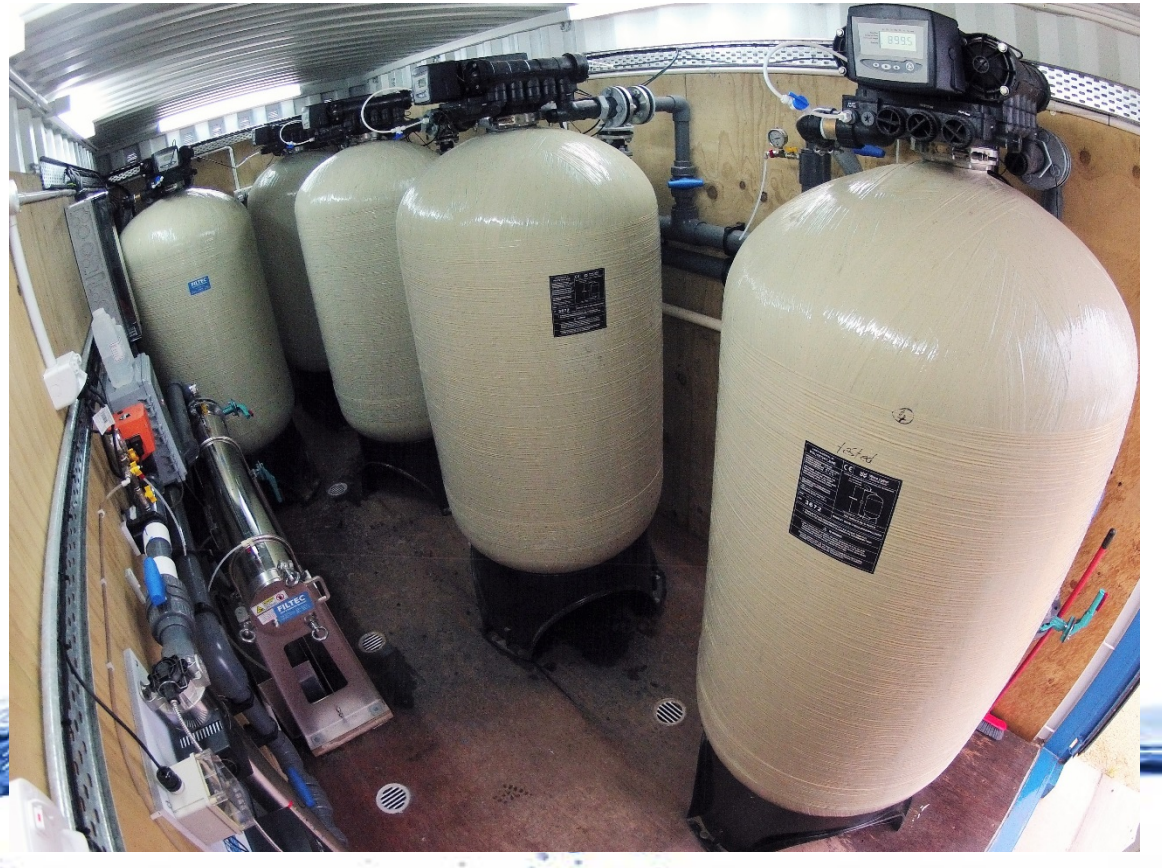


Tokomaru

- Background
  - Horowhenua District Council, operated by Downer
  - Population of 550
  - Surface water, infiltration gallery, chlorination only, history of boil water notices
  - Cost of traditional plant of $2.5 million – pushed out by 20 years
- Features
  - Sand media + carbon media + High Flow cartridge filtration, and UV – all containerised
  - Turned off when turbidity > 2 NTU
  - Trialled at pilot scale for 6 months
  - Design by Filtec, implemented 2013-15, cost $350,000
  - Cartridge costs of $8,000 per year (50% higher last 2 years), carbon cost of $10,000 in first year

Tokomaru - Challenges and Success Factors

- Risks of extended duration storm events and catchment changes (now adding additional storage)
- Compliance generally maintained, but one boil water notice
- Process solution relies on selective use
- Community now has a treated water supply
- Achieved full compliance for 15/16

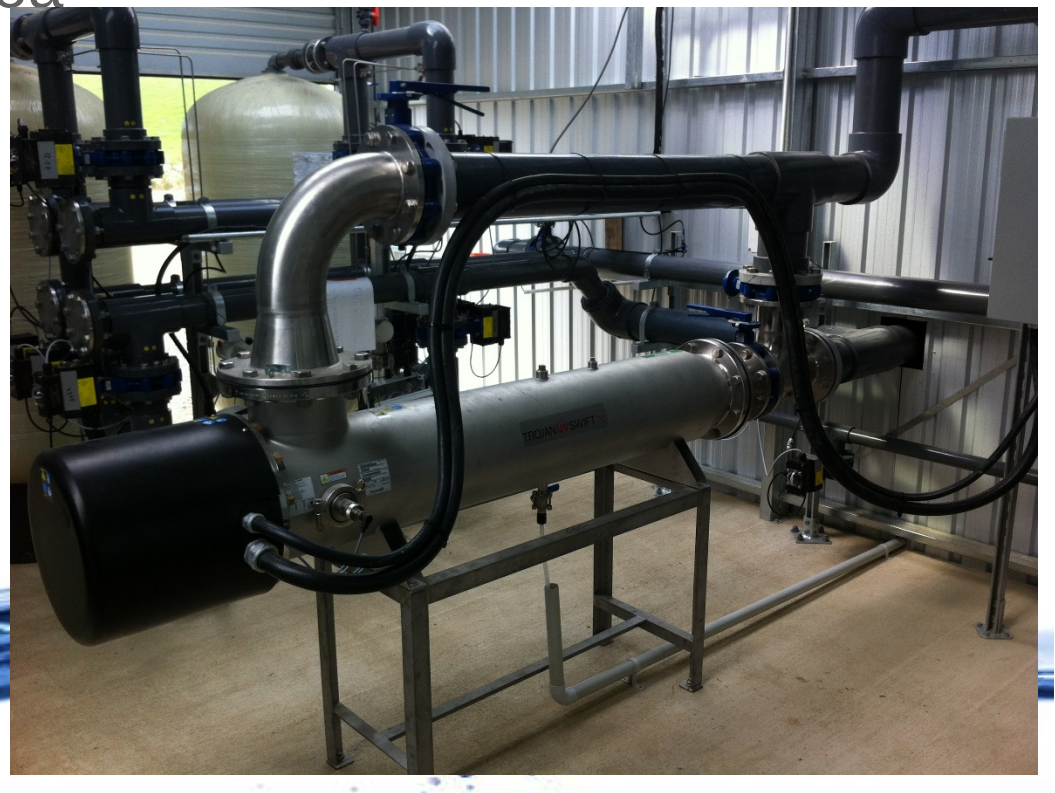


Eketahuna

- Background
  - Tararua District Council
  - Population of 440
  - Surface water bush catchment in foothills of Tararua Ranges
  - Infiltration gallery (average 0.5 NTU)
- Features
  - Selective abstraction (< 2 NTU)
  - Macrolite media filtration and UV
  - Design by Filtec, implemented in 2011/2012 at a capital cost of $490,000
  - Very low operational costs

Eketahuna - Challenges and Success Factors

- Ensuring everyone understood requirements of DWSNZ
- Low cost treatment solution
- Reliant on good raw water quality
- Compliance 15/16 for bacteria but not for protozoa

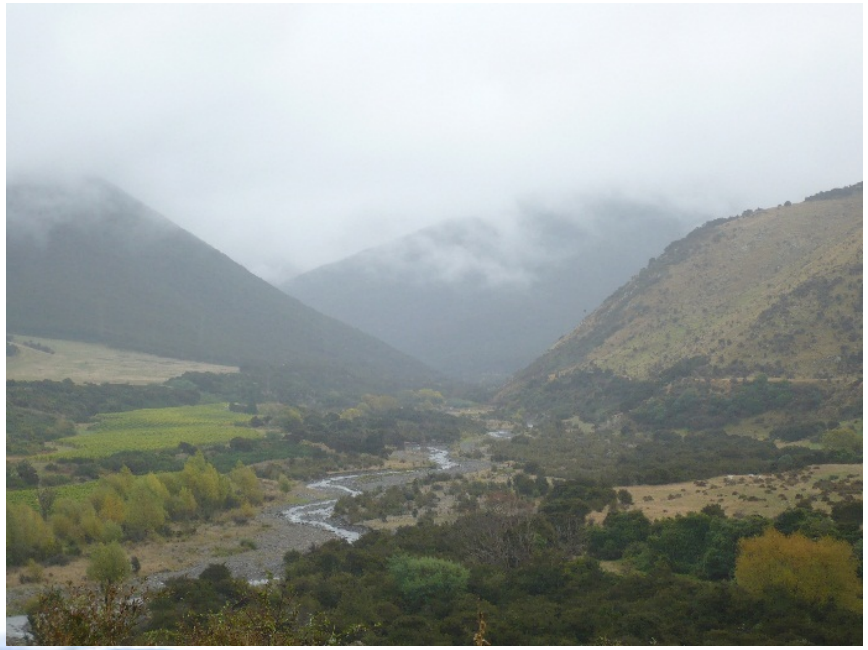


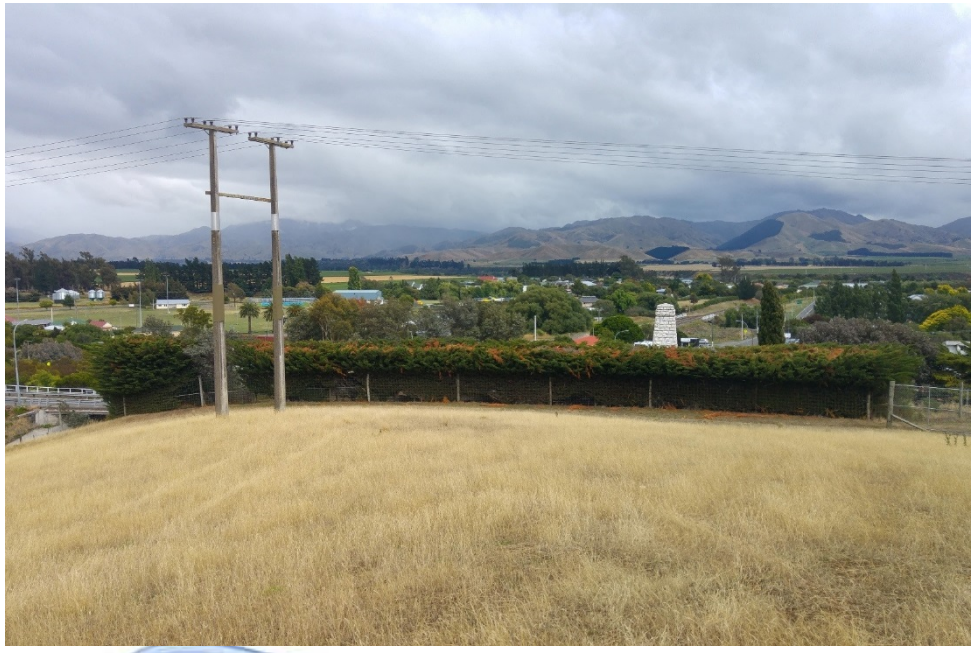
Seddon

- Background
  - Marlborough District Council (owner and operator)
  - Part of larger Awatere rural water supply scheme
  - Population of 840 (seasonal peak)
  - Upland stream catchment with infiltration gallery (spikes of up to 80 NTU)
- Features
  - CH2M Beca - preliminary design and client advisor role for D&C delivery
  - CAP funding of $1 million in late 2015
  - Specimen design on basis of conventional process but alternatives invited
  - Contract awarded to Filtec in late June for $2.6 million (membrane filtration process)
  - Need to hydraulically separate from rural supply

Seddon - Challenges and Success Factors

- Convincing community of health risks of un-treated supply
- Rural supply will remain un-treated – point of entry being considered
- Membrane-based process favoured over conventional



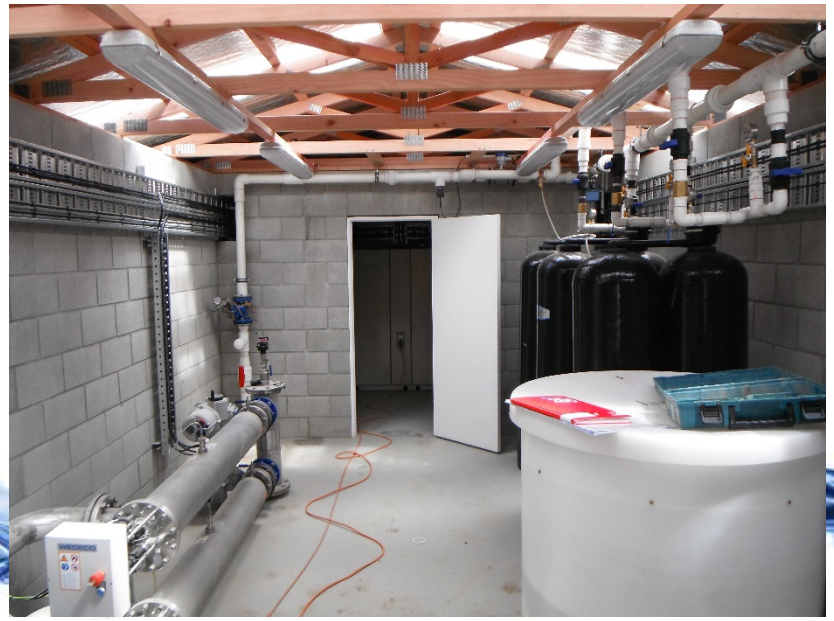


Little River

- Background
  - Christchurch City Council owner, City Care operated
  - Population of 240
  - Surface water source from creek (3 log), slow sand filtration and chlorination
  - Insufficient catchment yield and non-compliant (filtered water spikes > 1 NTU)
- Features
  - New well drilled – elevated hardness (up to 320 mg/L) and salinity
  - Treatment plant upgrading (CH2M Beca design) – softening of groundwater, slow sand filter refurbishment and UV
  - Total cost of $2 million

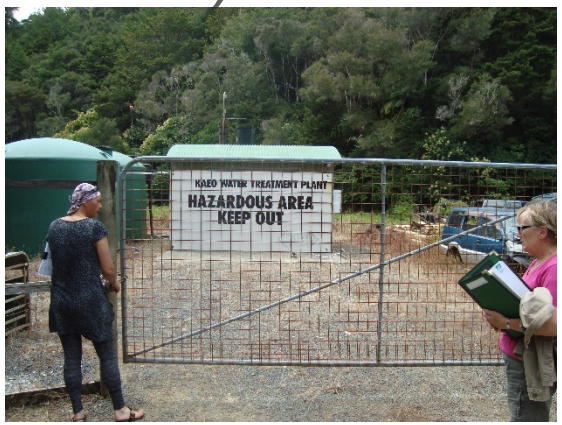
Little River - Challenges and Success Factors

- Increased complexity of treatment from softening
- Blending of surface water and groundwater:
  - improved resilience
  - counters water quality negatives of each source
- Compliance in 15/16 for bacteria but not for protozoa



Kaeo

- FNDC ➔ private ownership in 2001 ➔ Wai Care Environmental Consultants
- Population of 72 in 27 households
- Shallow well, high iron, Deferum iron removal plant (CAP funded in 2011)
- Poor treated water quality, not financially sustainable
- Unsuccessfully applied for CAP funding in 2015 with two options
  - Upgrading existing plant - $200,000
  - Implement new groundwater source and expanding the supply - $750,000



- Early 2016 media attention – idea of upgrading school supply to serve community
- Lesson - need to implement simple robust solutions, which can be challenging for poor quality sources

Treatment Technologies (1 of 2)

- Media filtration + cartridges + UV
  - Small supplies
  - Effective where water quality is good (< 2 - 5 NTU)
  - Risks if use selective abstraction and/or source water deteriorates
  - Simple and low cost
- Coagulation (+ clarification) + media filtration
  - Difficulty of coagulation control under varying raw water quality
  - Similar cost to membrane filtration for small plants
  - Other factors can favour membranes
    - Level of attendance
    - Experience required

Treatment Technologies (2 of 2)

- Membrane filtration
  - Consistent high quality water even under varying raw water quality
  - More technically complex, but can be sustainably operated in small remote supplies
  - Greater certainty of compliance
  - Availability of pre-engineered small plants
  - Significant part of future

Conclusions - Non-technology Factors

- Costs for small supplies can be 4 x or greater higher than main metropolitan areas
- Economically disadvantaged
- Small supplies are unaffordable if costs are ring-fenced
- Small supplies only affordable if:
  - costs are harmonised across a large customer base
  - community run supplies

Conclusions - Technology Factors

- Cartridge filtration and UV disinfection
  - Effective where water quality is good (< 2 - 5 NTU)
  - Not suitable for higher turbidity sources
  - Simple and low cost
- Membrane filtration
  - High quality and more robust level of treatment
  - Compliance more assured under varying raw water quality
  - More complex technology but proven for small remote supplies
  - Pre-engineering is improving economics and operability
- Coagulation/Clarification/Filtration
  - Greater level of optimisation required under varying raw water quality
  - Still more economic for large plants but less so at small scale

Conclusions – Decision Matrix

Source Water Quality	Best Match Treatment Process			
	Risk Profile		Operational Capability	
	Higher	Lower	High	Low
Very High Quality < 2 NTU, <5 TCU	Cartridge + UV	Media Filtration + Cartridge + UV	Cartridge + UV	Cartridge + UV
High Quality < 2 – 4 NTU	Media Filtration + Cartridge + UV	Direct Filtration Membrane Filtration	Direct Filtration	Media Filtration + Cartridge + UV
Good Quality < 10 NTU, < 20 TCU	Direct Filtration	Conventional Membrane Filtration Direct Filtration + UV	Direct Filtration	Membrane Filtration
Poor Quality > 100 NTU, > 50 TCU	Conventional	Membrane Filtration	Conventional Membrane Filtration	Membrane Filtration

Questions

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