Kerikeri Water Supply Strategy

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Far North District Council

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Contents

Executive Summary

Background

Far North District Council's (FNDC) current water supply scheme provides a potable water service to Kerikeri and Waipapa. Kerikeri is a key centre in the Far North District and its population has grown significantly over the last 20 years. Waipapa is an important and growing commercial hub.

There are significant challenges in meeting the water demands of the current populations and these challenges will increase as growth in the area continues and the impacts of climate change become more pronounced.

This Study

This Kerikeri Water Supply Study is a strategic level study that sets out how forecast increases in water demand for Kerikeri and Waipapa could be met over the next 30 years. It provides guidance on how the current scheme might evolve over this time horizon including key steps and decision points.

It draws on a wide range of existing information and includes the outputs of two workshops with key FNDC and Far North Waters staff. Representatives of key water source asset owners, Kerikeri Irrigation Company (KIC) and Northern Water Company have also been consulted in the development of options.

Due to the high level of this study, further, study would be required before implementing the options out.

Investment Logic Mapping

To inform decision making and the development of viable options for the Kerikeri water supply scheme, an investment logic mapping (ILM) exercise was carried out to identify the overarching problems. The ILM exercise identified the following four key problems;

- Problem 1: Poor historical land use and infrastructure planning integration has resulted in unplanned network and has impacted on the affordability of services
- Problem 2: Current/default rating policies and capital investment strategies for bulk water supply results in inequitable outcomes for all users
- Problem 3 - Problem 3: Reliance on surface water and private infrastructure is not able to meet customer expectations or provide sufficient resilience.
- Problem 4: Site constraints at existing water treatment plant (WTP) presents challenges with upgrading plant/equipment while operational resulting in ageing infrastructure that is not resilient to demand and supply issues.

Four potential key benefits from investing to address the key problems in the Kerikeri water supply scheme have been identified as:

- Benefit 1: More confident/ optimised planning and infrastructure investment decisions
- Benefit 2: More transparent and equitable funding mechanism
- Benefit 3: Improved resilience to climate change and security of supply of water
- Benefit 4: A more resilient water supply for now and future.

Proposed Strategy

The proposed strategy continues a similar approach to that taken by the current scheme in the short to midterm with the goal of introducing alternate ground water sources if these can be found through further investigations. This would provide Kerikeri's water scheme with greater resilience in water sources.

Four options were developed that met the anticipated future demands of the scheme.

The preferred option retains use of both Puketotara Stream and Lake Waingaro Reservoir as water sources (but with an increased water allocation from Waingaro), expands the treatment plant on its current site and upgrades the central spine of the water distribution network.

The indicative implementation programme of the preferred option is set out below together with indicative costs. These costs are high level only and include an allowance for planning, design, construction monitoring and a 30% contingency.

Note that the timing of Stages 2 and 3 could be delayed by reducing the rate of water demand growth through a demand management programme. Similarly, timelines can be pushed out if actual growth is lower than the 2% growth rate assumed as the basis of the water demand forecasting.

Preferred Option Implementation Programme

Stage	Primary Focus	Activities	Timeline	Indicative Costs
1	Increasing network and WTP capacity to be able to deliver 4000m^3/day.	a) Upgrade Kerikeri WTP to 4000m^3/day b) Upgrade the inlet works and delivery line for the Puketotara source c) Relocate FNDC connection point on KIC Lake Waingaro supply line and extend FNDC supply line	2020 - 2025	$11.2M
2	Mains pipeline renewal and increasing treated water storage	a) Upgrade distribution spine in Kerikeri network b) Additional treated water storage	2025 – 2030 2030	$8.8M $1.5M
3	Renewals and increasing capacity at the Kerikeri WTP	c) Upgrade and renew Kerikeri WTP from 4000m^3/day to 5000m^3/day d) Replace existing reservoirs at Kerikeri WTP	2030 - 2035	$6.7M

Conclusions

Key conclusions of this study include;

1) There is an immediate need to upgrade at least some elements of the Kerikeri WTP and a further need to increase its capacity within the next 5 years
2) There is a need to upgrade parts of the Kerikeri distribution network over the next 5 years to meet levels of service under anticipated growth in demand
3) It is theoretically possible, subject to satisfactory agreement with Kerikeri Irrigation Company, for Kerikeri's water sourcing needs to be met by the Lake Waingaro Reservoir for the next 30 years

Recommendations

Key recommendations include;

1) FNDC engages with KIC to explore opportunities to increase their water allocation from Lake Waingaro Reservoir
2) Investigation into potential new groundwater supply sources be investigated with the aim securing a water source that is not reliant on surface water
3) Investigate opportunities for a new dammed reservoir with a hydrological review of flood frequency and identification of potential dam sites
4) Investigation and design worked is progressed for an upgrade of the Kerikeri WTP on its current site
5) Investigation and design work is progressed for an upgrade of the existing Puketotara Stream abstraction well and raw water line to the Kerikeri Water Treatment Plant.

1. Introduction

1.1 Study Overview

FNDC's current water supply scheme provides a potable water service to Kerikeri and Waipapa. Kerikeri is a key centre in the Far North District and its population has grown significantly over the last 20 years. Waipapa is an important and growing commercial hub.

There are significant challenges in meeting the water demands of the current populations and these challenges will increase as growth in the area continues and the impacts of climate change become more pronounced.

This Kerikeri Water Supply Study is a strategic level study that sets out how forecast increases in water demand for Kerikeri and Waipapa could be met over the next 30 years. It provides guidance on the how the current scheme might evolve over this time horizon including key steps and decision points.

The study first establishes the strategic case for the need to invest in the Kerikeri water supply and what the key problems to be solved are. It then examines the existing scheme in more detail and develops a water demand forecast. Using the water demand forecast as the driver, a range of options to meet future demand are developed. This includes a long list review of the various elements in a scheme with the key ones being the sources of water and how and where it is treated. Four shortlisted scheme options are described together with timelines and relative rough order costs. These options are then reviewed through a multi-criteria analysis to select a preferred option. This option is then reconciled against the problems identified in strategic case to ensure it supports their resolution and confirmed as appropriate. Any key assumptions to be resolved and further investigations and studies are set out in this study's recommendations.

The study draws on a wide range of existing information and includes the outputs of two workshops with key FNDC and Far North Waters staff. Representatives of key water source asset owners, Kerikeri Irrigation Company and Northern Water Company have also consulted in the development of options.

The study provides a demand forecast to inform the timing of any necessary increases in scheme capacity. It also uses the Kerikeri network hydraulic model to study impacts on the level of service to customers as demand increases in the existing network.

Due to the high-level nature of this study, a detailed study would be required before implementing the options it sets out.

1.2 Objectives

The overall objective of this study is to determine the most appropriate solution to meet the future water needs of Kerikeri and Waipapa so that appropriate allowances can be provided for in FNDC's Long Term Plan.

A key objective is to provide a view of the Kerikeri water supply strategy for the next 30 years to inform investment decisions for the next 10 years. This will enable these decisions to be made with more confidence that the investments will ultimately support the long-term solution.

Key objectives of this study are summarised below;

- Establish the strategic case for investment
- Determine a long-term strategy for water supply to Kerikeri and Waipapa

- Identify works required in the next 30 years (and associated indicative costs) to inform FNDC's Long Term Plan with a focus on the first 10 years
- Identify further investigations and studies required to progress the strategy

1.3 Background

The Kerikeri water supply scheme has approximately 2,200 service connections supplying approximately 5,500 customers. In the 2013 census, Kerikeri was found to have a population of 6,504 and Waipapa, a population of 870.

FNDC utilises two water sources for the scheme – the Puketotara Stream and the Lake Waingaro reservoir. Lake Waingaro reservoir and its associated infrastructure are owned and operated by the Kerikeri Irrigation Company (KIC). FNDC has negotiated and annual allocation of water from the KIC to supply raw water to Kerikeri. Up to 70% of the water for Kerikeri/ Waipapa comes from KIC with Puketotara Stream making up the balance.

The Puketotara Stream is a tributary of the Kerikeri River and runs along the western edge of Kerikeri. FNDC has a consent to take water from the stream but must comply with conditions on minimum stream flows and maximum water takes. The capacity of this source is not sufficient to meet the peak water demands of Kerikeri and Waipapa. In addition, there are water quality issues at high flow. The capacity of the infrastructure at the stream source to convey flows onto treatment is less than the maximum flow allowable under the resource consent and this infrastructure needs upgrading.

Lake Waingaro is a reservoir southwest of Kerikeri that was constructed by the Ministry of Works in the early 1980's as part of an irrigation scheme. Ownership transferred to the KIC in 1990. Due to the age of the infrastructure, this source can be unreliable due to breaks in water transmission lines which disrupt supply. The reservoir is also susceptible to occasional blooms of cyanobacteria (blue green algae) which can potentially form toxins making the water unusable.

In addition to the issues with the current water sources, there are also challenges with the condition and future capacity of the WTP and constraints on the piped distribution system.

There is a concern about the impacts of drought on the current water sources as they are all surface water sources. FNDC does not have access to any groundwater sources for the Kerikeri supply.

The Kerikeri water supply scheme has a defined service area that covers parts of Kerikeri and Waipapa. However, in times of drought, the scheme is used to fill water tankers servicing properties outside the service area. The tankering activity coincides with peak demand from the service area and this places and extra demand on the capacity of the scheme.

This background sets the context of the study and some of the issues that need to be considered and resolved.

2. Strategic Case

Prior to delving into the development of probable solution, it is important to review the strategic context and identify the need for investment for the Kerikeri water supply scheme. This section reviews the national and regional governing framework for freshwater and infrastructure development to ensure that any solution proposed in the following sections is in alignment. It also implements a simplified business case approach to identify the overarching issues facing the Kerikeri water supply scheme and the benefits that would result from investing in a solution.

2.1 District Objectives

This section details the drivers and obligations that probable solutions for the Kerikeri Water demand strategy will need to incorporate and address in order to demonstrate alignment with plans for the wider district.

2.1.1 Regional Policy Statement for Northland 2018

The Regional Policy Statement (RPS) for Northland discusses a framework for the management of natural resources including land, freshwater and soils in the Northland region. The Statement recognizes the pressures on Northland's freshwater resources and on extension Kerikeri's freshwater resources which include increasing demand, climate change, requirement for higher levels of treatment due to elevated levels of sediments, nutrient and pathogens present in freshwater. It discusses climate change specifically and the consequences of these pressures impacting communities by way of increased health risks from drinking untreated water, diminished cultural and spiritual values of water and industrial constraints on water usage.

The effects of each of these pressures and consequences are currently being experienced in Kerikeri. Of specific relevance to this project are the following policies:

> *Policy 5.2.1 – Managing the use of resources*
>
> *Encourage development and activities to efficiently use resources, particularly network resources, water and energy, and promote the reduction and reuse of waste.*
>
> *Policy 5.2.2 - Future-proofing infrastructure*
>
> *Encourage the development of infrastructure that is flexible, resilient, and adaptable to the reasonably foreseeable needs of the community.*
>
> *Policy 5.2.3 – Infrastructure, growth and economic development*
>
> *Promote the provision of infrastructure as a means to shape, stimulate and direct opportunities for growth and economic development.*

The RPS clearly states its desire for infrastructure-led growth, but also requires any infrastructure investment/planning to be cognizant of any regional/sub-regional growth strategies. These policies are required to be followed via the various district plans for the region (i.e. the Far North District Plan).

2.1.2 Operative Far North District Plan 2009

The District Plan contains finer grained objectives and policies than the NPS-UD or RPS but is required to follow the directions set by those higher order documents. In particular, note the following which are relevant to the study:

Objective 7.3.1 - To ensure that urban activities do not cause adverse environmental effects on the natural and physical resources of the District.

Objective 7.3.6 - *To ensure that sufficient water storage is available to meet the needs of the community all year round.*

At a high level, these objectives provide some opportunity to consider the water supply constraints in Kerikeri when considering any plan changes or resource consents under the District Plan.

2.1.3 FNDC Long Term Plan (LTP) 2018 – 2028

The strategic priorities stated in the FNDC Long term plan (LTP) relevant to this project are:

- Affordable core infrastructure
- Address affordability
- Working in partnership with Maori to develop greater understanding of aims and aspirations, find common outcomes and develop better processes and resources.

2.1.4 Far North District Council Long Term Plan 2018 - 2028 Water Supply Asset Management Plan

This plan contains detailed information on all assets of all communities in the Far North District. It contains information on significant capital projects due to take place, specific issues facing schemes and assets and the likely growth in demand for water supply in communities across the district. It states the council's priorities for the provision of freshwater and high-quality drinking water supply.

2.1.5 Infrastructure Strategy 2018-48

The FNDC Infrastructure Strategy outlines the significant infrastructure issues facing the district, summarizes the main options for managing those issues, and then identifies the likely associated costs over the next 30 years. Of the six key infrastructure issues identified in the strategy, Kerikeri is impacted by population change, resilience and climate change, asset management and socio-economic issues.

2.2 National Objectives

This section details the drivers and obligations that potential improvement options for the Kerikeri water supply scheme will need to incorporate and address in order to demonstrate alignment with national objectives and policies for freshwater usage.

2.2.1 Central/Local Government Three Waters Reform Programme

- The New Zealand Government three waters reform programme builds on progress made through the Three Waters Review. Ultimately this will increase obligations on water suppliers to provide safe and reliable drinking water. Taumata Arowai – New Zealand's new water services regulator has been established and is tasked with administering and enforcing the new drinking water regulatory system with increased obligations and responsibilities for water service providers. . The Water Services Bill (April 2021) has passed its first reading and it proposes a new regulatory regime for managing drinking water supplies and imposes further duties on drinking water suppliers .

2.2.2 National Policy Statement on Urban Development (NPS-UD) 2020

The NPS-UD sets out national level guidance on the growth of urban settlements, with the most critical objective for this project being Objective 6. This objective provides a statutory connection to the preparation of infrastructure business cases, as well as Long Term Plans (and their associated 30-Year Infrastructure Strategies). In essence, the NPS-UD seeks that regional policy statements, district plans and associated plan changes/precinct plans all have an appropriate level of regard to infrastructure investment decisions.

2.2.3 New Zealand Drinking Water Standards

The purpose of the New Zealand Drinking Water Standards is to ensure that “Potable drinking-water, available to everyone, is a fundamental requirement for public health”. It defines the minimum standards for drinking-water quality and details the requirement for its sourcing, treatment and distribution.

2.2.4 National Policy Statement for Freshwater Management 2020

The National Policy Statement for Freshwater Management states the responsibilities outlined by central government that are required to be fulfilled by local and regional councils. The key requirements relevant to this project are to:

- Manage freshwater in a way that ‘gives effect’ to Te Mana o te Wai.
- Improve degraded water bodies and maintain or improve all others using bottom lines defined in the NPS.
- National objectives to promote environmental health and wellbeing.
- Monitor and report annually on freshwater (including the data used); publish a synthesis report every five years containing a single ecosystem health score and respond to any deterioration.

2.2.5 Resource Management Act 2002

The Resource Management Act promotes the sustainable management of natural and physical resources including freshwater. In the context of this project, sustainable management would be defined as managing use, development, and protection of freshwater resources in a way which enables the wellbeing of communities while sustaining the potential of freshwater resources to meet future demand and taking care to avoid inflicting detrimental impact on the environment. Proposed solutions for the water supply strategy of Kerikeri and Waipapa will need to incorporate the objectives of this Act to ensure compliance.

2.2.6 Health Act 1956

In regard to access to drinking water supplies, Section 2A of the Health Act states the responsibilities of FNDC as a drinking water provider, those relevant to this project are listed below:

- Every networked supplier, bulk supplier, and water carrier must ensure that an adequate supply of drinking water is provided to each point of supply to which that supplier supplies drinking water.
- require a networked supplier or a bulk supplier to ensure the uninterrupted provision of drinking water to all points of supply at all times; or
- may restrict supply to a point of supply if the relevant customer has unpaid accounts for any previous supply of drinking water or has failed to remedy water leaks that the customer is obliged to remedy; but
- must, despite any non-payment or failure referred to in paragraph (a), continue to provide an adequate supply of drinking water.

2.2.7 Local Government Act 2002

The Local Government Act further outlines the responsibilities and obligations of district councils in ensuring the sanitation and delivery of water services. In regard to decision making which significantly affects a body of water, it must consider the relationship of Māori and their culture and traditions with their ancestral land, water, sites, wāhi tapu, valued flora and fauna, and other taonga.

2.3 Business Case Approach

A simplified approach to the Treasury Better Business Case Model has been adopted to present a clear strategic case for the need to invest in the Kerikeri water supply scheme. This approach provides a structured but efficient process to set out a case that will enable FNDC decision makers to make informed decisions on the need for future investment in Kerikeri's water supply.

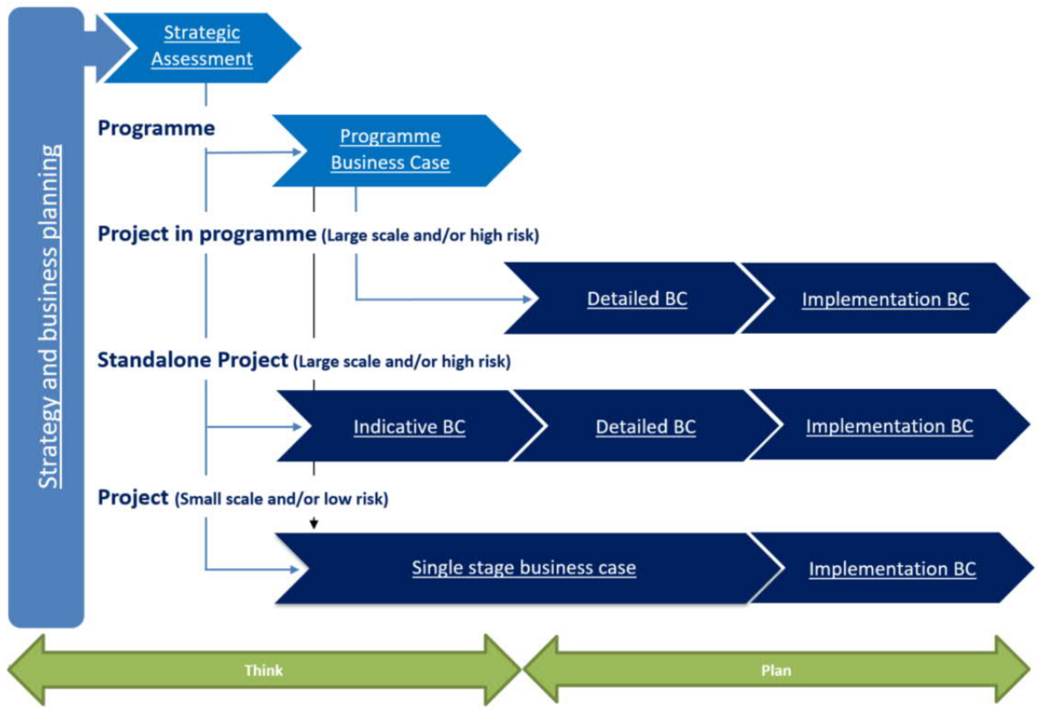


Figure 2.3-1 Treasury Better Business Case Framework

The Business Case approach provides a framework for investment at a project or programme level. The process clearly identifies the problems, the benefits of solving these problems and the likely outcomes that could be expected. This approach can be used for long term planning of the upgrade of facilities such as the WTP and that involves various projects.

2.4 The Investment Logic

A workshop was held on the 24 August 2020 with key people involved in the planning and supply of water to the Kerikeri area. In the workshop the team brainstormed "what are the problems facing Kerikeri's Water Supply?" through the Mural collaboration space. The problems, issues and opportunities identified were grouped into similar issues and refined into four problem statements. The four problem statements are:

- Problem 1: Poor historical land use and infrastructure planning integration has resulted in unplanned network and has impacted on the affordability of services (15%)
- Problem 2: Current/default rating policies and capital investment strategies for bulk water supply results in inequitable outcomes for all users (5%)

- Problem 3: Reliance on surface water and private infrastructure is not able to meet customer expectations or provide sufficient resilience. (30%)
- Problem 4: Site constraints at existing WTP presents challenges with upgrading plant/equipment while operational resulting in ageing infrastructure that is not resilient to demand and supply issues (50%)

The weightings of the problems were discussed in the workshop to identify which problems were greater than others. The weightings are shown in brackets above.

Once the problems had been identified the team were asked “what are the Benefits of solving these Problems?” Again, the team used Mural to document all the possible benefits which were grouped and summarised into the four benefits below:

- Benefit 1: More confident/ optimised planning and infrastructure investment decisions
- Benefit 2: More transparent and equitable funding mechanism
- Benefit 3: Improve resilience to climate change and security of supply of water
- Benefits 4: A more resilient water supply for now and future.

Following the workshop, the wording of the problems and benefits were refined, and the potential options to solve these problems were developed.

The problems and benefits identified are shown in the investment logic map (ILM) in Figure 2.4-1.

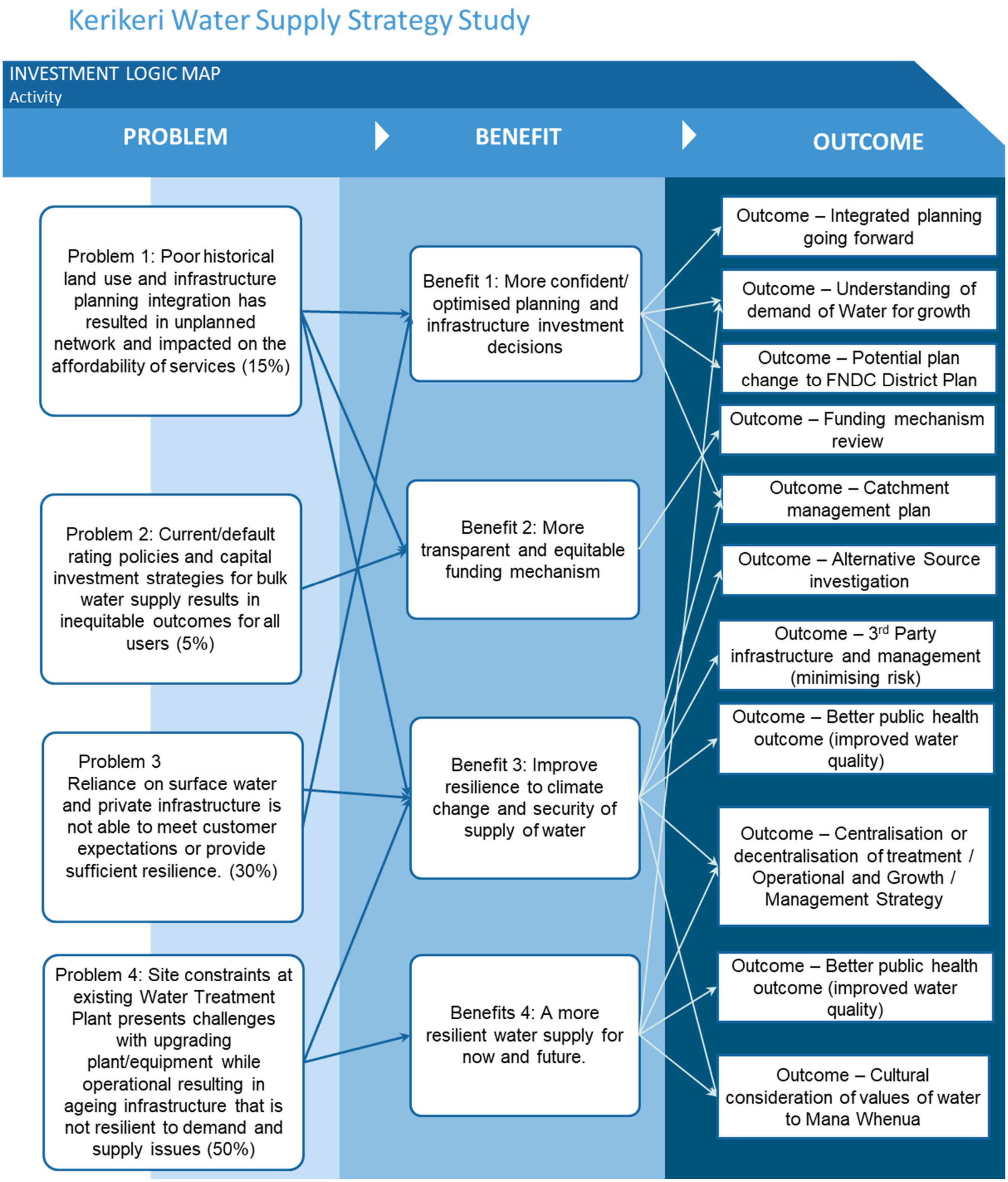


Figure 2.4-1: Investment Logic Map

2.4.1 Problem 1

Poor historical land use and infrastructure planning integration has resulted in unplanned network extensions and impacted on the affordability of services (15%)

Problem 1 was identified as a result of the increase in population in the Far North District Council area, with a specific increase in residential population in the areas of Kerikeri Central, Kerikeri South, Riverview and Waipapa. The water network currently serves some of these area as discussed further in Section 3. Table 2-1 details the population of each of these areas of which parts are on the water network. Figure 2.4-2 shows the overall growth of the Far North District population.

Table 2-1: Current population, land area and density served by Kerikeri Water Supply

Area	Population (2018 usual residents	Land Area (in hectares_	Population Density (person per hectare)
Kerikeri Central	3,493	371	6.72
Kerikeri South	2,550	1,547	1.65
Riverview	2,109	622	3.39
Waipapa	873	916	0.95

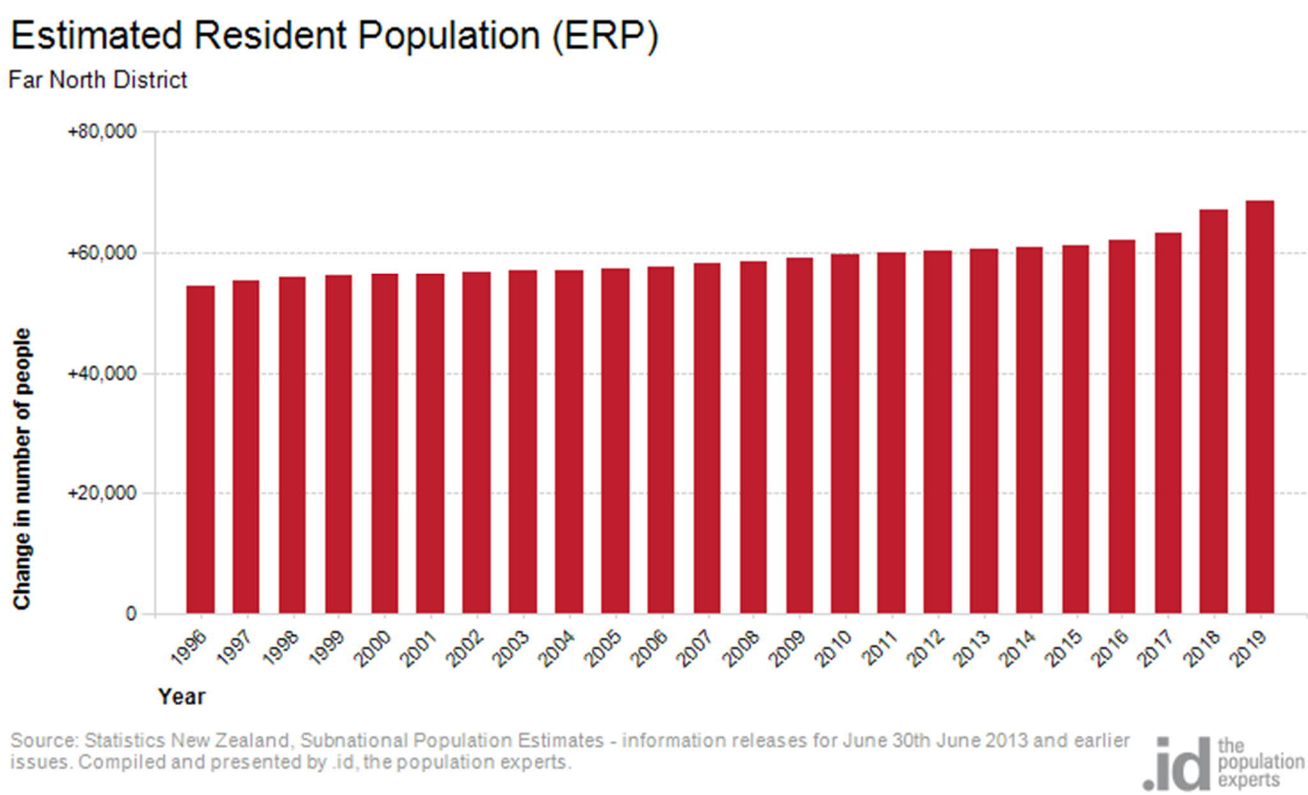


Figure 2.4-2: Population Estimates for Far North District Council Area

Over the last few years, a greater number of requests to join the Kerikeri water supply have been made through the conversion of agricultural and orchard land into life style blocks. The lack of land use planning to define where this can occur has resulted in these new properties unable to be connected to the water supply. The infrastructure required to support these new areas has not been planned for, and the very low density of the population outside Kerikeri Township results in a high cost of infrastructure per new connection. With the lack of integrated water infrastructure network and land use planning, the existing network is also undersized to provide reliable water supply. The lack of long-term land use and infrastructure planning has resulted in the development of an unplanned water network and with costly maintenance and expansion.

2.4.2 Problem 2

Current/default rating policies and capital investment strategies for bulk water supply results in inequitable outcomes for all users (5%)

During periods of drought and low rain levels, the surrounding rural areas rely on the Kerikeri water supply scheme to supply bulk water to replenish rural water tanks. These demands are generally highest over the summer months (as shown in Figure 4.4-1) when the scheme is under most pressure. The price charged to users for the bulk water covers only the unit cost of its treatment. It does not include the costs to develop, operate and maintain the wider Kerikeri water supply scheme infrastructure or any investments to upgrade it to meet current and future demands. These costs are funded by customers directly connected to the scheme. High demand by bulk water tankers is causing level of service issues by lowering network pressure. The cost to fix network issues currently lies with connected customers.

Therefore, there is an inequity as the cost of the bulk water only covers the treatment cost, and not any of the capital costs including the treatment plant and network restoration. The local residents and business that are on the town supply and in the scheme's official service area, pay a targeted rate which funds the scheme's operation, maintenance and capital investments. This therefore has an inequitable outcome where those in the service area are subsiding bulk water supply tankers under the current arrangements.

Consideration could be given to users outside the service area paying a unit rate that includes a share of the wider scheme costs.

2.4.3 Problem 3

Reliance on surface water and private infrastructure is not able to meet customer expectations or provide sufficient resilience (30%)

The Kerikeri water supply scheme currently utilises two sources of water:

- Puketotara Stream
- Lake Waingaro

Both of these are surface water sources. During a period of low rainfall, the levels in the stream drop and this results in a lower volume of water being available for intake into the treatment plant. Also, high flows in the stream lead to elevated turbidity levels which impact on the treatment plant performance.

Lake Waingaro is a private reservoir built for the main purpose of providing water for irrigation to the surrounding orchards. It is owed by the KIC, a private company owned by shareholders who generally hold land within the scheme's distribution area. Over the last year the very dry conditions have resulted in the rupture of the main KIC distribution pipeline which feeds water to FNDC's connection point. The reservoir has an unprotected catchment area and is prone to algal blooms which make treatment for drinking water more difficult.

As both of these sources rely on surface water during periods of drought, both sources are likely to be affected by climate change. The availability of water supply and the demand for water is provided in more detail in Section 3.2. This problem has identified that both sources have issues with supply during drought, along with other issues that affect the resilience of the supply.

2.4.4 Problem 4

Site constraints at existing WTP presents challenges with upgrading plant/equipment while operational resulting in ageing infrastructure that is not resilient to demand and supply issues (50%)

Problem 4 highlights deferred asset renewal at the WTP partly due to uncertainties with respect to the future needs and strategy of the Kerikeri water supply scheme.

The existing site of the WTP is large, but due to the steep topography the majority of the remaining site is unusable without some civil works to create building platforms. As a result, the plant has limited available space to expand to replace aging infrastructure while maintaining the operations of the plant.

Key process elements such as the clarifier and sand filters are at the end of their serviceable life and require replacement.

There is a need to understand how immediate works to improve the plant will align with the future needs of the scheme with respect to increased treatment capacity and treatment plant location.

2.4.5 Benefits

Though the workshop the team identified what the benefits would be if the problems were solved. Four benefits where identified as follows:

- Benefit 1: More confident/ optimised planning and infrastructure investment decisions
- Benefit 2: More transparent and equitable funding mechanism
- Benefit 3: Improve resilience to climate change and security of supply of water
- Benefits 4: A more resilient water supply for now and future.

By proposing solutions to allow these benefits to be realised they will resolve the problems identified. Many of the benefits relate to more than one problem so the key is to understand how to measure the benefits and what the targets should be. The measures or key performance indicators (KPIs) for the benefits will need to be defined based on what is achievable in the short, medium and long term and will depend on the solutions identified.

2.4.6 Outcomes

A number of outcomes were identified that would support the realisation of benefits. These include:

- Integrated planning going forward
- Understanding of demand of Water for growth
- Potential plan change to FNDC District Plan
- Funding mechanism review
- Catchment management plan
- Alternative Source investigation

- Third Party infrastructure and management (minimising risk)
- Better public health outcome (improved water quality)
- Centralisation or decentralisation of treatment / Operational and Growth / Management Strategy
- Better public health outcome (improved water quality)
- Cultural consideration of values of water to Mana Whenua

The above outcomes will form the basis of the options development. They seek to respond to both the problems and the benefits at a high level, without determining a solution at this stage in the process.

3. Existing Kerikeri Water Supply Scheme

The existing Kerikeri water supply scheme supplies potable water to approximately 2,200 service connections and 5,500 customers in the Kerikeri and Waipapa. The scheme's service area covers the majority of the Kerikeri township and Waipapa but excludes some areas such as the residential properties south of the Kerikeri Inlet off Kerikeri Inlet Rd. The network is shown in Figure 2.4-1.

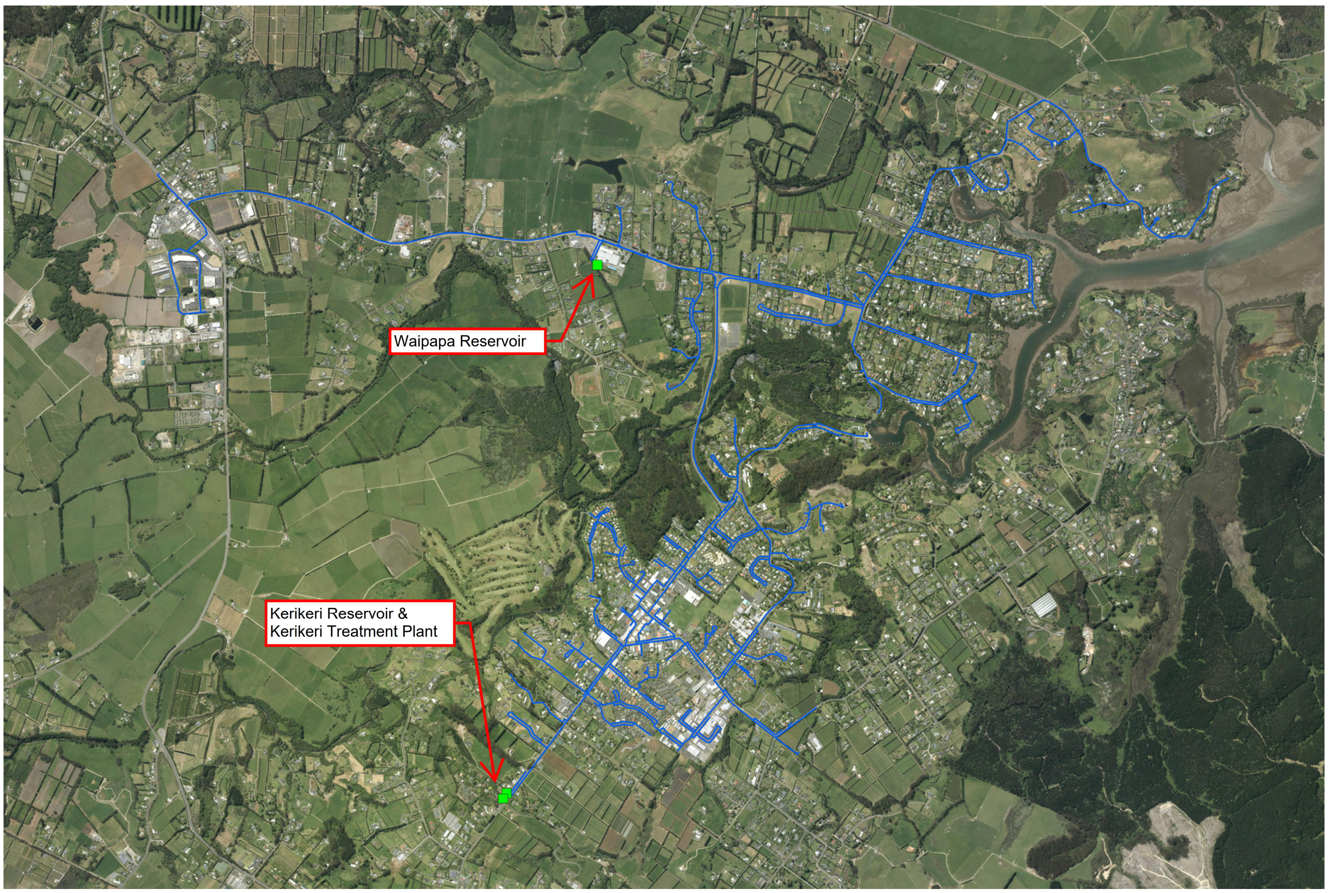


Figure 2.4-1: Existing Kerikeri Potable Water Network (Reservoirs in Green)

3.1 Demand

The demand in the Kerikeri network is seasonal with significantly larger demand in summer compared to average demand through-out the year. This is most likely due to higher populations and increased water use for irrigation over the summer months. Another key factor in peak summer water demand is the practice of water tankers utilising a tanker filling station at Waipapa Reservoir. These tankers supply customers operating on rainwater tanks that are outside the scheme's designated service area. This effectively increases the population serviced by the scheme during dry periods and leads to the sustained 5-day average peak summer demand being significantly higher than average summer demand. The existing network struggles to meet the required Level of Service (LoS) during these periods and this impacts adversely on the level of service to its customers.

The current and future demands for the Kerikeri scheme are assessed in detail in Section 4.

3.2 Water Sources

The Kerikeri water supply scheme utilises two water sources:

- Puketotara Stream
- Lake Waingaro

Lake Waingaro is the primary source into the WTP with the Puketotara Stream acting as a minor, secondary (often supplementary) source during high demand periods or when water quality from Lake Waingaro is poor due to algal blooms. Approximately 70% of the scheme's water is sourced from Lake Waingaro with the balance supplied from the Puketotara Stream. The demand projections stated in Section 4 discuss the future supply requirements for the Kerikeri – Waipapa scheme and highlights the need for multiple sources to maintain resilience and redundancy within the scheme.

3.2.1 Puketotara Stream

The Puketotara source is the only source for the Kerikeri scheme that FNDC has direct access to. Water is sourced from the Puketotara Stream under a water take consent FNDC has from the NRC. This allows up to 2,100 m^3/day to be abstracted.

A renewal for this consent is currently lodged with NRC. It proposes the following take limits as referenced in the FNDC Memo 'Resilience for Puketotara Water Take;

- 3,200 m^3/day for 28 days per year = 89,600m^3
- 2,400 m^3/day for 28 days per year = 67,200m^3
- 960 m^3/day for 309 days per year = 296,640m^3.

The water take consent is subject to certain conditions such as maintaining minimum residual flows in the stream. These can restrict the times and volumes that water can be abstracted from this source.

Water is abstracted from the stream using a well with submersible pumps that pump the raw water through a rising main to the Kerikeri WTP. The Puketotara stream only contributes to ~30% of Kerikeri scheme water supply and despite being Council's only direct source, it cannot be considered to be the primary source of the Kerikeri scheme. Between March 2020 and March 2021, a total of the 684,167 m^3 were extracted from the Puketotara stream and Lake Waingaro reservoir. The Puketotara stream was responsible for only 31% or 214,266 m^3 of the total quantity of water extracted.

3.2.2 Lake Waingaro Reservoir

The Lake Waingaro Reservoir southwest of Kerikeri forms part of the Kerikeri Irrigation Scheme and is owned and operated by the KIC. FNDC contract with KIC to receive an annual allocation of 736,000m^3/ year of raw water. The irrigation scheme includes a distribution system that KIC also own and operate.

FNDC have a metered connection point on the KIC distribution at the intersection of Kerikeri Rd and Maraenui Drive. Upstream of this point, raw water is conveyed from the reservoir via predominantly AC pipes along a route that passes under the Bay of Islands airport before connecting to Wiroa Road and Kerikeri Road. This pipeline is a 375 mm diameter asbestos cement (AC) pipe at the FNDC connection point and flow through the connection is limited 30l/s to avoid adverse pressure drops to other KIC users. The maximum draw is 2,592 m^3/day.

From the KIC connection point, an FNDC raw water pipeline runs along Kerikeri Rd to connect with the Kerikeri WTP.

3.3 Water Treatment Plant

The Kerikeri WTP pictured in Figure 3.3-1 is located at 398 Kerikeri Road, Kerikeri. The plant is operated on behalf of FNDC by Ventia and has been servicing the Kerikeri and Waipapa townships since it was erected in the 1970's. The plant receives raw water from Puketotara stream and Lake Waingaro, the treatment process is comprised of the following unit processes;

- Pre pH Correction – Via the addition of soda ash to balance pH and also for mineral precipitation
- Coagulation – After initial pH adjustment raw water is dosed with a coagulant Polyaluminium chloride (PACL)
- Flocculation - Crystalfloc is dosed at the inflow into the clarifier to support solid settling in raw water
- Clarification – Settling of larger solids takes place at the clarifier
- Sand Filtration – suspended solids are further filtered by the sand filters
- UV Disinfection - to inactivate any bacteria and protozoa remaining in the stream
- Chlorination – to provide further disinfection to the treated water stream

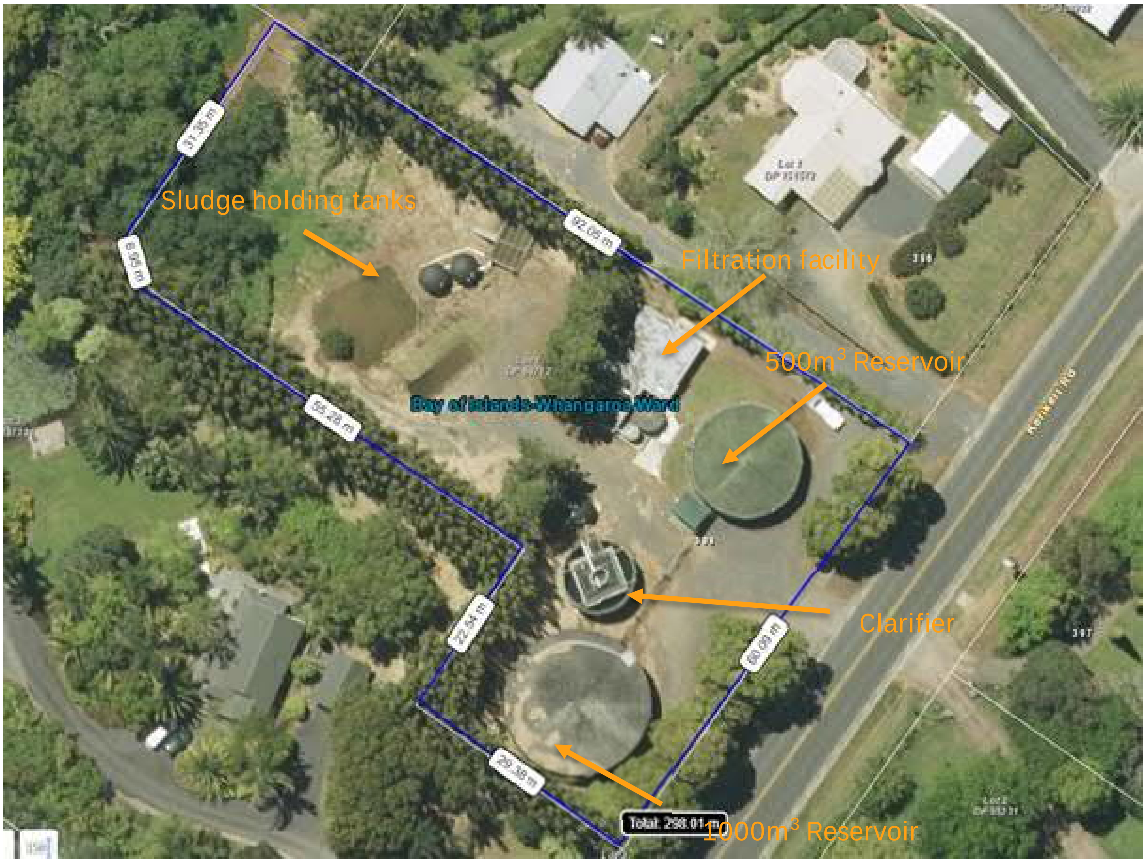
▪ 

Figure 3.3-1 Aerial view of the Kerikeri WTP

Waste flows and sludge from the clarification and filtration units are routed to the waste holding tanks before being routed to the sewer. The filters are backwashed fortnightly with waste flows deposited into the sewer. Under discharge consent AUT.007409 the Kerikeri WTP has approval to discharge backwash water from the clarifier to the Puketotara stream under the following conditions;

(a) A maximum volume of 200 cubic metres per day.

(b) A maximum discharge rate of 15 Litres per second.

(c) A maximum frequency of two times per year

Issues

The rated capacity of the treatment plant is 3,500 m^3/day, however the plant is it is currently underperforming due to a number of issues which include:

1) Aging process equipment.

   a. The structural integrity of the clarifier is compromised, it is current being held together with structural wrapping.

   b. The sand filters are aged and deteriorated.

2) Raw water increasingly difficult to treat – this is due to the higher levels of sediment carryover and algal bloom related toxins being present in the raw water intake. This issue is likely to worsen as the effects of climate change heighten across the district.

3) The intake pipelines are aged and prone to breaks and air entrainment.

An overarching issue is the lack of usable footprint and challenging site topography which make upgrading the plant difficult There are also topographical issues at the current WTP site and there is limited footprint available for any upgrade or plant expansion. Should upgrades take place at the existing site, it would be important to consider how existing equipment would be incorporated, retrofitted or replaced.

3.4 Storage & Transmission

Treated water from the WTP is stored within the network within three reservoirs;

- Kerikeri Reservoir 1 at Kerikeri WTP (500m^3 with top water level 110.52m)
- Kerikeri Reservoir 2 at Kerikeri WTP (1,000m^3 with top water level 111.22m)
- Waipapa Reservoir on Waipapa Rd near Seeka Kerikeri (1,790m^3 top water level 68.88m).

Water from each reservoir is pumped into one of three distinct supply zones;

- Kerikeri: Operating Head of ~122m
- Riverview: Operating Head of ~104m
- Waipapa: Operating Head of ~124m.

The flows from the WTP are pressure boosted and supply the demand within Kerikeri zone and also fill Waipapa Reservoir as required. Flows from the Waipapa Reservoir are then separately pressure boosted again and supply the Riverview zone or Waipapa zone independently.

A key feature of the network is a central spine of watermain that runs along Kerikeri Rd and Waipapa Rd linking the reservoirs. The network pressure level of service of 25m is not consistently met during high demand periods suggesting improvements to the network, and this spine in particular, will be required to accommodate increased future demand.

4. Kerikeri Water Demand Forecast

4.1 Overview

The Kerikeri water supply scheme comprises three different distribution zones which have the following characteristics;

- Kerikeri (predominantly residential)
- Riverview (predominantly residential)
- Waipapa (predominantly commercial / industrial).

The potable water network supplies approximately 2,200 service connections with a population of approximately 5,500.

As described in Section 3.1, a key feature in peak summer water demand is the impact of water tankers utilising a tanker filling station at Waipapa. This effectively increases the population serviced beyond the scheme's service area and leads to the sustained 5-day average peak summer demand being significantly higher than average summer demand.

The current network is understood to be unable to maintain the required level of service during high demand days warranting a review of the network and identification of the required changes to service higher demand in future.

4.1.1 Historical Trends

To assess future demand, historical trends in the Kerikeri scheme have been analysed to identify three key scenarios which characterise how the scheme is utilised throughout the year. These are;

- Average Annual Water Consumption
- Average Summer Water Consumption
- Sustained (5-day average) Peak Water Consumption.

Historical trend data of the metered flows entering the WTP have been used to determine the Kerikeri water demand. This assumes that all flows which enter the WTP enter the scheme's water network which is necessary given the limited information provided regarding flows exiting the treatment plant. Two water sources currently supply the WTP;

- Lake Waingaro Source: Primary Inflow
- Puketotara River Source: Secondary Inflow.

Flows into the WTP are monitored on a daily basis and have been used to determine the typical and sustained peak water demand in the Kerikeri water supply scheme. The raw WTP inflow data is displayed in Figure 4.1-1.

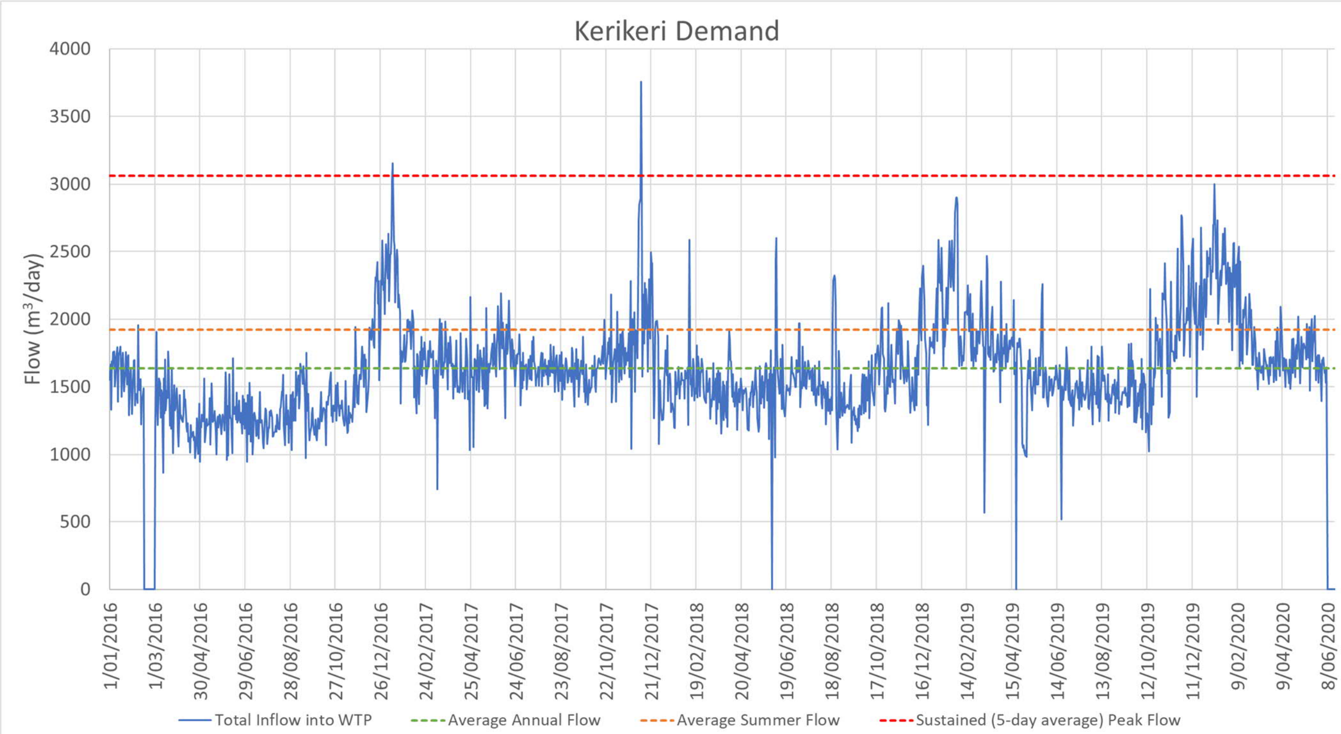


Figure 4.1-1: Total Flows into WTP since 2016 (Source: KerW Logbook.xlsx)

Based on the raw WTP flow data in Figure 4.1-1, the average annual flow has been calculated by a simple average, excluded days where no data was recorded. Over this time period, the average consumption in Kerikeri was 1,635m^3/day (Green line as per Figure 4.1-1).

The average summer demand has been determined to be 1,920m^3/day by averaging the flows in summer months (Dec / Jan / Feb). This is shown as the orange line per Figure 4.1-1.

One key feature of the demand data for the Kerikeri scheme is the presence of peaks which are significantly greater than the summer average. Whilst the treatment plant is not required to match the largest single day demand in the network (due to storage in the network acting as a buffer), it must be able to match any sustained high demand which occurs for multiple days. To account for this, a 5-day average has been calculated from the raw data to identify the highest sustained demand within the network. The highest (5-day averaged) peak demand over the records reviewed occurred in early December of 2017. Over this period, the 5-day averaged demand was 3,059m^3/day. This demand can be considered as the approximate required capacity of the Kerikeri WTP in 2020 to supply flows during a sustained high demand period.

Table 4-1 summarises the demand scenarios which characterise demand in 2020 and have been utilised for demand forecasting.

Table 4-1: Characteristic 2020 Demand

Scenario	Demand
Average Water Demand	1,635m^3/day
Average Summer Water Demand	1,920m^3/day
Sustained Peak Water Demand	3,059m^3/day

4.1.2 Expected Growth

Using the demand characteristics calculated for 2020, the values in Table 4-1 can be used as a basis to forecast into the future with the use of a predicted growth rate. This study has used a growth rate for Kerikeri demand of ~2% which is based on FNDC's current population projections for Kerikeri (.idcommunity, 2019).

A check to see if this growth rate is representative of the Kerikeri scheme has been carried out by comparing trends in average annual demand and average summer demand values over 2008 to 2018 period. The values used were taken from the document "DRAFT Kerikeri Water Management Plan Draft with FNDC Comments.docx". This analysis is shown in Figure 4.1-2.

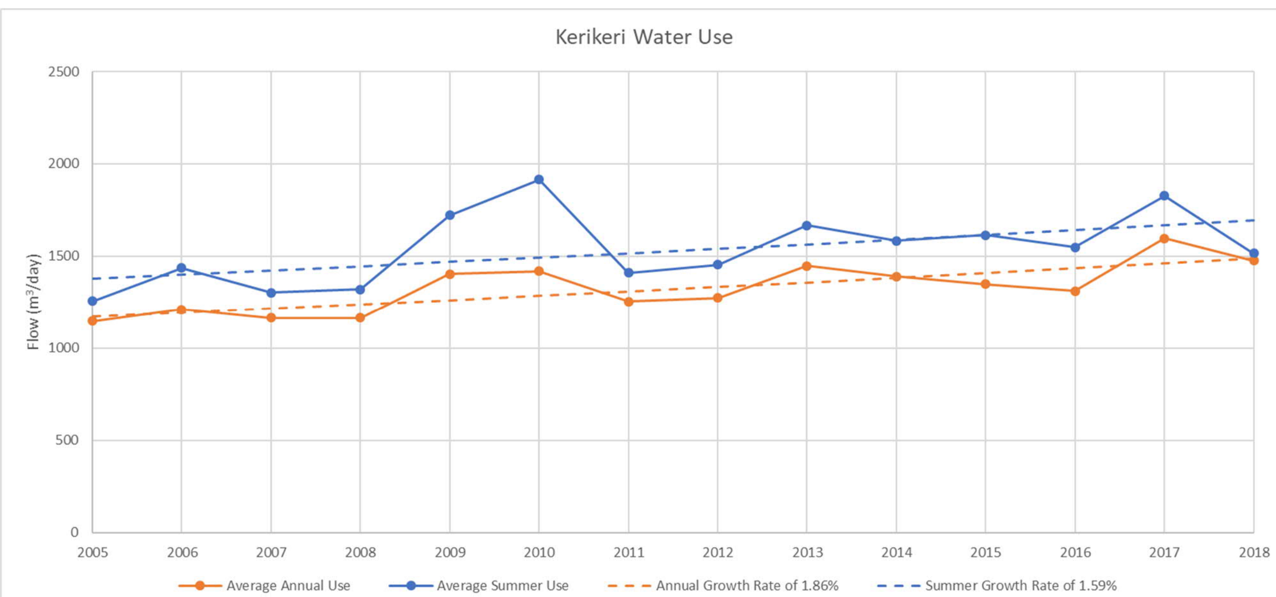


Figure 4.1-2: Demand Change (and Growth Rate) from 2005 - 2018

A 'best fit' growth rate has been matched to the annual demand over this period for annual averages and summer averages to give the following growth rates:

- Average Annual Use: 1.86% growth rate
- Summer Average Use: 1.59% growth rate

Whilst neither of these historical growth rates perfectly match FNDC's 2% population growth forecast, it provides a rough confirmation that this growth rate is representative of observed historical trends in water demand for the Kerikeri scheme.

A 2% growth value has been applied to all demand components including residential, 10-hour consumers and 24-hour consumers as more discrete information on these is not currently available.

4.2 Residential

FNDC's approach to future residential development in Kerikeri and Waipapa will be to encourage development within those areas currently zoned residential. No significant increase in the current residentially zoned area is proposed. FNDC also have a preference to maintain the current service area for Kerikeri's water supply scheme i.e. not to extend this area beyond its current boundaries.

FNDC analysis suggests that Kerikeri has sufficient latent residential capacity to meet future population increase over the period from 2020-2045 within undeveloped residential zoned land inside the current service area.

At this stage billing data specifying the customer type (residential / commercial / industrial) is not available to allow specific demand and growth residential customers.

From the above, this study assumes the location of the residential demand will remain similar to the present but with its consumption increasing at the 2% growth rate as per Section 4.1.2.

4.3 Commercial & Industrial

FNDC are in the process of developing spatial data for the expected future locations of commercial and industrial areas within the Kerikeri/ Waipapa region. These are there still to be confirmed.

For this study, the growth of commercial and industrial demand has therefore been assumed to be 2%, in line with the assumed population growth rate as per Section 4.1.2.

4.4 Supply to Water Tankers

Water tankers are known to use the Kerikeri water supply scheme to supply properties in the wider region outside the service area. Typically, these properties rely on rainwater tanks as their primary source of water and can run out of water during dry periods. This effectively increases the demand on the scheme during periods of prolonged low rainfall.

The supply to the tankers comes from the treated water output from the Kerikeri WTP and is therefore captured in the values in Table 4-1. Given that the tankers can have a significant influence on the sustained summer peak demand, a greater understanding of this component of demand is warranted. In recent summers, a number of FNDC's water supply schemes across the Far North District have suffered from water shortages and the Kerikeri scheme has been relied upon as an alternate source of water in some cases. This extra demand on the Kerikeri scheme adversely impacts on its levels of service. However, the inverse scenario also takes place in some instances where bulk supplies from other schemes have been used to supplement thee Kerikeri scheme.

FNDC provided Figure 4.4-1 which details the flows to bulk tankers over the previous five years. The flows are low for the majority of the year, however in January of each year can be up to approximately 7,500m^3/month (average of 250m^3/day). This is a significant amount of flow in the network when compared to the average summer flow of 1,920m^3/day per Table 4-1.

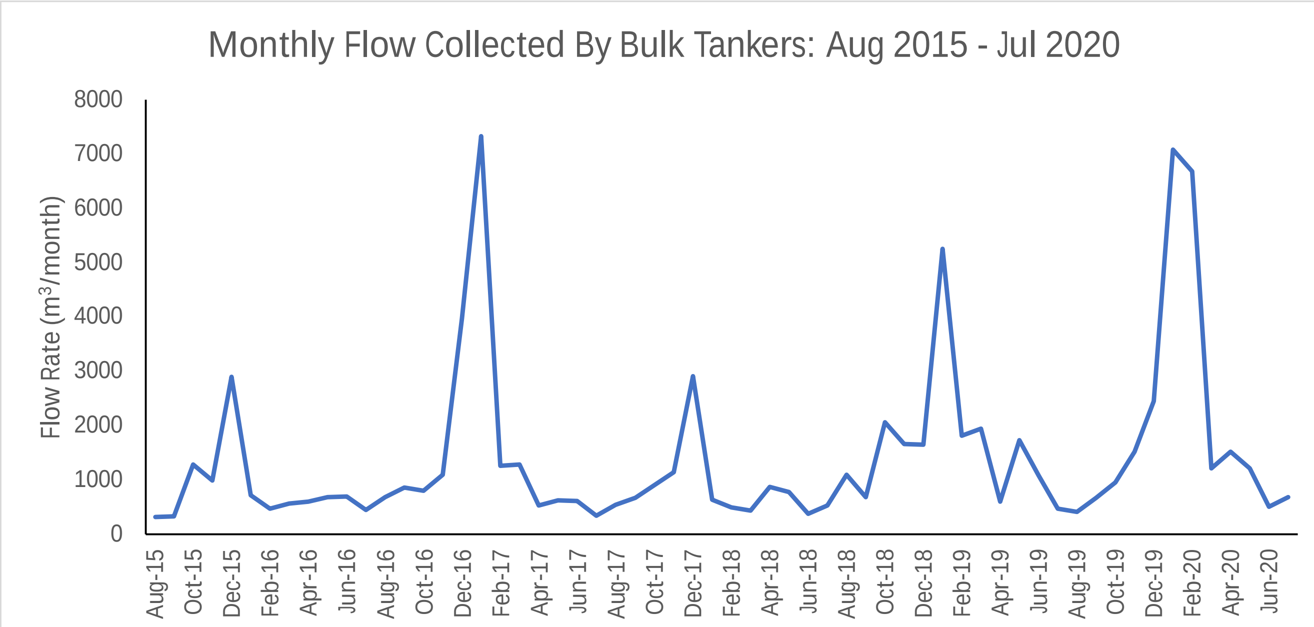


Figure 4.4-1: Tanker Flows from Kerikeri Network

The location of the tanker fills is understood to be from the Waipapa reservoir. It is unclear if the connection to the network is upstream of the reservoir (hydraulically from the pumped Kerikeri distribution zone) or downstream of the reservoir (hydraulically from either the pumped Riverview zone or from the pumped Waipapa zone). FNDC have noted that when tankers fill, the pressure within the network can drop significantly. It is therefore expected that the tankers may be drawing from the inlet into the Waipapa reservoir (hydraulically from the pumped Kerikeri distribution zone). If this is the case, the tanker would require significant amounts of flow through long distances of piping which would generate losses. This could explain the related poor network performance (relative to the required Level of Service) that has been observed. Further investigation is required to confirm how the tanker filling point is configured with respect to the optimal hydraulic arrangement.

It is generally recommended that tanker filling point be located *immediately* downstream of a reservoir connected via large bore piping (or dedicated piping with pumps) to limit their effect on the network. Hydraulically, it is preferable for the tankers to draw from the reservoir at the WTP to prevent pumped flows being transferred between tanks unnecessarily.

4.5 Forecasted Demand

Demand forecasts have been prepared based on the 2020 demand characteristics for annual average demand, summer average demand and sustained (5-day average) peak demand as per Table 4-1. The 2% annual growth (per Section 4.1.2) has been applied to these demands to forecast future demand.

4.5.1 Profile

The forecasted demand profiles are summarised in Figure 4.5-1.

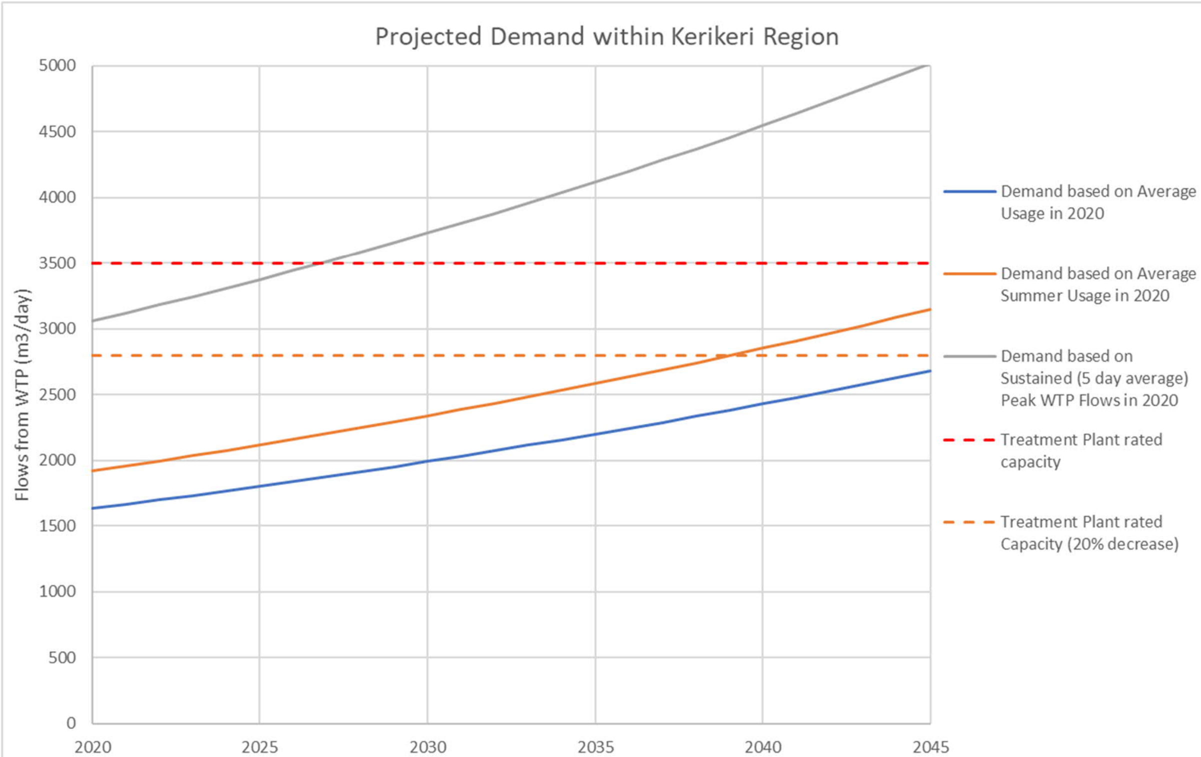


Figure 4.5-1: Projected Demand Curves

The Water Supply Plan for Kerikeri discusses future flows to 2043, when the forecast demand would be ~4,850m^3/day. The forecast demand reaches 5,000m^3/day in 2045. For simplicity, an ultimate flow of 5,000m^3/day has been selected for design. It should be noted that there are a number of assumptions in this forecast demand as discussed in Section 4.6.4 below.

The current Kerikeri treatment plant has a rated capacity of 3,500m^3/day. Based on Figure 4.5-1, the existing treatment plant capacity would be unable to provide the required sustained (5-day average) peak flows past ~2028. Strategies to defer treatment plant upgrades (by managing demand) are discussed in Section 4.6.

4.6 Demand Management

One unique feature of the demand in Kerikeri is the seasonal demands causing the sustained (5-day average) peak flows to be significantly greater than the summer average flows. This is of particular interest as it drives the capacity requirement of the WTP. Due to the sustained nature (at least 5 days) of these peak flows, it is not practical for this demand to be balanced solely with storage (due to concerns such as water age). High flows over these periods therefore bring forward the need for upgrades in treatment plant capacity to service the relatively infrequent peak demand. Significantly lower capacity is required for most of the year. If this difference between the peak and the average summer demand can be reduced, the requirement to upgrade treatment capacity can be pushed further out into the future.

Possible explanations for this elevated sustained peak demand could be the tanker filling activities and/or an increase in visitors. This issue warrants further investigation as lowering this peak presents a significant opportunity to reduce capital investment.

Demand management is therefore an important tool to use in managing the need for treatment capacity upgrades and other infrastructure upgrades within the Kerikeri water supply scheme. Demand management could lower the peak demand closer to the average summer demand, allowing deferral of treatment works upgrades. It effectively pushes the water demand curve in Figure 4.5-1 to the right, further out in time.

Demand management can comprise a number of different initiatives and is typically captured in a Water Demand Strategy. Two key areas of focus are water consumption and non-revenue water (NRW) which can include leakage from the network.

4.6.1.1 Consumption

Water consumption is often expressed as per capita consumption expressed as litres/ head/ day (l/h/d). Actual consumption is influenced by a range of factors, including the amount of wet industry in the community and behaviours with respect to water conservation. In NZ, a typical target value for consumption is 200 l/h/d.

Based on the approximate number of residents within the Kerikeri scheme's service area, the amount of water consumed per person is roughly 300 l/h/d for the average annual demand, 350 l/p/d for the average summer demand and 560 l/p/d for the peak summer. These values suggest that there is room to reduce consumption through demand management. It is noted that the peak summer 560 l/p/d could be distorted by the tankers filling or increased 'effective' population from tourism, as discussed previously.

Raising community awareness of the impacts of high-water usage may assist in minimising the peak in residential usage during high demand days in summer and could form part of a water demand strategy.

Developing a specific management plan for water tanker filling operations with the aim of avoiding filling during the sustained summer peak could also be beneficial. The aim here would be to spread out peak loading.

These initiatives, amongst others, would assist in lowering the sustained peak demands observed in summer and could defer treatment plant upgrades.

4.6.1.2 Non-Revenue Water Loss

The NRW in the Kerikeri scheme is currently 26% of that produced at the WTP. NRW is the difference between water produced at the treatment plant and delivered to the supply network and that measured as consumed through customer meters. Although a significant proportion of this will be through leakage of the network, it will also include use of water through hydrants and can be influenced by data quality and measurement issues.

However, 26% NRW does suggest a significant loss of the water and the potential opportunity to reduce leakage. A more proactive renewals program including identification and replacement of problematic mains could potentially decrease the sustained peak demand and annual average demand which would assist in deferring treatment plant upgrades and the need to seek increases in current water sources.

4.6.2 Demand Management Summary

Kerikeri has relatively high per capita consumption rates over summer and an NRW value of 26%.

Given the apparent potential to reduce water demand within the Kerikeri service area and the significant benefits this could offer, the development and implementation of a water demand strategy is recommended.

Reducing demand will take the pressure off existing water sources and/or allocations and delay the need to provide increased treatment capacity.

4.6.3 Proposed Staging of Capacity Upgrade

The forecasted demand curve is a key planning tool and drives the requirement for new infrastructure investment. As water demand increases, there is a need to ensure that this can be met by the available supply. It is good practice to plan for adequate supply to be in place ahead of the forecast demand requirement, together with its supporting infrastructure i.e. to be ahead of the demand curve. This approach ensures that available supply is always more than the demand. Practically, capacity is increased in steps which can align with the modular nature of the associated treatment facilities and the implementation of discrete capacity upgrade projects.

To ensure efficient infrastructure investment, it is important not to provide the increased capacity unnecessarily early. However, there is also a need to provide contingency with respect to time for unanticipated delays in delivering the increased supply and new infrastructure. The time required for any necessary design, consenting, construction and commissioning must also be allowed for ahead of the capacity coming online.

Considering the above, a judgment must be made as to when a step up in capacity is required and how many steps there should be. The level of confidence in the information upon which the demand curve is based, together with the sensitivity of the curve to factors which may change over time are important considerations in this judgement.

The proposed approach to staging the increases in capacity for Kerikeri is set out below using the current water demand forecast. There is a matter of urgency with the first step, but there is more time to consider the second step - this allows refinement of the demand curve and the timing of the second step as more information becomes available over time. Depending on the option chosen to achieve the second step capacity increase, an allowance of up to 5 years lead in time should be made prior to the step. This allows time to undertake a detailed feasibility study, secure any necessary property, complete design, obtain consents, construct and commission the new works.

The first step addresses the immediate issues with the current Kerikeri WTP to bring the condition of the asset to an acceptable level and to increase its capacity to 4,000 m^3/day. This is 500 m^3/day above its current rated capacity for Kerikeri WTP of 3,500 m^3/day. Implementation of this step is required as soon as possible to reduce risk of plant failure.

The proposed second step would take capacity up to 5,000 m^3/day with a timing of around 2033. This point occurs when the current project demand exceeds the proposed 4,000m^3/day upgraded capacity of the Kerikeri WTP. Implementation of a demand management plan could potentially allow the second step in capacity increase to be delayed. A 1,000 m^3/ day increase in capacity is relatively small and it may be more optimal to increase capacity in a greater step. Further consideration of this timing and the size of the capacity increase can be made as more information becomes available through detailed feasibility studies.

The proposed staging of treatment plant capacity increases and how they align with the current demand forecasts is shown in Figure 4.6-1.

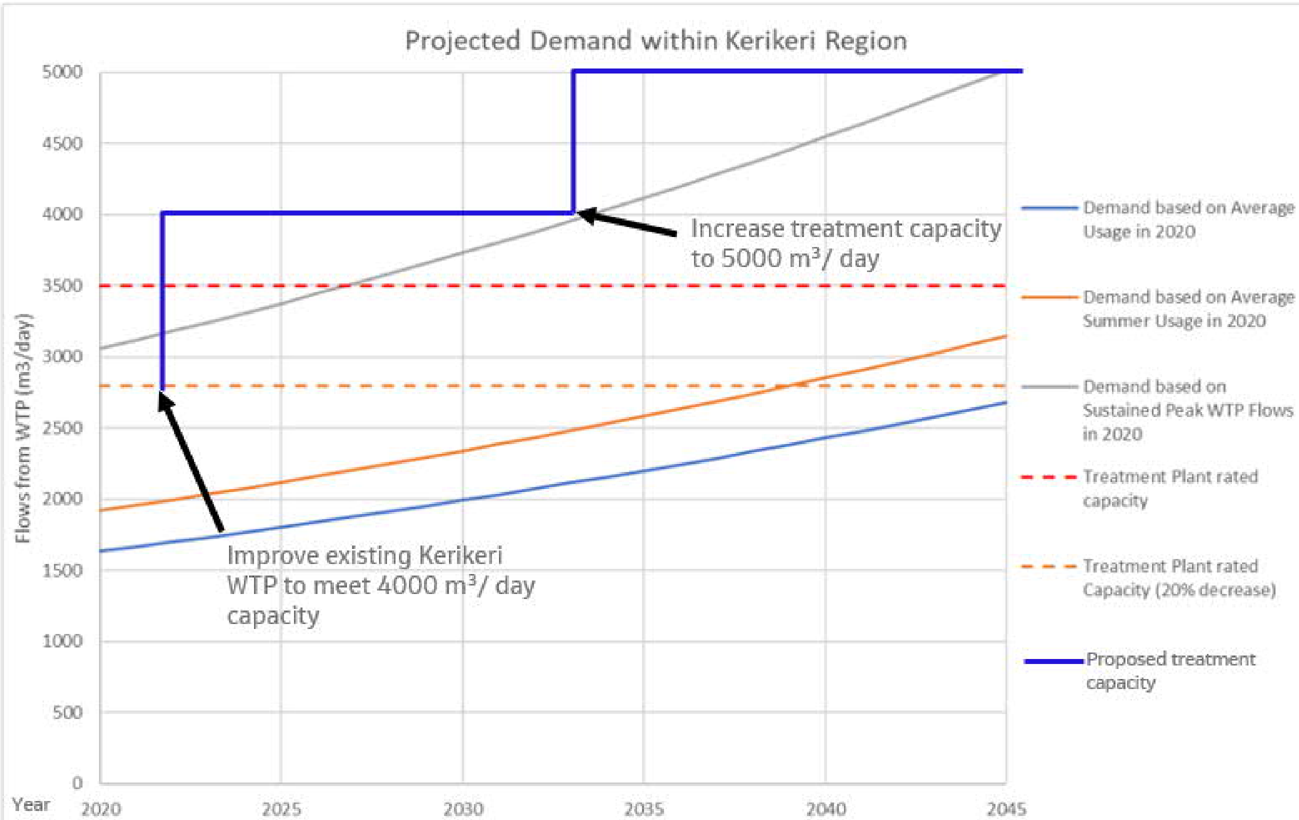


Figure 4.6-1: Staging of Treatment Capacity Upgrades

4.6.4 Key Assumptions and Sensitivities

The demand forecasting is predicated upon certain assumptions, the most key of which are summarised below:

- The 2016-2020 usage data used to characterize the 2020 demand figures is assumed to be a realistic representation of how the network will continue to be operated in future.
- The value of 2% growth has been assumed as per FNDC reports and advice. Potential variations to this are discussed in Section 4.6.5.
- The location of future increases in Residential / Commercial / Industrial demand has been assumed at the same location as the existing demand with a higher magnitude. If the location of the future demand is significantly different then the network may become stressed in different areas. Once the District Planning team at FNDC have completed spatial forecasting (currently ongoing), its effects should be considered before actions from this report are implemented.
- The amount of Commercial growth could not be provided and has been assumed as 2% based on the information from FNDC. If the results of the District Planning team's work provide a more appropriate value, this should be considered before actions from this report are implemented.

4.6.5 Sensitivities

Demand forecasting is highly sensitive to changes in some of the assumed values, most notably the population growth rate. This study has assumed a growth rate of 2%. Figure 4.6-2 demonstrates the range of potential demand curves if the growth rate is varied between 1.5% and 2.5%.

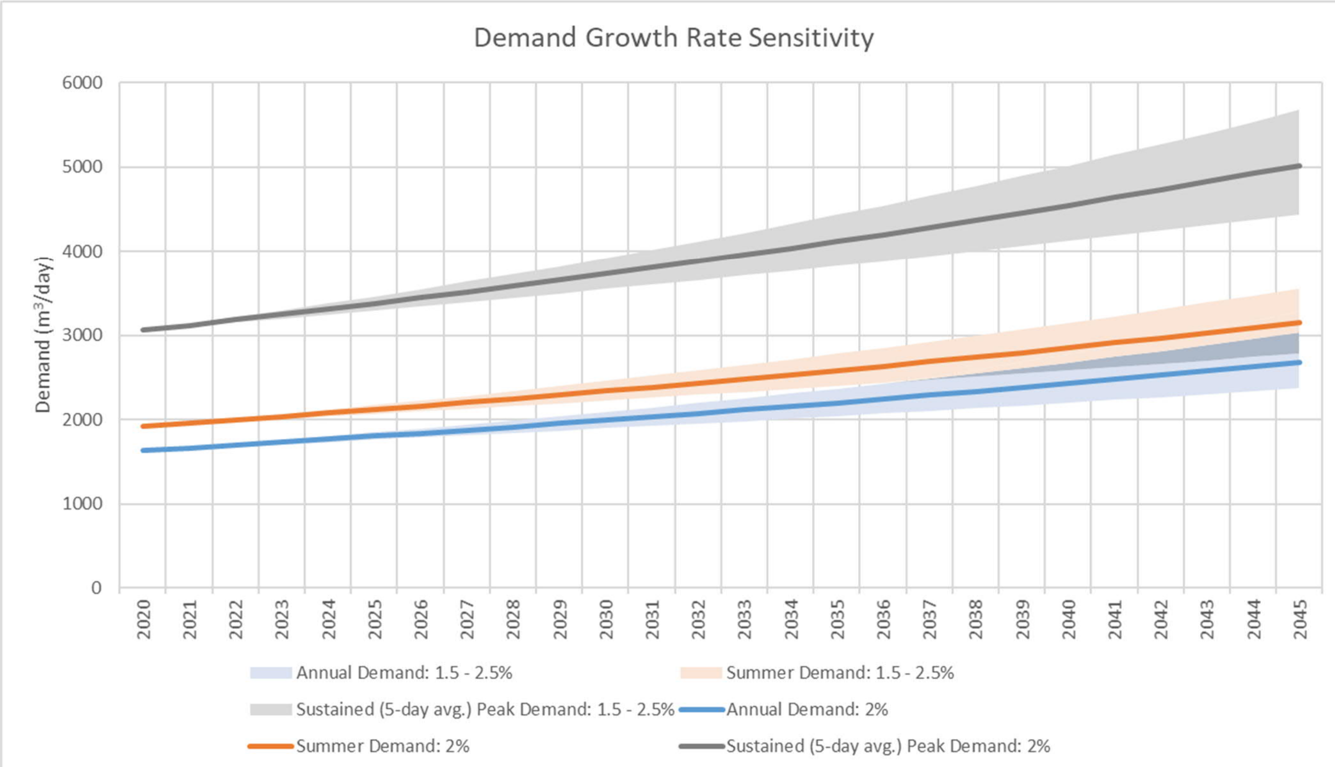


Figure 4.6-2: Demand Growth Rate Sensitivity (1.5 - 2.5%)

An example of how this could change the timing of required upgrades can be illustrated by considering the year at which sustained peak demand is projected to exceed 4,000m^3. If the growth rate is varied from 1.5 – 2.5%, this would change the timing of the required works from 2031 to 2038.

The demand and demand growth in the region should be reassessed on a regular basis to confirm if the growth rate deviates from the 2% value used in this report to better inform the timing of future works.

5. Options Development

5.1 Overview

Future options for the Kerikeri water supply must consider the key elements that form a viable water scheme. These are;

- Source
- Treatment
- Distribution
- Demand Management.

In the case of Kerikeri, there are choices or options to consider for each of these elements. Any overall scheme option must include at least one option for each of these elements. In theory, there are many permutations of these element options that could be used to develop a series of scheme options. To support an efficient and focused development of overall scheme options, the options for each these sub-elements have been considered first and assessed on merit. In this way, a long list for the above elements has been reduced to a short list from which scheme options can be derived. This process is described in the Elements Options Assessment section below. In practice, the source and treatment elements are ones where there is significant choice. The other elements are more binary or are tied directly to the choice of source and treatment.

5.2 Element Options Assessment

Options for each element are described in the sections below. Their relative advantageous and disadvantageous are noted in the long list summary at the end of this section where they are assessed according to their merit.

5.2.1 Source

Based on the Average Usage Demand Curve the following approximate annual quantities of water are required for the projected demand for Kerikeri.

Table 5-1: Estimated Annual Water Supply Requirements

Year	Annual Water Requirement (000 m^3)
2020	600
2030	730
2040	900
2045	1000

The current Kerikeri water supply scheme relies on two water sources. These are;

- Lake Waingaro Reservoir

- Puketotara Stream.

Lake Waingaro Reservoir and its associated infrastructure are owned and operated by the KIC and FNDC contracts the company to supply raw water. Between 60 – 85% (typically 75%) of the water for Kerikeri/ Waipapa comes from this reservoir with Puketotara Stream making up the balance.

As such, the current water sources all rely on surface water which can be impacted by drought conditions and is more susceptible to climate change. This review of current water sources provides an opportunity to introduce further diversification into the supply options if alternative ground water sources are possible.

A high-level review of potential water source options within the general Kerikeri – Waipapa areas has produced the following long list of options;

1) Puketotara Stream (existing source to continue)
2) Lake Waingaro Reservoir (existing source to continue)
3) Lake Manuwai Reservoir (new source but existing private asset)
4) Northern Water Company Reservoir (Waipapa) (new source but existing private asset)
5) New Ground Water Source (new source but does not currently exist - not identified/ proven)
6) New Stream/ River Source (new source but does not currently exist - not identified/ consented)
7) New Reservoir Dam (new source but does not currently exist - not identified/ consented)
8) Desalination (seawater)
9) Water Re-use (wastewater recycle).

Each of these water source options is discussed below.

Figure 5.2-1below shows the locations of the current and potential water sources that already exist.

Figure 5.2-1: Significant Existing Consented Water Sources – Kerikeri – Waipapa Area

5.2.1.1 Puketotara Stream

The only current water source that FNDC has direct access to is abstraction from the Puketotara Stream at a point approximately 3 km west of the Kerikeri town centre. Water is pumped from this point approximately 1 km to the Kerikeri WTP at 398 Kerikeri Rd.

FNDC held a consent to abstract water to a maximum take of 2,100 m^3/day provided flow in the stream does not drop below a residual flow of 113l/s; this consent expired in March 2020. FNDC applied to NRC for a renewal of this consent until 2055 with the following proposed increased limits;

- 3200 m^3/day (daily average rate – 37.04 l/s) for up to a total of 28 days per calendar year.
- 2400 m^3/day for up to a total of 28 days per calendar year
- 960 m^3/day for the remainder of the calendar year.

The status of this consent is not known to Jacobs at the time of writing this report.

The current maximum pumping rate from the stream abstraction to the treatment plant is 90m^3/hour (2,160 m^3/day) with two pumps on duty. This capacity would need to be upgraded to support the proposed increased limits above.

Although this is the only water source FNDC have as of right, it is not the preferred source. It supplies just 15 - 40% (typically 25%) of the Kerikeri demand with the balance being supplied from KIC's southern Waingaro Reservoir. The primary reasons for this are;

- Operational inputs, including power costs associated with abstracting water from the stream and pumping it to the treatment plant – the Waingaro source is gravity fed.
- High turbidity water quality issues when the stream is in high flow
- Limits on abstraction when the stream is in low flow.

5.2.1.2 Lake Waingaro Reservoir

Lake Waingaro Reservoir is located approximately 7 km to the southwest of Kerikeri town centre. It forms part of the Kerikeri Irrigation Scheme (KIC) constructed by the Ministry of Works in the 1980's. Ownership of the scheme and its assets transferred to the KIC in 1990. KIC ownership is spread across various shareholders and generally associated with land ownership within the area serviced by the scheme. These shareholders are primarily horticultural users irrigating. However, as land is converted from horticulture to residential use, there is an increasing proportion of residential users.

FNDC is not a shareholder but has an agreement with KIC for it to supply raw water to the Kerikeri water supply within the limits of a set allocation – this source currently provides approximately 60 – 85% (typically 75%) of the total raw water into Kerikeri.

KIC use a central transmission line to feed distribution branch lines to their shareholders. This transmission line starts off at the reservoir as a 600 mm AC pipeline; transitions to 450 mm AC at SH10 / Wairoa Rd intersection; and then 375 mm AC to Kerikeri Road / Maraenui Drive. FNDC take their water from this scheme at a meter on the intersection of Maraenui Drive and Kerikeri Rd where KIC's line is a 375 mm AC pipe.

The AC pipe has a history of breakages, potentially exasperated with long dry periods causing ground movements that place additional loads on the pipe. KIC is proposing to carry out a detailed condition assessment study of this line and determine what works might be required to improve its performance.

The reservoir is also susceptible to occasional blooms of cyanobacteria (blue green algae) which can potentially form toxins. This can cause significant issues with water treatment. FNDC has previously considered introducing aerators to the reservoir to mitigate this risk but it has not progressed as it would need to be co-ordinated with KIC since they own and operate the asset. The algal blooms tend to be located in the warmer upper levels of the reservoir. KIC have the ability to draw water from the reservoir at lower levels which can sometimes avoid the algal bloom layers. However, water from the lower levels can be subject to other quality issues.

Supply Availability

Under the current arrangement with KIC, FNDC are permitted to use an allocation of 736,000 m^3/year (equivalent to 2,016 m^3/day). Inflow data into the treatment plant from each source indicates that FNDC typically use between 400,000 – 500,000m3/year of the available allocation. In addition, the rate at which FNDC can take water from their connection point is restricted to 30 l/s or 2592 m3/day. This restriction is in place to avoid unacceptable pressure losses for other customers within the KIC network.

The total available supply from the reservoir is 4,800,000 m^3/year of which approximately 4,100, 000 m^3/year is allocated (including FNDC's 736,000 m^3/yr. Of the total volume available, 700,000 m^3/year currently remains unallocated – the equivalent of 1,918 m^3/day. Furthermore, a high proportion of the 4,100, 000 m^3/year allocated goes unused each year – a reflection in the reducing amount of horticultural activity in the areas serviced by the scheme.

From the above, it can be seen that there is potential for FNDC to negotiate an increased allocation from the currently unallocated supply in the order of an additional 2,000 m^3/day. This would bring the total to around 4,000 m^3/day. There is further potential if KIC was able to free up further supply through negotiations with those shareholders currently not using their full allocation. This potential could increase availability to meet the demands of the Kerikeri water supply for at least next 30 years.

5.2.1.3 Lake Manuwai Reservoir

Lake Manuwai Reservoir is located approximately 9 km northwest of Kerikeri town centre and 5 km northwest of Waipapa. Like Lake Waingaro to the south, it also forms part of the Kerikeri Irrigation Scheme constructed by the Ministry of Works in the 1980's and is owned by KIC.

FNDC currently has no arrangement with KIC to access this source. It did reserve an allocation for a period of time, but this involved an annual payment to keep the allocation reserved each year. The arrangement was eventually discontinued as FNDC had no immediate plans to use the reserved allocation.

FNDC has no infrastructure in place to access this source. KIC have some transmission lines that runs from Lake Manuwai servicing their shareholders but there is no significant line running to Waipapa. Should FNDC wish to use this source, a new connection would be required at an appropriate point and this could be close to the reservoir itself. From this point a new raw water line would be required to feed supply to a water treatment facility connected to the Kerikeri water network.

Lake Manuwai Reservoir is shallower than Lake Waingaro Reservoir which potentially makes it more vulnerable to algal blooms. KIC installed aerators at the reservoir approximately 8 years ago to mitigate the risk of algal blooms but they still occur from time to time. Most recent ones have been associated with low water levels in the reservoir due to drought conditions.

Supply Availability

The total available supply from the Lake Manuwai Reservoir is approximately 7,000,000 m^3/year of which approximately 50 % is allocated. Therefore approximately 3,500,000 m^3/year is theoretically available for use – the equivalent of 9,600 m^3/day, far in excess of FNDC's projected demand requirements over the next 30 years. As with Lake Waingaro, there is reducing amount of horticultural activity in the areas serviced by the scheme and this has been reducing demand on the reservoir.

From the above, there is potential for FNDC to negotiate a new long-term allocation of water that would be sufficient for Kerikeri's anticipated water demand well beyond the next 30 years.

5.2.1.4 Northern Water Company Reservoir

The Northern Water Company is a private entity which owns and operates a scheme that was established in the 1980's to provide irrigation for horticulture. This scheme pre-dates the KIC scheme and is much smaller in scale. Landowners in the serviced area (approx. 90 ha) comprise the majority of shareholders. Much of the area is now lifestyle blocks (only 6 ha in orchards) and the demand for the water has therefore decreased.

The scheme comprises two water sources; 1) a dammed reservoir and 2) a water take from a tributary of the Waipekakoura River. There is a pump station that feeds water to serviced land to the north of the reservoir. The reservoir itself is approximately 1.5 km west of Waipapa and 4.5 km northwest of Kerikeri.

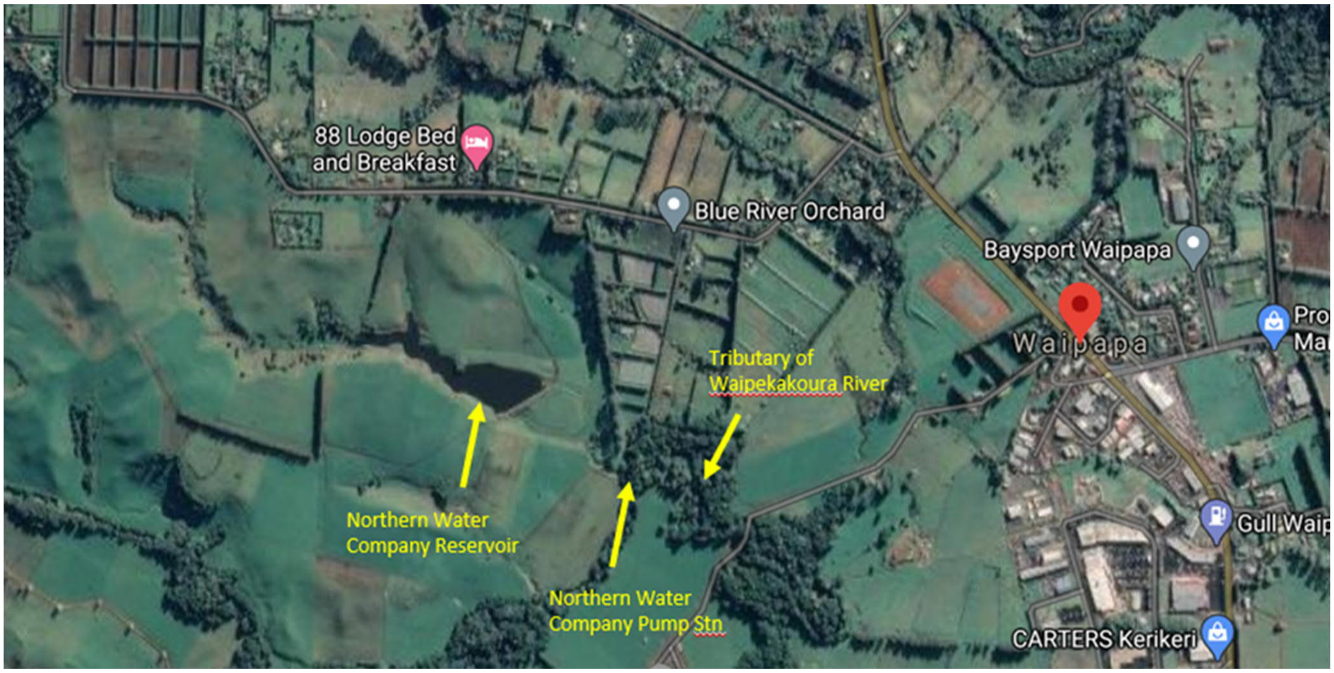


Figure 5.2-2: Northern Water Company Scheme Location

Supply Availability

The scheme can produce up to 1750 m^3/day - 1250 m^3/day from the reservoir and 500 m^3/day from the stream. Last summer at the peak of the dry season current users only required 240 m^3/day; however, these rates cannot be supplied all year around. The scheme has been designed to supply the 1250 m^3/day for 100 days of drought based on 125,000 m^3 usable storage.

The stream take consent is due for renewal in 2023. It will have limitations on timing and quantities of abstracted associated with maintaining minimum flows in the stream.

From the above, FNDC could potentially have access to 1,500 m^3/day for up to 100 days of the year. As such it would not be adequate for all of Kerikeri's water demand but could potentially supplement peak summer demand including tanker requirements.

5.2.1.5 New Ground Water Source

FNDC do not currently have a groundwater source for the Kerikeri supply. Currently all water sources rely on surface water. The introduction of a groundwater source would introduce some diversity into the water sources and provide improved resilience against drought conditions.

Water from a groundwater source would also most likely be of a superior quality to the current surface water sources and would avoid current issues associated with algal blooms in the reservoirs and turbidity in the Puketotara Stream.

There have been no recent physical investigations into groundwater sources for Kerikeri.

Review of Local Geology

A high-level review of the local geology reported and mapped by GNS (GNS, 2009) and key bore database parameters obtained from the Northland Regional Council (NRC) has been carried out under this study to assess local groundwater supply potential in the Kerikeri area. The focus of this review was available data from within a 5 km radius of Kerikeri.

The local geology together with bore locations and their total depth and measured groundwater yield data is provided in Figure 5.2-3.

Observations from this review included the presence of numerous groundwater wells in the Kerikeri area which have been drilled to depths of generally less than 50 m although some have been drilled to 100 m or more. Groundwater yield data for these is variable and there are numerous wells for which there are no data. Measured yields are predominantly modest being less than 3 l/s, but some bores have successfully provided larger yields of up to approximately 20 l/s.

A more detailed review of available bore logs would be necessary to identify the most prospective aquifer units and to inform the design of any future groundwater investigation programme. However, based on the information available, the most prospective area for groundwater appears to be associated with the Miocene age basalt and rhyolite rocks that comprise the Puhipuhi-Kerikeri (Pvkb unit shown in yellow in Figure 5.3) and Kaikohe-Kerikeri Volcanic Groups (Pvks and Pvkr units shown in yellow in Figure 5.2-3). These volcanic rocks are extensive to the east of Kerikeri. This is consistent with the results of previous work completed by GNS who report that '*Many volcanic rocks in the area are water-bearing, but basalt and scoria of the Kerikeri Volcanic Group provide the best supplies. The highest yields are usually obtained from either scoriaceous beds within flows, or basal rubble zones beneath lava flows.'*. The groundwater yields obtained from these volcanic units are quite variable but the highest yields appear to be mostly found in the 30 – 80 m depth range.

Further Investigation

Williamson Water and Land Advisory have previously provided a report to FNDC on potential groundwater supply options specifically for the Waipapa community. This report proposes an exploration programme to investigate areas that are within council-owned land or road reserve areas and that are outside the potentially restricted allocation areas. More detailed mapping and geophysical surveying has been recommended to identify target areas where the basalt is expected to be thickest and to try and identify zones of highest permeability.

Supply Availability

There is currently no groundwater supply availability to FNDC. However, this initial review indicates there is some supply potential particularly within the groundwater aquifers hosted by the Kerikeri Volcanic Group rocks. Available bore yield data indicates the yields to be modest (generally < 3 L/s) although some bores have resulted in more substantial flows (~ 20 L/s).

More study and investigation would be required to progress this source option. It is recommended that a more detailed desktop analysis be completed before committing to an investigation drilling programme.

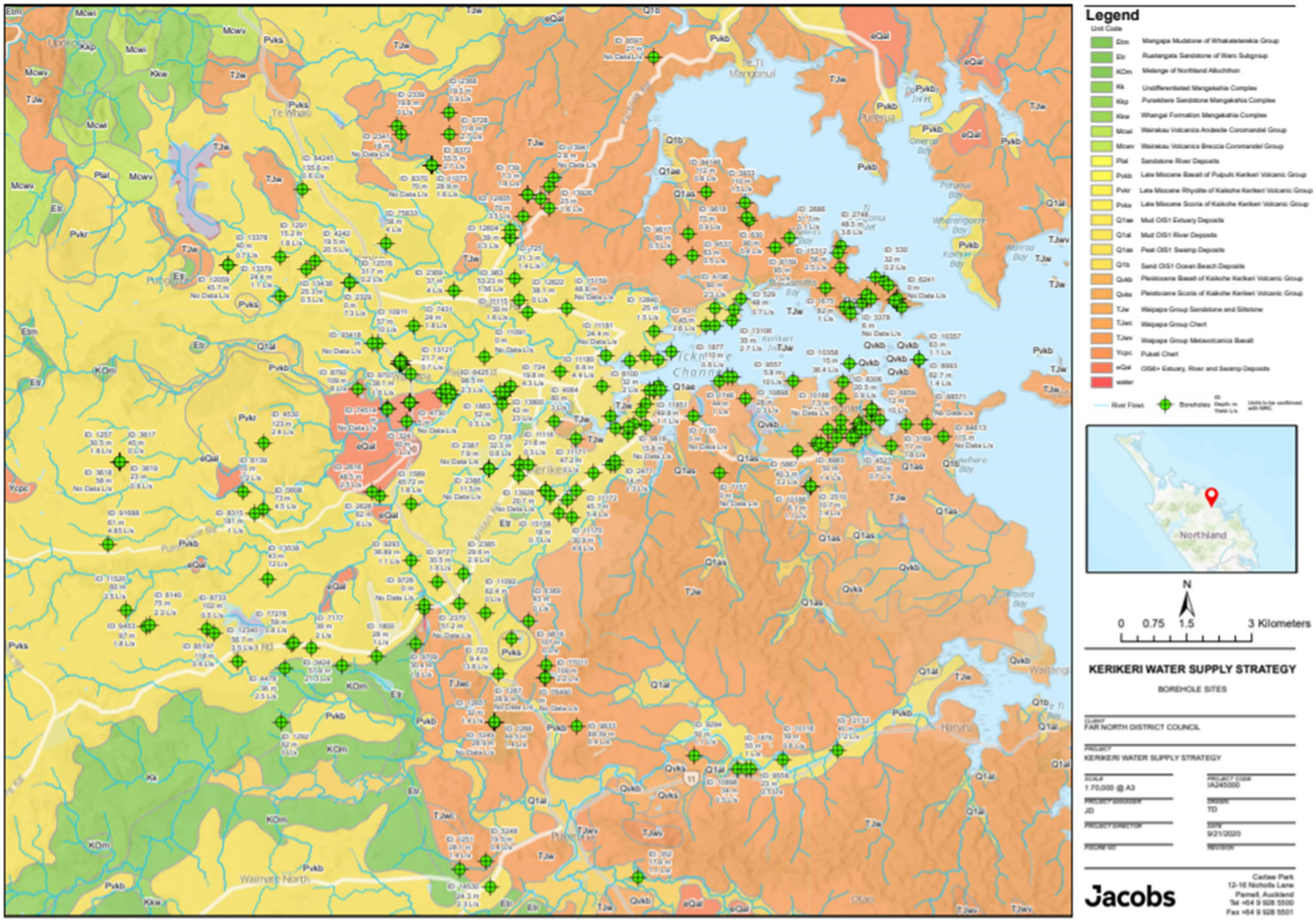


Figure 5.2-3 Local geology map and existing bore locations with total drilled depth and groundwater yield measurements

5.2.1.6 New River/ Stream Source

FNDC's only river/ stream take is from the Puketotara Stream in Kerikeri. Further stream sources could potentially be investigated but there is a high level of allocation within the area already. New stream or river sources are feasible but are under increasing regulatory pressure and new consents could be difficult to obtain

A new river or stream source may not provide the security of supply sought by FNDC. Other potential water take locations are likely to have the same summer low flow restrictions and the high flow turbidity issues. For example, when one stream is under low flow restrictions, then most others in the area are also likely to be. Thus. adding further surface water supplies may not resolve summer low flow availability issues. The same applies to high flows and increased turbidity.

The proposed Northland Regional Plan outlines an allocation regime that calculates the allowable allocation from a river as between 10 and 50% of the seven day mean annual low flow, depending on the classification of the river (Outstanding/Coastal/Small/Large).

In the Kerikeri River Catchment (including Puketotara Stream), the 7-day mean annual low flow is 23% allocated. In the Waitangi Catchment, the 7-day mean annual flow is 34% allocated.

Allocations in the Rangitane River and Okura River catchments are 11% and 6% of 7-day MALF respectively. Based on the data from Northland Regional Council, allocation in Waipapa Stream is 263% of the 7-day MALF (primarily into the Lake Manuwai reservoir).

It is worth noting that in addition to providing water for irrigation, the KIC scheme was built to ease allocation pressure on surface water bodies. In the 1970s, many of the areas streams and rivers were severely overallocated due to the number of irrigation takes. The KIC scheme reduced pressures on these streams.

Further work would be required to determine the viability of an additional surface water supply.

5.2.1.7 New Reservoir Dam

FNDC do not own any of the reservoir dams in the general vicinity of Kerikeri. They rely on negotiating water allocations from the Waingaro reservoir with KIC. This makes FNDC reliant on a privately owned third party for the majority of Kerikeri's water supply.

Although technically possible, a future dam would most likely be difficult to implement due to landownership and consenting challenges. It is also probable that the KIC dams are located in the most obvious locations for dams, so there could be limited scope for further dam development.

As with new river/stream sources, under the current regulatory framework the development of dams, and the diversion of surface water courses is challenging, and would require thorough and robust environmental assessment to support consenting.

Scope does exist for the damming and storage of river high flows, and the proposed Regional Plan does provide a consenting pathway for this (Rule C.5.1.10). Storage of high flows is becoming more common in New Zealand as stricter environmental flow limits are put in place restricting the use of surface water during summer. High flow takes access water flow when a river is in flood and divert into storage for later use.

A logical next step to assess the viability of this would be to undertake a hydrological review of flood frequency, and to undertake a spatial exercise to identify potential dam sites in the area. This dam suitability exercise should quickly indicate whether this is a feasible option or not.

5.2.1.8 Desalination

Desalination uses seawater as the raw water source and provides treatment through reverse osmosis and other processes to produce drinking water.

It is not currently used for any council water supplies in New Zealand due to its cost and environmental effects.

The process is energy intensive and produces a brine (high concentrations of salt) that must be discharged back into a high energy marine environment. This means that any desalination plant could not readily operate with a discharge at the Kerikeri Inlet.

5.2.1.9 Water Re-use

Water re-use uses wastewater as the water sources and treats it to a level that is suitable for drinking water.

It is not currently used for any council drinking water supplies in New Zealand due to its cost, social acceptance and cultural implications.

5.2.1.10 Summary of Water Supply Quantities Available

Given some water sources discussed above are proven and in existence and some are only speculative at this stage, it is useful to summarise the known water sources and the potential volumes that may be available from each in the future. From the above review, the following known existing water sources in the vicinity of Kerikeri are either already utilised or potentially available for the supply;

- Puketotara Stream
- Lake Waingaro Reservoir
- Lake Manuwai Reservoir
- Northern Water Company Reservoir.

The quantities available from these sources are summarised in Table 5-2.

Table 5-2: Summary of Available Water Sources and Quantities (per year)

Source	Current Available Supply (000 m^3)/ yr.	Potential Additional Available Supply (000 m^3)/ yr.	Total (000 m^3)/ yr.
Puketotara Stream (current source)	-	-	390*
Lake Waingaro (current source)	736	700	1436
Lake Manuwai (potential source)	nil	3500	3500
Northern Water Co. (potential source)	nil	150	150

*Based on submitted consent renewal for water take (not yet granted)

The estimated water volume requirements for Kerikeri range from 584,000 m^3/year for 2020 through to 985,500m^3/year for 2045. From the above, it can be seen that the current water sources (Puketotara Stream & Lake Waingaro) have the potential to cater for the total Kerikeri supply water requirement over this time frame. This would however be subject to securing an additional water allocation from KIC using a portion of Lake Waingaro's currently unallocated supply.

Relying solely on these existing sources could limit resilience to climate change and diversity in the range of sources of supply. These factors, and any mitigations, will need to be considered in planning future water sources.

5.2.2 Treatment

As demand in the Kerikeri water supply scheme increases, its treatment capacity will need to also increase. This will be in steps that ensure there is always enough capacity to meet peak demand. The treatment facility will also need to be capable of handling the anticipated raw water quality to produce the required treated water quality standards.

The current raw water sources supplying the Kerikeri water scheme are surface water sources; Lake Waingaro and the Puketotara stream. Additionally, Lake Manuwai has in the past been considered as another potential surface water source.

The water quality of these surface water sources is currently impacted by the external environmental factors listed below;

- Non-point source discharges of sediment, minerals (Mn and Fe in particular) and nutrients and mineral levels
- Point source discharges and contamination by pathogenic organisms and elevated levels of cyanotoxins resulting from algal bloom events.

Any treatment process designed for the Kerikeri scheme would need to account for these issues and sources of variance in raw water quality. The New Zealand Drinking Water Standards state that surface water sources are required to achieve a treatment requirement of 3 - 4 log credits to achieve protozoal, additional treatment and monitoring is required for water bodies which are known to be susceptible to outbreaks of algal bloom.

5.2.2.1 Current Treatment Process

The existing Kerikeri WTP achieves 4 log credits of treatment by a process which is comprised of coagulation, clarification, filtration, UV disinfection followed by chlorine disinfection as seen in Figure 5.2-4 below. It was initially built in 1971 and has had a series of modifications and upgrades over the years. The WTP is sited on a dedicated site off Kerikeri Rd. Although this site is relatively large, much of it is sloping and significant civil works would be required to cater for a larger WTP footprint.

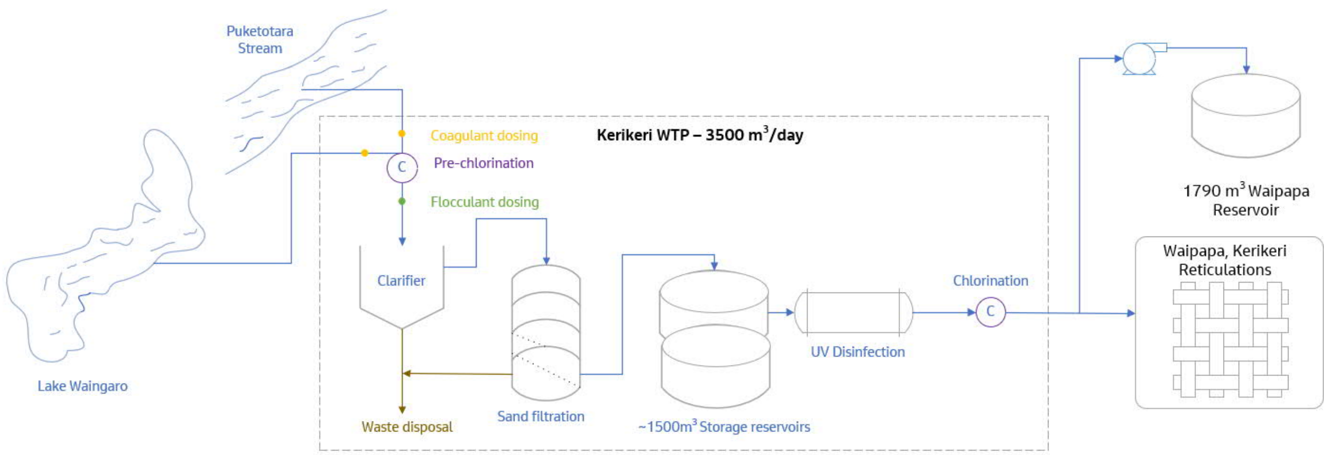


Figure 5.2-4: Kerikeri WTP Treatment Process Schematic

At present there are several issues affecting the treatment capability and capacity of the current WTP that need immediate attention. These include;

- Aged and deteriorated raw water supply infrastructure
- Performance and structural integrity of the clarifier
- Declining condition of the existing sand filters
- Lack of footprint available on site

These components have either reached or are approaching the end of serviceable life and will need to be replaced soon.

Options for associated replacements and upgrades need to consider;

- The process log credit requirement
- Resilience to changing raw water
- Appropriate design life and ability to stage capacity upgrades.

Two options for treatment upgrades have been considered for the Kerikeri water scheme. Both involve lamella clarification followed by either microfiltration or sand filtration. Note that these options have been suggested without detailed knowledge of the water quality data. Full analysis of scheme water quality would be required to confirm approach and determine specific options for treatment.

These options are described below.

5.2.2.2 Clarification with Sand Filtration

A lamella clarifier followed by sand filtration is a robust treatment process which has been demonstrated to provide an effective level of treatment.

A lamella clarifier seen in Figure 5.2-5 is an inclined plate gravity settling unit that is able to remove high quantities of solids, algae matter and sludge prior to further treatment. The unit produces a more concentrated sludge stream allowing for greater raw water recovery and lower waste stream flows. A lamella clarifier is also a compact unit which would require a much smaller footprint in comparison to the concrete clarification tank currently located on site. This feature would be beneficial when dealing with the site constraints of the current Kerikeri WTP.

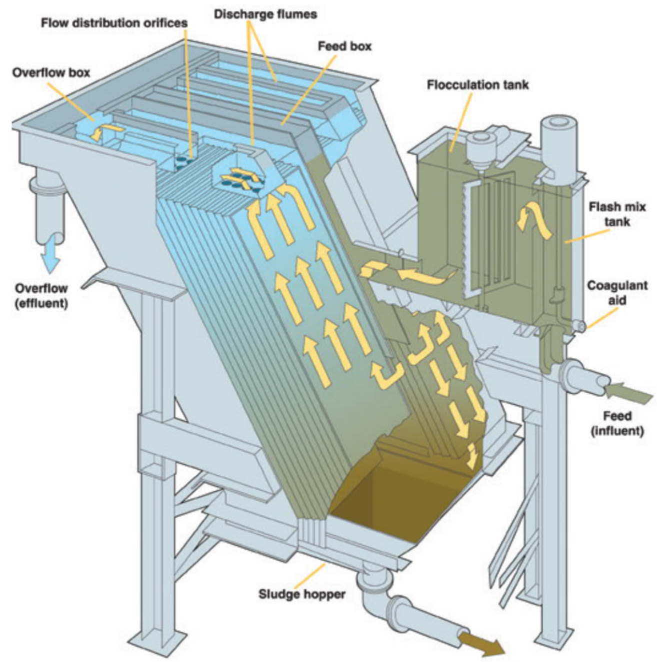


Figure 5.2-5 Lamella Clarifier Treatment Unit

Sand filtration units are both cost effective and efficient filtration units used to remove suspended solids from raw water. The filtration units are comprised of layers of varying in particle size and specific gravity to trap suspended solids and pathogens as the raw water stream flows through the unit. As a primary process, with an appropriate level of maintenance and monitoring, sand filtration can achieve 2.5 log credits of protozoal treatment. These units provide a relatively long serviceable design life and are able to be scaled up with relative ease as demand for water supply increases. The units could continue to be housed within the existing process facility on site, requiring little additional footprint.

5.2.2.3 Clarification with Microfiltration

Lamella clarification in conjunction with microfiltration would produce a high-quality drinking water supply and is a resilient and future-proofed treatment option.

Microfiltration is a pressure driven filtration process which removes particulates larger than one micrometre in size. This would remove most bacteria, protozoa and sediment from the raw water stream. The filtration unit features a fine pore membrane that pressurised raw water is filtered through. It produces a consistent and concentrated waste water stream which would lead to lower overall waste flows on site. As a primary process, a microfiltration unit is able to achieve up to 3 log credits of treatment and produce a high-quality pre-treated water stream.

In terms of capital and operating costs a microfiltration unit is a more expensive option which requires pumping and greater power consumption in comparison to a sand filtration unit. This option could also be scaled up efficiently and with ease with multiple trains of filtration being added as the water demand increases. The microfiltration unit may also require housing; however, this would need further assessment to be confirmed.

5.2.2.4 Cyanotoxins

Cyanotoxins are toxins produced by cyanobacteria or blue-green algae. Lake Waingaro is known to have seasonal occurrences of algal bloom particularly during summer. Depending on the levels of nitrate and phosphate nutrient present in the lake waters, blooming cyanobacteria/blue green algae can produce cyanotoxins at very high levels. Cyanotoxins are soluble contaminants which are difficult to and are poisonous to humans in high concentrations.

The best method of lowering cyanobacteria within the Kerikeri water supply scheme would be to eliminate it at its source, at Lake Waingaro. If fertiliser runoff and heavily nutrient loaded discharges were lowered or suppressed particularly during summer seasons, the occurrences of algal bloom and levels of cyanotoxins in raw water extracted would greatly diminish.

Certain forms of disinfection treatment can reduce concentrations of dissolved cyanotoxins present in a raw water supply. Chlorination and ozone treatment are both effective at removing certain forms of cyanotoxins, ozone is very effective in oxidising microcystins, anatoxin-a, and cylindrospermopsin whereas chlorination is an effective oxidant for cylindrospermopsin and saxitoxin. Further analysis of water quality data is required to determine which cyanotoxins are present in the raw water supply and which treatment processes would be most appropriate for cyanotoxin removal, though at report assumes that continued chlorination will be sufficient.

5.2.3 Distribution Network

As water demand in the Kerikeri water supply scheme increase, the distribution network will need to be able to deliver increased flows to the required levels of service – these are mostly around acceptable minimum pressures and firefighting flow requirements.

The current distribution system for Kerikeri is illustrated in Figure 5.2-6. Key features are a distribution spine which runs from the current connection point to KIC's Lake Waingaro distribution line at Maraenui Drive west of Kerikeri, along Kerikeri Rd, through the town centre and north along the Twin Coast Discovery Highway (Waipapa Rd) towards Waipapa. The spine varies in diameter from DN100/DN150/DN200 and is approximately 5km in length and includes many offtakes to customers in the Kerikeri area. It links three treated water storage reservoirs – two at the Kerikeri WTP site (1,000 m^3 and 500 m^3) and a third on Waipapa Rd (1790 m^3).

The network utilises booster pumping and comprises three water distribution zones (WDZs); Kerikeri, Riverview and Waipapa. The operation of these three is summarised in Table 5-3.

Table 5-3: Current Water Distribution Zone Operation Head

	Operating Head	Pressure Boost by pump sets
Kerikeri WDZ	122m	~15m boost by pumps at WTP
Riverview WDZ	105m	~38m boost by pumps at Waipapa Reservoir
Waipapa WDZ	124m	~57m boost by pumps at Waipapa Reservoir

5.2.3.1 Network Performance (Level of Service)

The transmission network in Kerikeri appears to have been sized for lower demand than is currently required during current sustained peak demand. The majority of customers in Kerikeri distribution zone and Riverview distribution zone have elevations which could theoretically allow gravity supply from the Kerikeri WTP Reservoir and Waipapa Reservoir respectively. However, both zones are supplied by pumped flows which is expected to be due to the large head losses through small piping requiring additional pressure to achieve the Level of Service (LoS).

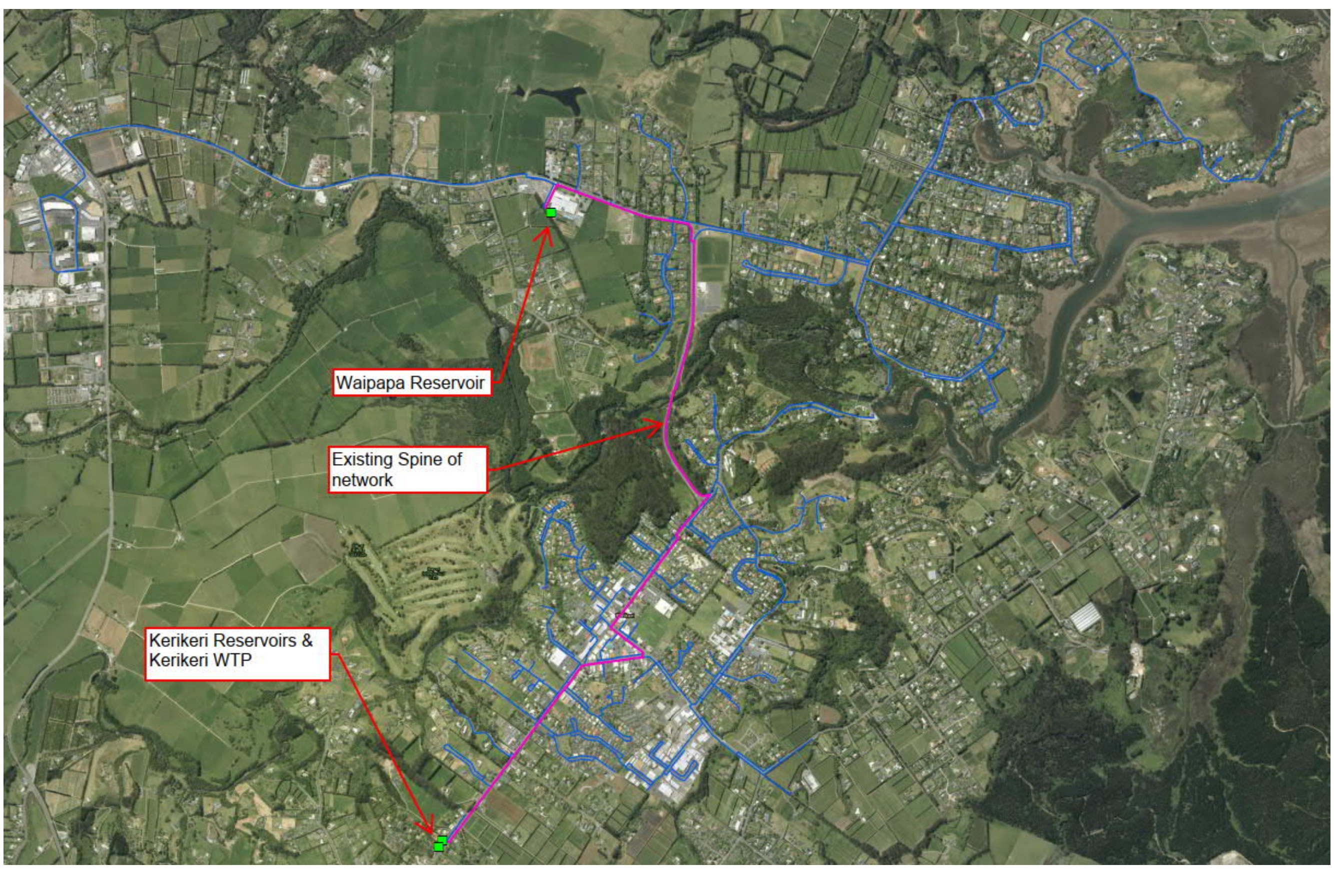


Figure 5.2-6: DN100/DN150/DN200 spine through Kerikeri Region

The performance of the network has been assessed with a series of scenarios as demand increases. These include do nothing or minimal alterations, upgrades to pumps and upgrades to mains. Each of these have been trialled in the network hydraulic model to determine their impacts on Level of Service (LoS). The results of these trials for each scenario are summarised in Table 5-4.

Scenarios 1 to 5 model the existing network with pump station upgrades to maintain the existing pump station outlet pressures at higher flows as described in Table 5-4. Increases in pump station outlet pressures have not been modelled due to the risks present with increasing the pressure of aging AC piping (such as fractures at pressures significantly below the nominated pressure rating). As the demand approaches and exceeds 3,000m^3/day large amounts of the network drop below the level of service (LoS) of 25m as per Figure 5.2-7

Table 5-4: Level of Service Summary from Modelling (Additional Information provided in Appendix A)

Scenario	Changes Required	Demand	% of model nodes with Minimum Pressure <20m	% of model nodes with Minimum Pressure <25m	% of model nodes with Minimum Pressure <30m	Pumps' Capability
Scenario 1	No changes	2,000m^3/day	7.3% (network near WTP)	27.9% (network in Kerikeri WDZ)	44.8% (network in Kerikeri WDZ)	Riverview: 2 of 3 pumps online (60% capacity) Kerikeri: 2 of 2 pumps online (71% capacity)
Scenario 2	No changes	3,000m^3/day	26.5% (network in Kerikeri PR)	36.2% (network in Kerikeri WDZ)	52.7% (network in Kerikeri WDZ)	Riverview: 3 of 3 pumps online (91% capacity) Kerikeri: 2 of 2 pumps online (93% capacity)
Scenario 3	Minor Changes Riverview pump outlet pressure decreased to allow higher flows from pumps Kerikeri pump outlet pressure decreased to allow higher flows from pumps	3,500m^3/day	40.6% (network in Kerikeri PR)	55.5% (network in Kerikeri WDZ)	62.2% (network in Kerikeri WDZ)	Riverview: 3 of 3 pumps online (86% capacity) Kerikeri: 2 of 2 pumps online (100% capacity)
Scenario 4	Major Changes Upgrades required to Riverview pumps and Kerikeri pumps	4,000m^3/day	42.7% (network in Kerikeri PR)	52.3% (network in Kerikeri WDZ)	55.3% (network in Kerikeri WDZ)	Riverview: Pump discharge pressure maintained at current value (41m) at ~33L/s Kerikeri: Pump discharge pressure maintained at current value (17m) at ~67L/s
Scenario 5	Major Changes Upgrades required to Riverview pumps and Kerikeri pumps	5,000m^3/day	58.6% (network in Kerikeri PR)	62.2% (network in Kerikeri WDZ)	63.3% (network in Kerikeri WDZ)	Riverview: Pump discharge pressure maintained at current value (41m) at ~41L/s Kerikeri: Pump discharge pressure maintained at current value (17m) at ~81L/s
Scenario 6	Major Changes 375mm ID spine installed Kerikeri PR is supplied by gravity (except some customers near WTP)	3,000m^3/day	6.0% (network near WTP)	7.2% (network in Kerikeri WDZ)	10.5% (network in Kerikeri WDZ)	Riverview: 3 of 3 pumps online (91% capacity) Kerikeri: Gravity except some customers near WTP
Scenario 7	Major Changes 375mm ID spine installed Kerikeri PR is supplied by gravity (except some customers near WTP)	4,000m^3/day	6.1% (network near WTP)	8.0% (network in Kerikeri WDZ)	11.2% (network in Kerikeri WDZ)	Riverview: 3 of 3 pumps online (120% capacity, however pressure reduces to achieve flow. Pressures shown in cells to the left reflect this) Kerikeri: Gravity except some customers near WTP
Scenario 8	Major Changes 375mm ID spine installed Kerikeri PR is supplied by gravity (except some customers near WTP) Upgrade required to Riverview Pumps, or consider rezoning higher properties from Riverview PR into Kerikeri PR	5,000m^3/day	6.1% (network near WTP)	8.5% (network in Kerikeri WDZ)	18.0% (network in Kerikeri WDZ)	Riverview: Pump discharge pressure maintained at 28m at ~41L/s Kerikeri: Gravity except some customers near WTP

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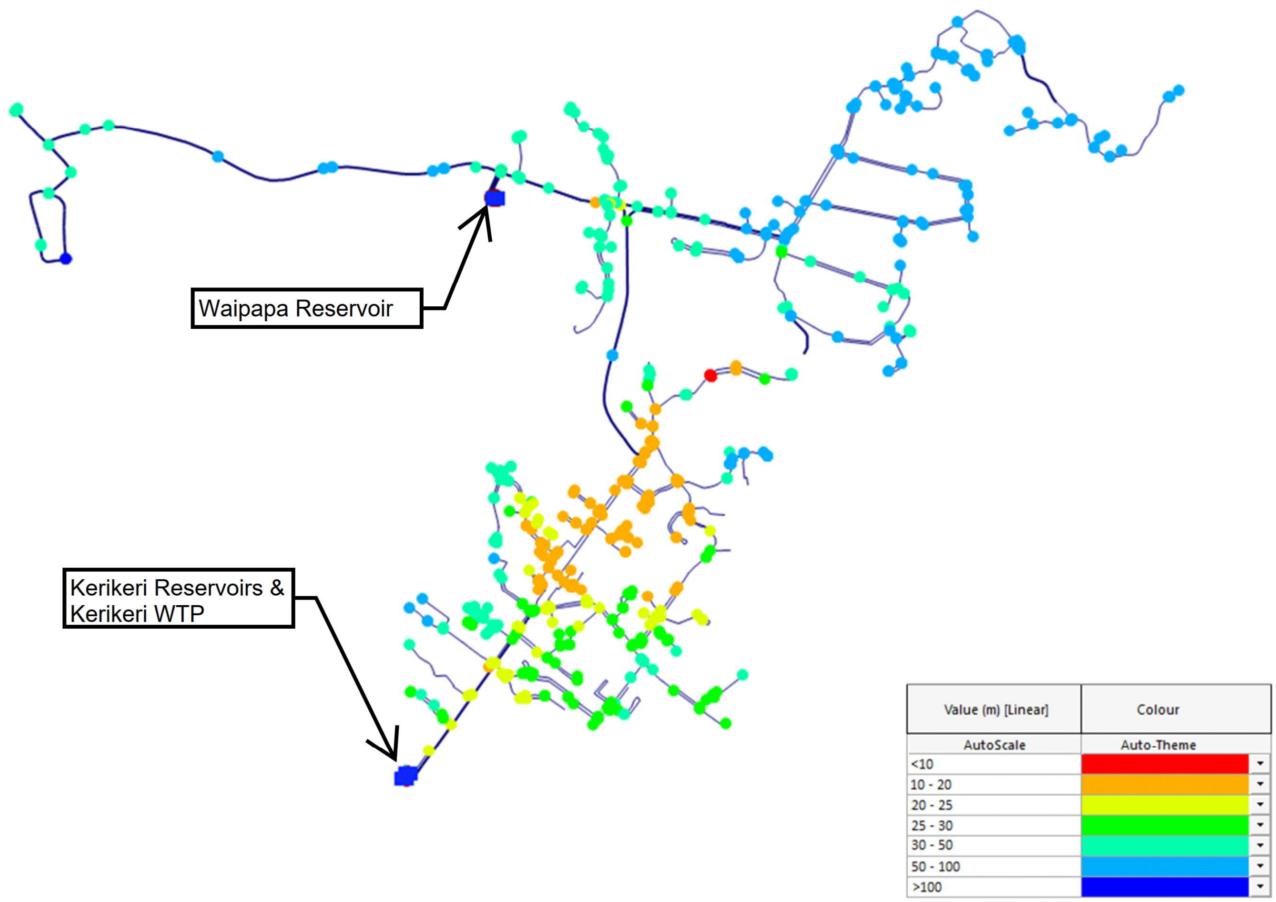


Figure 5.2-7: Scenario 2 – Current Network – Demand of 3,000m^3/day

As the current network does not meet the required LoS at the current sustained peak demand (3,069 m^3/day), it is expected that the current network configuration is unlikely to be able to accommodate peak flows for many years into the future without significant issues with the existing pump stations and larger amounts of the network below LoS.

Significant changes to the network will likely be required in the short to mid-term as level of service deteriorates. To improve the LoS to customers, generally two options can be implemented;

- Upgrading pump stations to provide increased pressure
- Increasing size of piping in network to decrease pressure losses.

Implementing pumps to accommodate undersized piping is not recommended for future operation of the Kerikeri network as it is typically more costly from a CAPEX vs. OPEX perspective and frequently results in a less resilient network. It also requires higher pressures which can adversely affect piping (especially AC piping which constitutes 31% of the network).

The piping in the current network spine (DN100 / DN150 / DN200) is smaller than would be expected for the current peak sustained demand in the network (3,069 m^3/day) with some piping in the network operating at very high velocities (3.3m/s) and large pressure losses (head loss of 80m/km). This indicates that the network is operating inefficiently and increasing the pressure with pumps is likely to be a costly short-term fix. For these reasons, upgrades to the network have focused on upgrading piping rather than upgrading pumps.

It is recommended that larger piping be installed (as per Scenario 6 to 8 of Table 5-4) to decrease the significant losses currently present in the network. If the spine of the network is increased to 375mm internal diameter (375mm ID) then only 8.5% of the network will be below LoS (25m) when the demand is 5,000 m^3/day. This LoS is better than the performance of the current network at a demand of 2,000 m^3/day. The 8.5% of the network which is unable to meet LoS is located very close to the WTP and is discussed further below.

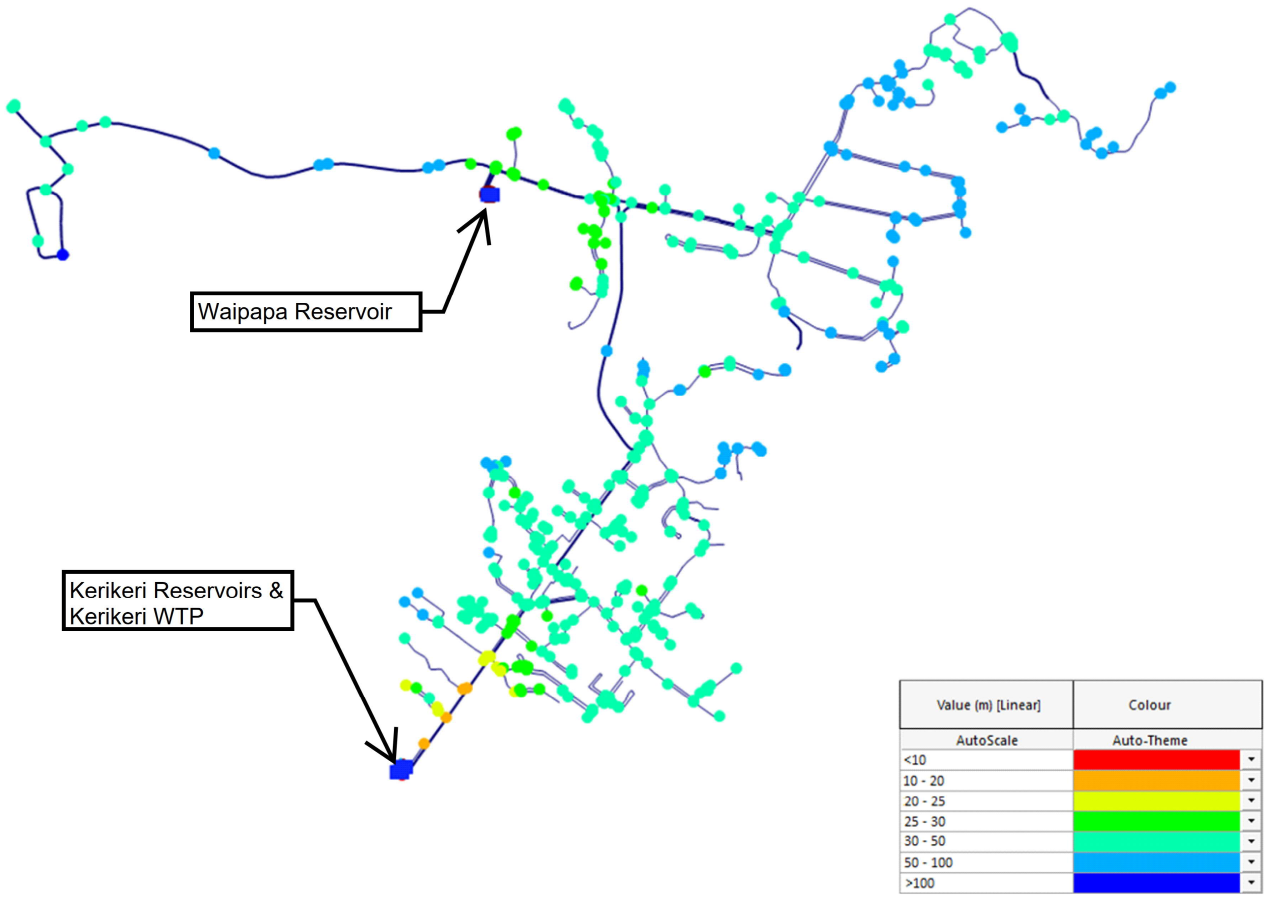


Figure 5.2-8: Scenario 8 – Upgraded network spine – 5,000 m^3/day

Installing a larger spine has the additional benefit of allowing the majority of customers in Kerikeri WDZ to be supplied via gravity from the higher elevation at the WTP. Piping very close to the treatment plant does not have the elevation required to meet the LoS and the vast majority of the 8.5% of the network which cannot meet LoS is located close to the WTP. Two options are present to remedy this;

- Pressure boost all flows to Kerikeri to meet LoS for a few customers
- Install small piping and a small pump set to solely supply those customers near the WTP who cannot be supplied via gravity.

Due to the small number of customers who cannot be supplied by gravity (approximately 20-30 local to the WTP) it is likely worth investigating pumping small flows just to these customers rather than pressure boosting all flows to the entirety of Kerikeri WDZ. This should be investigated just prior to detailed design of the upgrade to the spine of the network.

Replacing the current spine does pose some complexity as it is operational and has many service connections to it. An alternate solution of installing a second main (potentially smaller than 375mm ID) could be considered. It would follow a similar path to the existing spine with cross connections between the new spine and existing spine at distances of roughly 500 – 1,000m. The performance of the network would be highly similar whether the spine is replaced or a second (twinned) spine is installed. This can be explored further and would be subject to further investigations. For the purposes of this study and option development, we have assumed full replacement of the existing spine.

5.2.3.2 Mains Replacement

Modelling of the current network under anticipated future demands shows levels of service deteriorating in the short to mid-term. With the current spine size and the current pumps' boosting pressure, the existing system is already nearing capacity on high demand days (~3,000 m^3/day) and some customers will be receiving pressures below the agreed level of service.

Therefore, upgrading of the spine is required to meet forecast demands on the network with this work likely to be required within the next 3 years to 10 years.

Early indicative analysis suggests;

- Spine requires an upgrade to 375mm ID where Kerikeri is supplied by a single WTP (the current case)
- Spine requires upgrading to 300mm ID and 250mm ID if Kerikeri is supplied from both the south and north by two separate treatment plants.
- Leaving spine as is (do nothing case) would not meet required levels of service as demand increases (or at current demand levels).

It is important to note that the above analysis has been carried out using the 2013/14 network hydraulic model provided by FNDC. Before these works are confirmed and progressed, it is recommended that multiple pressure and flow loggers be installed at key locations during a prior summer to verify the network performance.

5.2.3.3 Storage Upgrades

Current treated water storage in the network's reservoirs is 3,790 m^3. Under FNDC's Engineering Standards, storage should be adequate for firefighting needs and sufficient for 2 days of average daily demand. For 2020, average daily demand is 1,635 m^3/day giving a 2-day volume of 3,270 m^3. This is within the current available storage by 520 m^3. By 2030, average demand is expected to be approximately 2,000 m^3/day which would require a 2-day volume of 4,000 m^3, just above the current available storage volume. Therefore, storage may need to be increased sometime around 2030.

5.2.4 Elements Long List Summary and Review

The key options for each of the elements discussed above are summarised below as long list. Each has been assessed on its relative merit considering its associated positives and negatives. This assessment is then used to determine whether they can be considered in the development of the overall scheme options. The summary table also indicates whether they form part of the four short listed scheme options developed in Section 5.3.

Assessment has been categorised as the following;

	Viable	Can include in shortlisted options
	Potentially viable	Not proven/ further investigation required. Could be incorporated into an option at a future date
	Not viable	Not suitable to include in shortlisted options

Element	Comments -ve and + ve	Assessment	Utilised in Short List Option Option 1	Option2	Option 3	Option 4
Water Sources						
Puketotara Stream	+Existing consented source + Infrastructure in place + FNDC has direct access - Turbidity issues - Insufficient quantity to meet all Kerikeri demand - Pumped / power cost		Yes	Yes but phased out	Yes	Yes but phased out
Lake Waingaro Reservoir	+Existing consented source + Infrastructure in place + Sufficient quantity for mid to long term supply - Owned by third party - Reliability issues wrt. pipeline breakages and algal blooms - Needs new pipeline to access higher quantities		Yes	Yes but phased out	Yes	Yes
Lake Manuwai Reservoir	+ Existing consented source + Sufficient quantity for long term supply + Introduces greater redundancy - Owned by third party - Reliability issues wrt pipeline breakages and algal blooms - No FNDC connection Needs new connection, infrastructure /pipeline to access		No	Yes	Yes	Yes
Northern Water Company Reservoir	+ Existing consented source + Close to Waipapa + Introduces greater redundancy - Owned by third party - Insufficient quantity to meet all Kerikeri demand - No FNDC connection Needs new connection, infrastructure /pipeline to access		No	No but could be connected in if required	No but could be connected in if required	No but could be connected in if required
New Groundwater Source	+ Provides diversification to waters sources + Better raw water quality		No but could be connected in if	No	No	No but could be connected in if

Element	Comments	Assessment	Utilised in Short List Option			
	-ve and + ve		Option 1	Option2	Option 3	Option 4
	+ FNDC would control - Groundwater source yet to be identified/ confirmed – not consented - Abstraction volumes uncertain - New infrastructure required		required, depending on location	but could be connected in if required, depending on location	but could be connected in if required, depending on location	required, depending on location
New River/ Stream Take	+ FNDC would control - River/ stream source yet to be identified, not consented - Abstraction volumes uncertain - New infrastructure required - Likely to have similar constraints and issues as exiting Puketotara water take		No	No	No	No
New Dam/ Reservoir	+ FNDC would control -Site yet to be identified, not consented - Significant new infrastructure required/ high cost - Significant land owner and consenting issues likely		No	No	No	No
Seawater Desalination	+ FNDC would control +Unlimited raw water supply - High cost and complexity - Environmental/ sustainability issues		No	No	No	No
Water Re-use	+ FNDC would control +Sustainable approach although more treatment process required - Still needs raw water source - New infrastructure required/ cost - Significant social and cultural issues		No	No	No	No
Treatment						
Lamella clarifier with sand filter	+lower capital cost sand filters + operation less complex +lower O&M costs - more vulnerable to algal blooms - larger footprint		No but could be subject to further investigation	No but could be subject to further investigation	No but could be subject to further investigation	No but could be subject to further investigation

Element	Comments	Assessment	Utilised in Short List Option			
	-ve and + ve		Option 1	Option2	Option 3	Option 4
Lamella clarifier with microfiltration	+more capable in handling algal blooms + small footprint - high capital cost - higher complexity - higher O&M costs		Yes	Yes	Yes	Yes
Distribution						
Do Nothing – no improvements to network	+low cost - does not provide for min levels of service		No	No	No	No
Upgrades to Riverview pumps and Kerikeri pumps	+less disruptive implementation + lower capital cost - high O&M costs - risk to existing AC pipes		No but could be subject to more investigation	No but could be subject to more investigation	No but could be subject to more investigation	No but could be subject to more investigation
Upgrade central mains spine to DN 375	+more efficient O&M +aging assets renewed -more disruptive implementation - higher capital cost		Yes	Yes	Yes	Yes
Additional future storage circa 2030	+ensures FNDC standards complied with		Yes	Yes	Yes	Yes
Water Demand Management	+can reduce demand and delay need for additional water sources and treatment capacity + promotes sustainable use of resources +can reduce network leakage - impact on demand can vary depending on effectiveness of implementation		No Have assumed this does not occur to be conservative but implementation would be beneficial	No Have assumed this does not occur to be conservative but implementation would be beneficial	No Have assumed this does not occur to be conservative but implementation would be beneficial	No Have assumed this does not occur to be conservative but implementation would be beneficial

5.2.5 Shortlisted Elements

From the above review, the shortlisted elements to be taken forwarded into shortlisted options are;

> Water Sources;
  - Puketotara Stream
  - Lake Waingaro Reservoir
  - Lake Manuwai Reservoir

> Treatment
  - Lamella Clarifier and Microfiltration

> Distribution
  - Upgrading of network spine watermain
  - Increase (1500 m^3) in treated water storage circa 2030

5.3 Development of Scheme Options

5.3.1 Overview

The elements shortlisted above have been used to develop four scheme options. Each option has a different configuration of the elements (mainly around water source and treatment) but all meet the future needs of Kerikeri's water supply.

The different approaches with each option lead to differences in costs, benefits and other key issues across the options. The relative merits of each option are compared through the MCA analysis in Section 6.

A key common feature of the four options is that they include the same programme of works for the first 10 years i.e. 2020 to 2030. This is mainly due to the first 10 years being focused on addressing the immediate and near-term needs around the treatment and network elements for which there is a common approach.

Each of the four options are presented in the following sections.

5.3.2 Option 1

5.3.2.1 Option 1 Description

Option 1 essentially retains the current water sources and upgrades the existing Kerikeri WTP to meet future demand. The central spine in the distribution network is also upgraded and additional network storage added as demand grows. Ultimately the Kerikeri WTP, which was first built in 1971, is renewed.

Water is primarily sourced from Lake Waingaro but with an increased allocation and available flow rate from KIC. The Puketotara source is retained to augment capacity and provide a backup source.

The general arrangement of Option 1 is shown in Figure 5.3-1. It would be implemented in 3 stages as set out below.

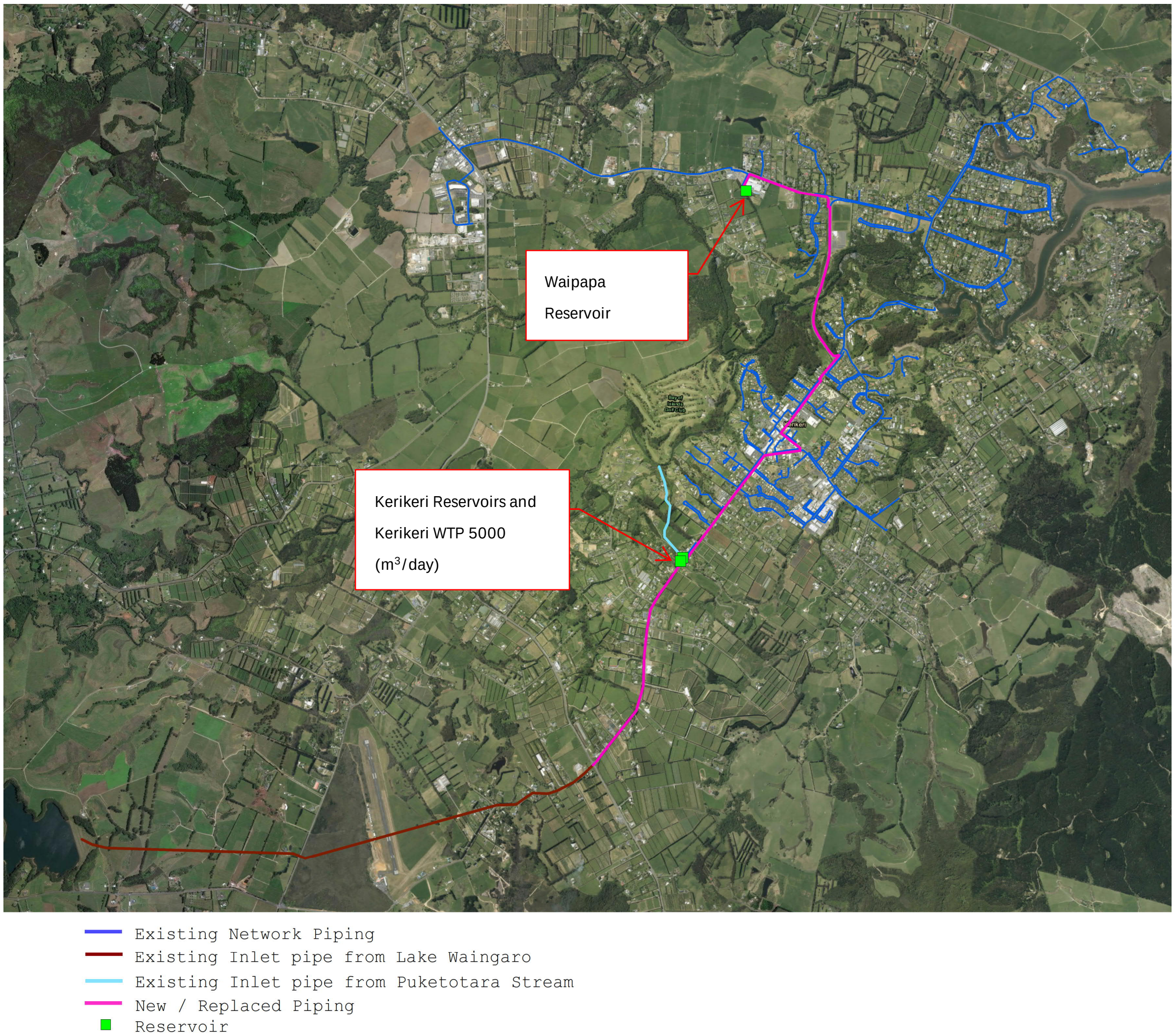


Figure 5.3-1: Option 1 Schematic – At completion of Stage 3

Stage 1 (2020 – 2025)

Stage 1 addresses the pressing issues with the Kerikeri water supply scheme.

The existing Kerikeri WTP is upgraded from its current rated capacity of 3,500m^3/day to 4,000m^3/day in the first 5 years. This 4,000m^3/day capacity allows the plant to meet the projected sustained average summer 5 day peak up to around 2033. The exact composition of the upgrade works would be determined by a more detailed study. For this study, the assumed upgrade would replace the existing clarifier (that is in poor condition and presents an immediate risk) and add a new lamella separator where the sand filters have reached the end of their serviceability.

The infrastructure associated with the Puketotara source would also be upgraded including the raw water line from the abstraction point to the WTP.

To ensure the required flow of raw water from Lake Waingaro is available to the plant, FNDC's raw water line would be extended along Kerikeri Rd from Maraenui Drive to a new connection point on the KIC line at SH10. This raw water line extension would be approximately 1.5 km of increased diameter pipeline (notionally 375mm ID) and would enable FNDC to tap into the KIC line where it is DN 600. The current connection point taps into a DN 375 KIC line. The proposed diameter of this 1.5km section would need to be agreed with KIC to ensure that adequate flow and pressure can be provided for all customers of the KIC network including Kerikeri WTP.

Possible consenting for this stage includes an Outline Plan (given the designated nature of the WTP site), an alteration to the designation (should additional land be required) and resource consents under the Northland Regional Plan (should the works trigger consent any discharge or bulk earthworks controls).

Stage 2 (2025 – 2030)

Stage 2 focuses on upgrading the distribution system to meet LoS requirements under the forecast increase in demand.

The existing AC central main, or spine, running through the network and linking the Waipapa treated water reservoir is replaced with approximately 5 km of 375mm ID watermain. This option assumes full replacement of the existing mains which would involve changing over any existing service connections to the new main. In this way, these works have a renewal component, replacing the older existing AC mains. Alternatively, the existing mains could be retained and the new main could be implemented as an independent transmission line with occasional cross connections to the existing AC spine (approximately every 500 – 1,000m). The benefits of this alternative could be explored with further study, referencing the condition of the existing AC pipes and their effective remaining serviceable life.

These works will also allow the network to work more efficient. Currently the mains are boosted by pumping to meet the required LoS but with adequately sized pipes, this could be done by gravity alone for majority of the network. Provision of the 375mm ID main will allow the mains to operate under gravity negating need for booster pumping for majority of the network.

This stage includes the provision of an additional 1,500 m^3 of treated water storage to meet FNDC Engineering Standards' requirement of a minimum of 2 day's storage. The timing of this will be driven by demand – the current demand forecasting suggests this may be required around 2030 and the 1500 m^3 increase in storage would be adequate for another 10 years. The location of this reservoir would be subject to more detailed study.

Possible consenting for this stage would include resource consents for the upgrading of distribution infrastructure (e.g. land use consents for earthworks) and the discharge of contaminants (if any works take place where there is contaminated soil). A Notice of Requirement to designated new water storage facilities is likely to be required, followed by an Outline Plan prior to construction at the designated storage site(s).

Stage 3 (2030 – 2035)

Stage 3 upgrades and renews the Kerikeri WTP from 4,000m^3/day to 5,000m^3/day and renews the two treated water reservoirs on the WTP site. Process elements renewed in the prior 2025 WTP upgrade are retained as appropriate but any remaining elements from the original 1971 construction are replaced.

At this stage it is assumed the upgrade will comprise renewing the entire treatment process, but this would be reviewed in further study and investigation, nearer the time of the upgrade.

This stage may require additional consents and changes to the WTP site's designation, although these consenting requirements would be confirmed once further design is undertaken.

5.3.2.2 Option 1 Costs

A high-level indicative cost for this option are in Table 5-5. These costs have an accuracy of +/-30%.

Table 5-5 Option 1 Cost Estimate

Physical works construction (all stages)	$16.8M
Consenting, design, construction management	$5M
Subtotal	$21.5M
Contingency (30%)	$6.4M
Total indicative cost	$28.2M

A more detailed build-up of this estimate is provided in Appendix C.

5.3.2.3 Option 1 Summary

A summary of Option 1 is presented in Table 5-6.

Table 5-6:Option 1 Summary

Stage	Element	Description	Timing	Cost
Stage 1				
1a	Upgrade Kerikeri WTP to 4000m^3/day	This upgrade addresses the immediate issues at the plant, replacing the clarifier and sand filters, and increases capacity to 4000m^3/day.	2020 - 2025	$7M
1b	Upgrade the inlet works and delivery line for the Puketotara source	Renews aging asset. Increases capacity and allows for higher delivery flow rate from Puketotara source.	2020 - 2025	$1.5M
1c	Relocate FNDC connection point on KIC Lake Waingaro supply line and extend FNDC supply line	New 1.5 km raw water pipeline extension from KIC current connection point at Maraenui Rd to new KIC connection point at SH10. Diameter subject to discussion with KIC to ensure adequate pressure	2020 - 2025	$2.7M

Stage	Element	Description	Timing	Cost
		and flow for all customers in KIC network (notionally 375mm ID). Increases capacity and allows for higher delivery flow rate from KIC line.		
Stage 2				
2a	Upgrade distribution spine in Kerikeri network	5 km of new 375mm ID watermain to improve network performance and meet LoS requirements. Allows mains to operate under gravity negating need for booster pumping for majority of customers.	2025 - 2030	$8.7M
2b	Additional treated water storage	New 1,500 m^3 storage reservoir (site TBC) to provide additional storage for further 10 years plus.	2030	$1.6M
Stage 3				
3a	Upgrade and renew Kerikeri WTP from 4000m^3/day to 5000m^3/day	This upgrade includes replacement of the bulk of the original WTP elements retaining components from the 2025 upgrade where appropriate	2030 - 2035	$5M
3b	Replace existing reservoirs at Kerikeri WTP	Total storage to be replaced is 1,500 m^3	2035	$1.7M

5.3.3 Option 2

5.3.3.1 Option 2 Description

Under Option 2, Kerikeri's primary water source ultimately switches from Lake Waingaro to Lake Manuwai with a new WTP at Lake Manuwai. The objective of this switch is to ultimately have access to a larger reserve of water.

Option 2 includes the same Stages 1 & 2 as Option 1. It too upgrades the existing Kerikeri WTP to meet future demand, upgrades the central spine in the distribution network and provides additional network storage as demand grows. In Stage 3, Kerikeri WTP is replaced with a new 5,000m^3 Northwest WTP in the vicinity of Lake Manuwai. At this stage, water from the Puketotara source would no longer be available for treatment.

The general arrangement of Option 2 is shown in Figure 5.3-2. It would be implemented in 3 stages as set out below.

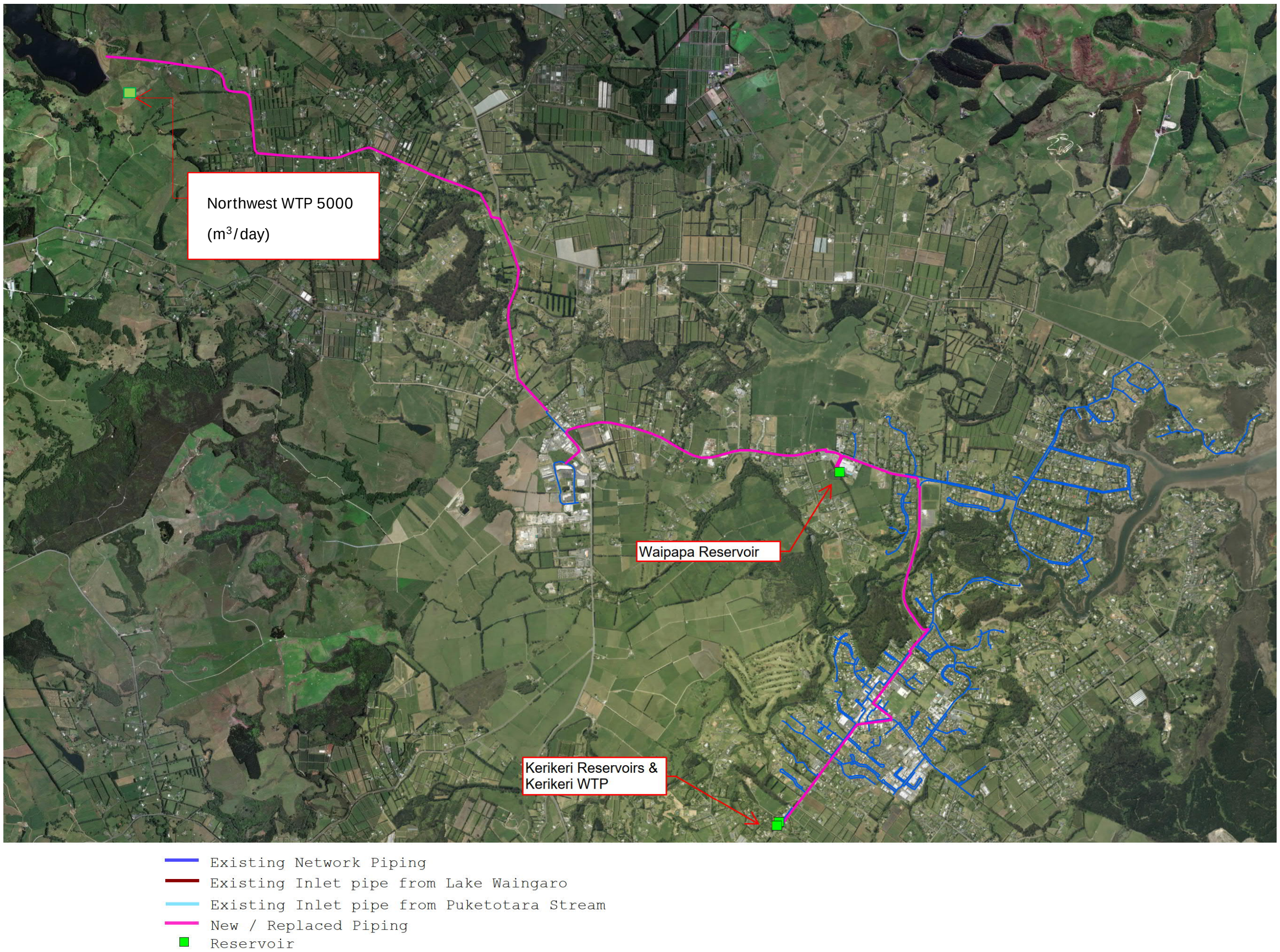


Figure 5.3-2: Option 2 Schematic – At completion of Stage 3

Stage 1 (2020 – 2025)

Stage 1 addresses the pressing issues with the Kerikeri water supply scheme and is the same as that for Option 1 (refer Section 5.3.2.1 for details)

Stage 2 (2025 – 2030)

Stage 2 focuses on upgrading the distribution system to meet LoS requirements under the forecast increase in demand and is the same as that for Option 1 (refer Section 5.3.2.1 for details).

Stage 3 (2030 – 2035)

Stage 3 provides a new 5,000m^3/day Northwest WTP near Lake Manuwai together with a new 9 km treated water transmission line from the WTP to the Waipapa Rd Reservoir. The Kerikeri WTP is decommissioned and the two water reservoirs on the site are replaced.

The site of the WTP would need to be confirmed with further investigations and study. Keeping the WTP close to Lake Manuwai is desirable as it maintains a higher elevation and makes the scheme more efficient by allowing gravity flow to the Waipapa reservoir (and potential gravity flows to the reservoirs at the current Kerikeri WTP site).

At this stage it is assumed the new plant will comprise renewing the entire treatment process, but this would be reviewed in further study and investigation, nearer the time of the upgrade.

The treated water transmission line would be 375mm ID with an assumed route running east from Lake Manuwai along Ness Rd, Waipapa West Rd, SH10 and then east along Waipapa Rd to the Waipapa Reservoir.

Potential consenting issues include securing a resource consent for the extraction of surface water and undertaking physical works within the lake. Additional planning approvals are likely to be needed for any new reticulation, while a Notice of Requirement and resource consents would be needed for the new WTP.

5.3.3.2 Option 2 Costs

A high-level indicative cost for this option are in Table 5-7. These costs have an accuracy of +/-30%.

Table 5-7 Option 2 Cost Estimate

Physical works construction (all stages)	$17.8M
Consenting, design, construction management	$5.8M
Subtotal	$23.6M
Contingency (30%)	$7.0M
Total indicative cost	$30.6M

A more detailed build-up of this estimate is provided in Appendix C.

5.3.3.3 Option 2 Summary

Option 2 is summarised in Table 5-8.

Table 5-8:Option 2 Summary

Stage	Element	Description	Timing	Cost
Stage 1				
1a	Upgrade Kerikeri WTP to 4000m^3/day	This upgrade addresses the immediate issues at the plant, replacing the clarifier and sand filters, and increases capacity to 4,000m^3/day.	2020 - 2025	$7.1M
1b	Upgrade the inlet works and delivery line for the Puketotara source	Renews aging asset. Increases capacity and allows for higher delivery flow rate from Puketotara source.	2020 - 2025	$1.5M
1c	Relocate FNDC connection point on KIC Lake Waingaro supply line and extend FNDC supply line	New 1.5 km raw water pipeline extension from KIC current connection point at Maraenui Rd to new KIC connection point at SH10. Diameter subject to discussion with KIC to ensure adequate pressure and flow for all customers in KIC network (notionally 375mm ID). Increases capacity and allows for higher delivery flow rate from KIC line.	2020 - 2025	$2.7M
Stage 2				
2a	Upgrade distribution spine in Kerikeri network	5 km of new 375mm ID watermain to improve network performance and meet LoS requirements. Allows mains to operate under gravity negating need for booster pumping.	2025 - 2030	$8.9M
2b	Additional treated water storage	New 1,500 m^3 storage reservoir (site TBC) to provide additional storage for further 10 years plus.	2030	$1.6

Stage	Element	Description	Timing	Cost
Stage 3				
3a	New Northwest WTP with 5000m^3/day	New 5,000m^3/day capacity WTP constructed in the north west (site TBC) to receive raw water from Lake Manuwai	2030 - 2035	$5.5M
3b	New raw water transmission line from Lake Manuwai to new Northwest WTP, new transmission line to Waipapa and upgrade of watermain along Waipapa Rd west.	9 km of new 375mm ID connecting; Lake Manuwai to new WTP and new WTP to Waipapa Reservoir. Allows raw water to be delivered to new WTP and for treated water from new plant to be delivered to Kerikeri network.	2030 - 2035	$800k
3c	Decommission existing Kerikeri WTP and replace existing reservoirs		2035	$2.5M

5.3.4 Option 3

5.3.4.1 Option 3 Description

Under Option 3, Kerikeri retains its Lake Waingaro and Puketotara Stream water sources and gains the additional Lake Manuwai source with an associated new WTP at Lake Manuwai. The objective of this option is to ultimately have access to a larger reserve of water whilst retaining more than one water source.

Option 3 includes the same Stages 1 & 2 as Option 1 (and 2). It too upgrades the existing Kerikeri WTP to meet future demand, upgrades the central spine in the distribution network and provides additional network storage as demand grows. In Stage 3 a new 1,000m^3/ day Northwest WTP is provided in the vicinity of Lake Manuwai and the Kerikeri WTP is renewed.

Note that the 1,000m^3 /day Northwest capacity augments the 4,000m^3/day capacity of the upgraded Kerikeri WTP to provide the total required 5,000m^3/ day capacity. However, this will mean that neither plant can meet the full demand requirement independently which in turn means that both lake sources would need to be available for peak demand. A variant of this option that would overcome this would be to have the Northwest plant with a 5,000m^3/ day capacity as with Option 2 but this would come with significant extra cost.

The general arrangement of Option 3 is shown in Figure 5.3-3. It would be implemented in 3 stages as set out below.

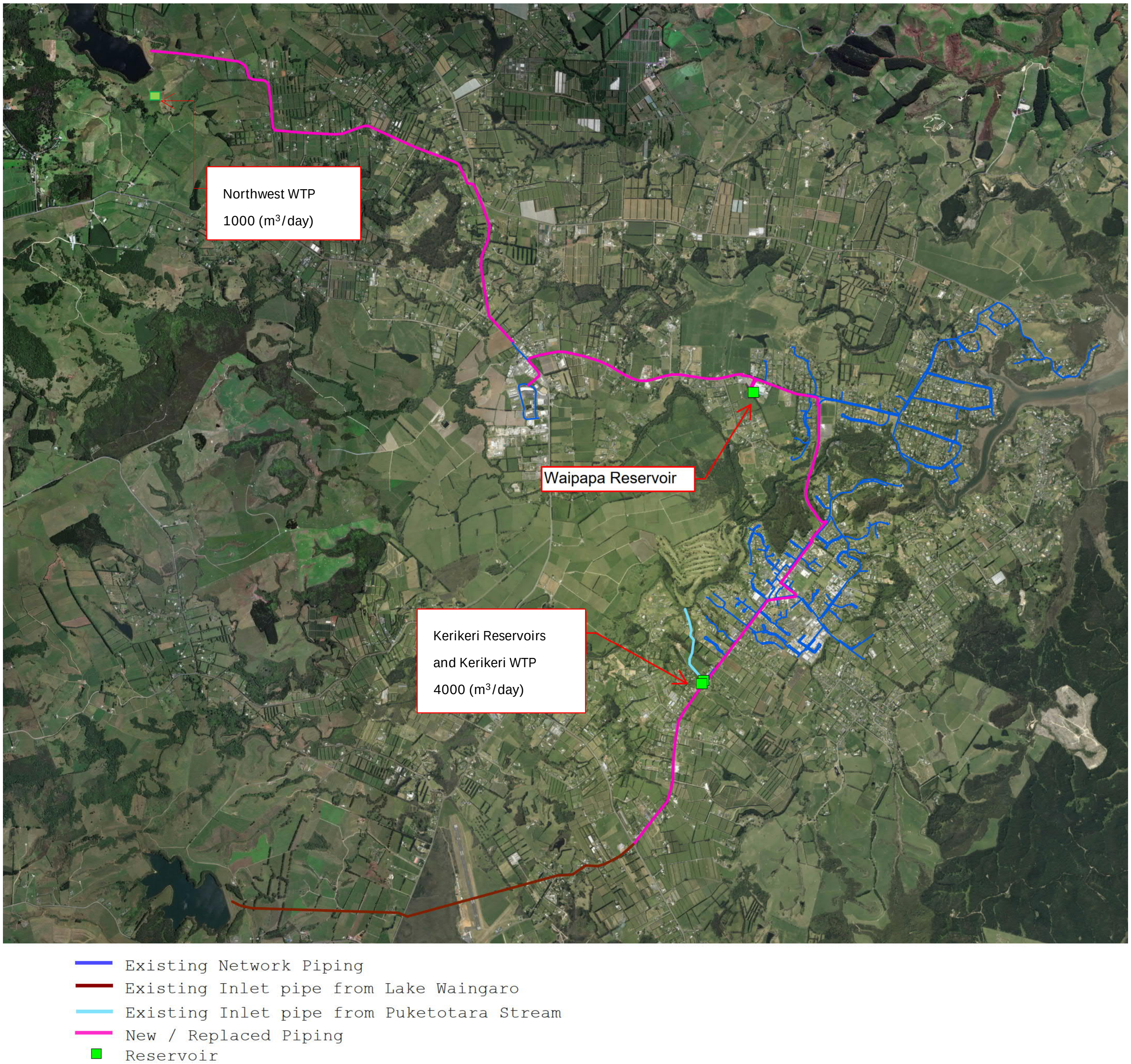


Figure 5.3-3: Option 3 Schematic – At completion of Stage 3

Stage 1 (2020 – 2025)

Stage 1 addresses the pressing issues with the Kerikeri water supply scheme and is the same as that for Option 1 (refer Section 5.3.2.1 for details)

Stage 2 (2025 – 2030)

Stage 2 focuses on upgrading the distribution system to meet LoS requirements under the forecast increase in demand and is the same as that for Option 1 (refer Section 5.3.2.1 for details).

Stage 3 (2030 – 2035)

Stage 3 provides a new 1,000m^3/day Northwest WTP near Lake Manuwai together with a new 9 km treated water transmission line from the WTP to the Waipapa Rd Reservoir. The Kerikeri WTP is renewed and the two water reservoirs on the site are replaced.

The site of the WTP would need to be confirmed with further investigations and study. Keeping the WTP close to Lake Manuwai is desirable as it maintains a higher elevation and makes the scheme more efficient by allowing gravity flow to the Waipapa reservoir.

At this stage it is assumed the new plant will be a containerised WTP unit, but this would be reviewed in further study and investigation, nearer the time of the upgrade.

The treated water transmission line would likely be a combination of 250mm ID and 300mm ID with an assumed route running east from Lake Manuwai along Ness Rd, Waipapa West Rd, SH10 and then east along Waipapa Rd to the Waipapa Reservoir. Note that the diameter for this line is less than that in Option 2 as it is has a lower capacity requirement as supply is also coming from the Kerikeri WTP.

Stage 3 also renews the Kerikeri WTP but maintains its capacity at 4,000m^3/day. Process elements renewed in the prior 2025 WTP upgrade are retained as appropriate but any remaining elements from the original 1971 construction are replaced. The sites two treated water reservoirs are also replaced.

At this stage it is assumed the upgrade will comprise renewing the entire treatment process, but this would be reviewed in further study and investigation, nearer the time of the upgrade.

Similar planning approvals to Option 2 would be required to be undertaken these works.

5.3.4.2 Option 3 Costs

A high-level indicative cost for this option are in Table 5-9. These costs have an accuracy of +/-30%.

Table 5-9 Option 3 Cost Estimate

Physical works construction (all stages)	$23.1M
Consenting, design, construction management	$7.3M
Subtotal	$30.4M
Contingency (30%)	$9M
Total indicative cost	$39.4M

A more detailed build-up of this estimate is provided in Error! Reference source not found.

5.3.4.3 Option 3 Summary

Option 3 is summarised in Table 5-10 below.

Table 5-10:Option 3 Summary

Stage	Element	Description	Timing	Cost
Stage 1				
1a	Upgrade Kerikeri WTP to 4,000m^3/day	This upgrade addresses the immediate issues at the plant, replacing the clarifier and sand filters, and increases capacity to 4,000m^3/day.	2020 - 2025	$7.1M
1b	Upgrade the inlet works and delivery line for the Puketotara source	Renews aging asset. Increases capacity and allows for higher delivery flow rate from Puketotara source.	2020 - 2025	$1.5M
1c	Relocate FNDC connection point on KIC Lake Waingaro supply line and extend FNDC supply line	New 1.5 km raw water pipeline extension from KIC current connection point at Maraenui Rd to new KIC connection point at SH10. Diameter subject to discussion with KIC to ensure adequate pressure and flow for all customers in KIC network (notionally 375mm ID). Increases capacity and allows for higher delivery flow rate from KIC line.	2020 - 2025	$2.7M
Stage 2				
2a	Upgrade distribution spine in Kerikeri network	5 km of new 375mm ID watermain to improve network performance and meet LoS requirements. Allows mains to operate under gravity negating need for booster pumping.	2025 - 2030	$8.9M
2b	Additional treated water storage	New 1,500 m^3 storage reservoir (site TBC) to provide additional storage for further 10 years plus.	2030	$1.6M

Stage	Element	Description	Timing	Cost
Stage 3				
3a	New Northwest WTP with 1000m^3/day	New 1,000m^3/day capacity WTP constructed in the north west (site TBC) to receive raw water from Lake Manuwai	2030 - 2035	$1.6
3b	New raw water transmission line from Lake Manuwai to new Northwest WTP, new transmission line to Waipapa and upgrade of watermain along Waipapa Rd west.	9 km of new 250/ 300mm ID connecting; Lake Manuwai to new WTP and new WTP to Waipapa Reservoir. Allows raw water to be delivered to new WTP and for treated water from new plant to be delivered to Kerikeri network.	2030 - 2035	$12.5M
3c	Renew Kerikeri WTP	This includes replacement of the bulk of the original WTP elements retaining components from the 2025 upgrade where appropriate	2030 - 2035	$1.8
3d	Replace existing reservoirs at Kerikeri WTP	Total storage to be replaced is 1,500 m^3	2035	$1.7M

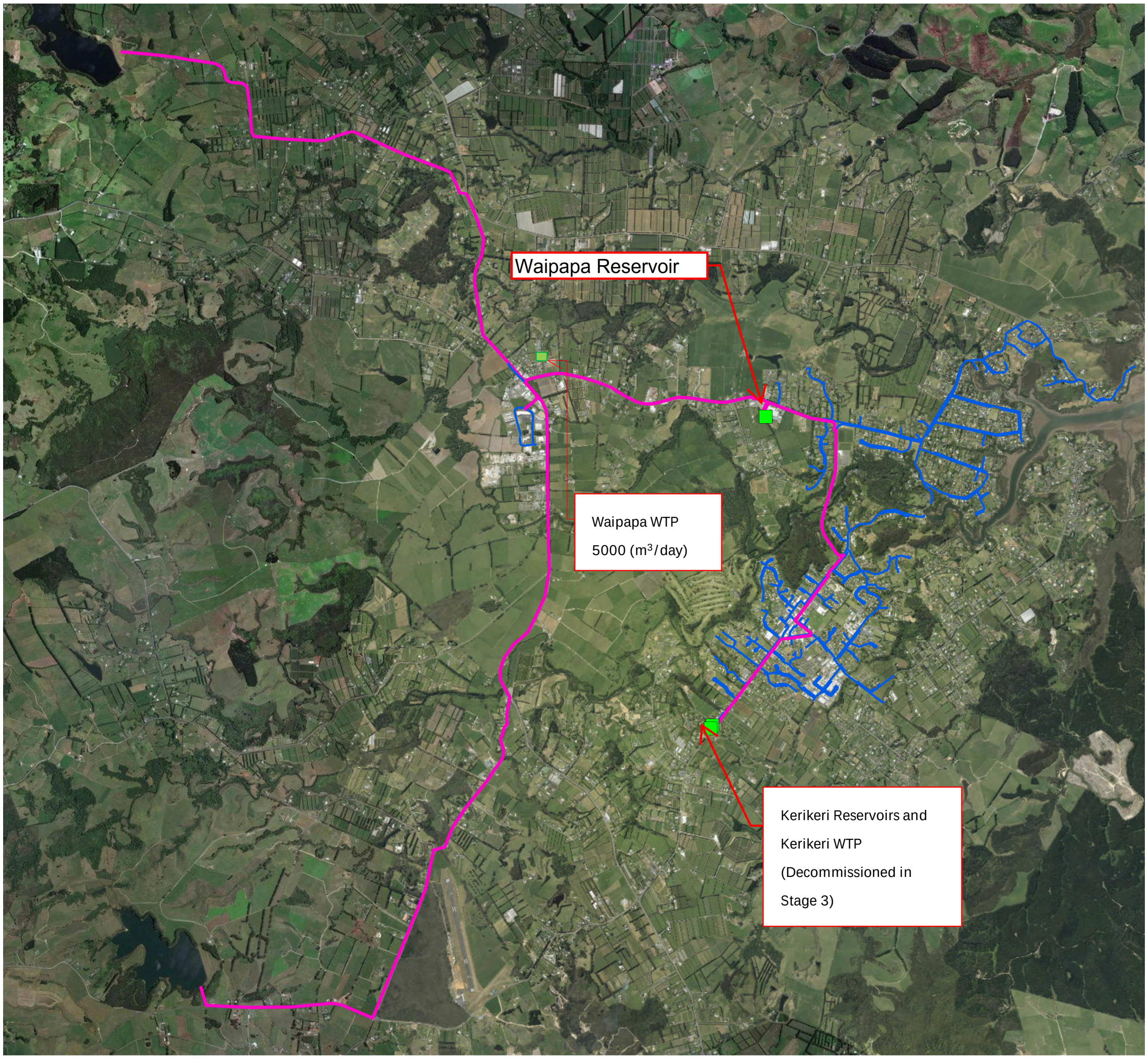
5.3.5 Option 4

5.3.5.1 Option 4 Description

Under Option 4, Kerikeri retains its Lake Waingaro and Puketotara Stream water sources and gains the additional Lake Manuwai source with a single new WTP near Waipapa. The objective of this option is to ultimately have access to a larger reserve of water whilst retaining more than one water source and have a single centralised WTP.

Option 4 includes the same Stages 1 & 2 as Option 1. It too upgrades the existing Kerikeri WTP to meet future demand, upgrades the central spine in the distribution network and provides additional network storage as demand grows. In Stage 3 a new 5000m^3/ day Waipapa WTP is provided in the vicinity of Waipapa and the Kerikeri WTP is retired.

The general arrangement of Option 4 is shown in Figure 5.3-4. It would be implemented in 3 stages as set out below.



Existing Network Piping
Existing Inlet pipe from Lake Waingaro
Existing Inlet pipe from Puketotara Stream
New / Replaced Piping
Reservoir

Figure 5.3-4: Option 4 Schematic – At completion of Stage 3

Stage 1 (2020 – 2025)

Stage 1 addresses the pressing issues with the Kerikeri water supply scheme and is the same as that for Option 1 (refer Section 5.3.2.1 for details)

Stage 2 (2025 – 2030)

Stage 2 focuses on upgrading the distribution system to meet LoS requirements under the forecast increase in demand and is the same as that for Option 1 (refer Section 5.3.2.1 for details).

Stage 3 (2030 – 2035)

Stage 3 provides a new 5,000m^3/day Waipapa WTP near Waipapa township. The new WTP would be fed by raw water transmission lines from Lake Manuwai (7 km of 375mm ID) and Lake Waingaro (9 km of 375mm ID). The Puketotara Stream source would no longer be available. A new transmission main would connect the WTP to the Waipapa Rd Reservoir. The Kerikeri WTP is decommissioned and the two water reservoirs on the site are replaced.

The preferred site of the WTP would need to be confirmed with further investigations and study. The aim would be to keep the location as elevated as possible but able to be readily connected to the raw water lines from Lake Manuwai to the northwest and Lake Waingaro to the southwest.

At this stage it is assumed the new plant will comprise renewing the entire treatment process, but this would be reviewed in further study and investigation, nearer the time of the upgrade.

The assumed route of the 375mm ID raw water line from Lake Manuwai would run east from Lake Manuwai along Ness Rd, Waipapa West Rd and SH10 to the chosen WTP site. The 375mm ID raw water line from Lake Waingaro would run east along Wiroa Rd and north along Waimate North Rd and SH10 to Waipapa.

A 375mm ID treated water transmission main would run from the WTP east along Waipapa Rd to the Waipapa Reservoir.

Planning approvals similar to Option 2 and 3 would be required.

5.3.5.2 Option 4 Costs

A high-level indicative cost for this option is in Table 5-11. These costs have an accuracy of +/-30%.

Table 5-11 Option 4 Cost Estimate

Physical works construction (all stages)	$31.6M
Consenting, design, construction management	$9.9M
Subtotal	$41.5M
Contingency (30%)	$12.3M
Total indicative cost	$53.8M

A more detailed build-up of this estimate is provided in Appendix C.

5.3.5.3 Option 4 Summary

Option 4 is summarised in Table 5-12.

Table 5-12: Option 4 Summary

Stage	Element	Description	Timing	Cost
Stage 1				
1a	Upgrade Kerikeri WTP to 4,000m^3/day	This upgrade addresses the immediate issues at the plant, replacing the clarifier and sand filters, and increases capacity to 4,000m^3/day.	2020 - 2025	$7.1M
1b	Upgrade the inlet works and delivery line for the Puketotara source	Renews aging asset. Increases capacity and allows for higher delivery flow rate from Puketotara source.	2020 - 2025	$1.5M
1c	Relocate FNDC connection point on KIC Lake Waingaro supply line and extend FNDC supply line	New 1.5 km raw water pipeline extension from KIC current connection point at Maraenui Rd to new KIC connection point at SH10. Diameter subject to discussion with KIC to ensure adequate pressure and flow for all customers in KIC network (notionally 375mm ID). Increases capacity and allows for higher delivery flow rate from KIC line.	2020 - 2025	$2.7M
Stage 2				
2a	Upgrade distribution spine in Kerikeri network	5 km of new 375mm ID watermain to improve network performance and meet LoS requirements. Allows mains to operate under gravity negating need for booster pumping.	2025 - 2030	$8.8M
2b	Additional treated water storage	New 1,500 m^3 storage reservoir (site TBC) to provide additional storage for further 10 years plus.	2030	$1.6M
Stage 3				
3a	New Northwest WTP with 5000m^3/day	New 5,000m^3/day capacity WTP constructed in the north west (site	2030 - 2035	$5.4M

Stage	Element	Description	Timing	Cost
		TBC) to receive raw water from Lake Manuwai		
3b	New raw water transmission line from Lake Manuwai to new Northwest WTP, new transmission line to Waipapa and upgrade of watermain along Waipapa Rd west.	7 km of new 375mm ID connecting; Lake Manuwai to new WTP and new WTP to Waipapa Reservoir. Allows raw water to be delivered to new WTP and for treated water from new plant to be delivered to Kerikeri network.	2030 - 2035	$12.5M
3c	Decommission Kerikeri WTP and replace existing reservoirs.	1,500 m^3 of storage replaced.	2035	$1.7
3d	New raw water transmission line from Lake Waingaro to new Northwest WTP	9 km of new 375mm ID piping from Lake Waingaro to new Northwest WTP. This allows access to both KIC water sources with treatment by a single WTP.	2035	$12.5M

5.3.6 Summary of Options

Table 5-13 lists and compares the benefits and risks of each of the proposed options.

Table 5-13 Comparison of Benefits and Risks for Proposed Options

	Option 1 – Lake Waingaro with Kerikeri WTP upgrade	Option 2 – Lake Manuwai with new WTP	Option 3 – Lake Manuwai and Waingaro with Kerikeri WTP and new WTP	Option 4 – Lake Manuwai and Waingaro with new WTP
Benefits	▪ Secure water supply for the design horizon ▪ Use of the existing WTP footprint ▪ New fit-for-purpose WTP	▪ Secure water supply for the design horizon ▪ New fit-for-purpose WTP	▪ Secure water supply for the design horizon ▪ Greater resilience with the use of both water sources ▪ Use of the existing WTP footprint ▪ New fit-for-purpose WTP	▪ Secure water supply for the design horizon ▪ Greater resilience with the use of both water sources ▪ New fit-for-purpose WTP

Risks	▪ Lack of diversity in water sources – only surface water ▪ Dependent on private water supply ▪ Raw water still prone to algal blooms	▪ Lack of diversity in water sources – only surface water ▪ High capex due to new supply infrastructure ▪ Dependent on private water supply ▪ Raw water still prone to algal blooms ▪ Land acquisition required ▪ Lengthier consultation process	▪ Lack of diversity in water sources – only surface water ▪ Dependent on private water supply ▪ Raw water still prone to algal blooms ▪ Large amount of mains infrastructure to be laid ▪ Land acquisition required ▪ Lengthier consultation process	▪ Lack of diversity in water sources – only surface water ▪ Dependent on private water supply ▪ High capex due to new supply infrastructure ▪ Raw water still prone to algal blooms ▪ Land acquisition required ▪ Lengthier consultation process

6. Scheme Options Assessment

6.1 MCA Analysis

This study used a Multi-Criteria Analysis (MCA) assessment framework to assess the shortlisted options described above. This has allowed the options to be ranked against assessment criteria and compared. Importantly, using an MCA assessment framework has enabled a structured, consistent, systematic and replicable process for assessing the options. The four shortlisted options were assessed using criteria from the five following categories;

- Operational Criteria – these criteria are associated to the operational performance of the options against sub criteria such as operability, constructability, redundancy and health and safety
- Environmental – these criteria are associated with the probable environmental impacts of each of the option, the ease of achieving RMA and drinking water compliance and also the ease of obtaining consents
- Community – these criteria address how each option will meet the needs and expectations of the Kerikeri community and tangata whenua
- Supply – these criteria specifically address the raw water source supplying each option to assess the performance against sub-criteria such as security, resilience and scaleability of the source
- Economic Criteria – these final criteria are associated with the likely capital and operating costs of each option and the ability stage investments over time.

6.1.1 Workshop

The MCA workshop for the shortlisted options took place on the 22nd of September 2020. The participants included key personnel from FNDC and Far North Waters (Ventia). Each of the shortlisted options were introduced, discussed and critiqued before progressing the MCA assessment. Assessment criteria was agreed upon during the workshop and grouped under the five categories. These are listed in Table 6-1. All participants evaluated the performance of each option against each sub criteria and a consensus score for each was agreed.

Table 6-1 Shortlisted Options MCA Criteria and Weightings

Criteria	Sub-criteria	Weighting
Economic Criteria (30%)	Capital Cost	40%
	Operating and Maintenance Costs	40%
	Project Timeline / Staging of Payments	20%
Supply (25%)	Security of Supply - access	40%
	Resilience - quality / quantity	40%
	Scaleability	20%
Community (10%)	Iwi Acceptance	33%

	Community Acceptance	33%
	Improved Level of Service (ability to meet LoS requirements)	33%
Environmental (10%)	Environmental Impact	40%
	Consentability / Compliance	60%
Strategic / Operational Criteria (25%)	Operability	30%
	Constructability	10%
	Redundancy	30%
	Health and Safety	30%

6.1.2 Option Assessment Outcome

Through the MCA exercise, Option 1 has been identified as the most favourable option, scoring more highly against the key criteria. The results of the MCA assessment are summarised in Table 6-2 and Figure 6.1-1.

Table 6-2 Results of MCA Analysis.

Key-Criteria Summary	Option 1	Option 2	Option 3	Option 4
Economic Criteria	0.24	0.20	0.15	0.13
Supply	0.07	0.08	0.23	0.19
Community	0.08	0.04	0.04	0.04
Environmental	0.10	0.04	0.04	0.00
Operational Criteria	0.12	0.15	0.09	0.17
Results	0.61	0.51	0.55	0.53
Rank	1	4	2	3

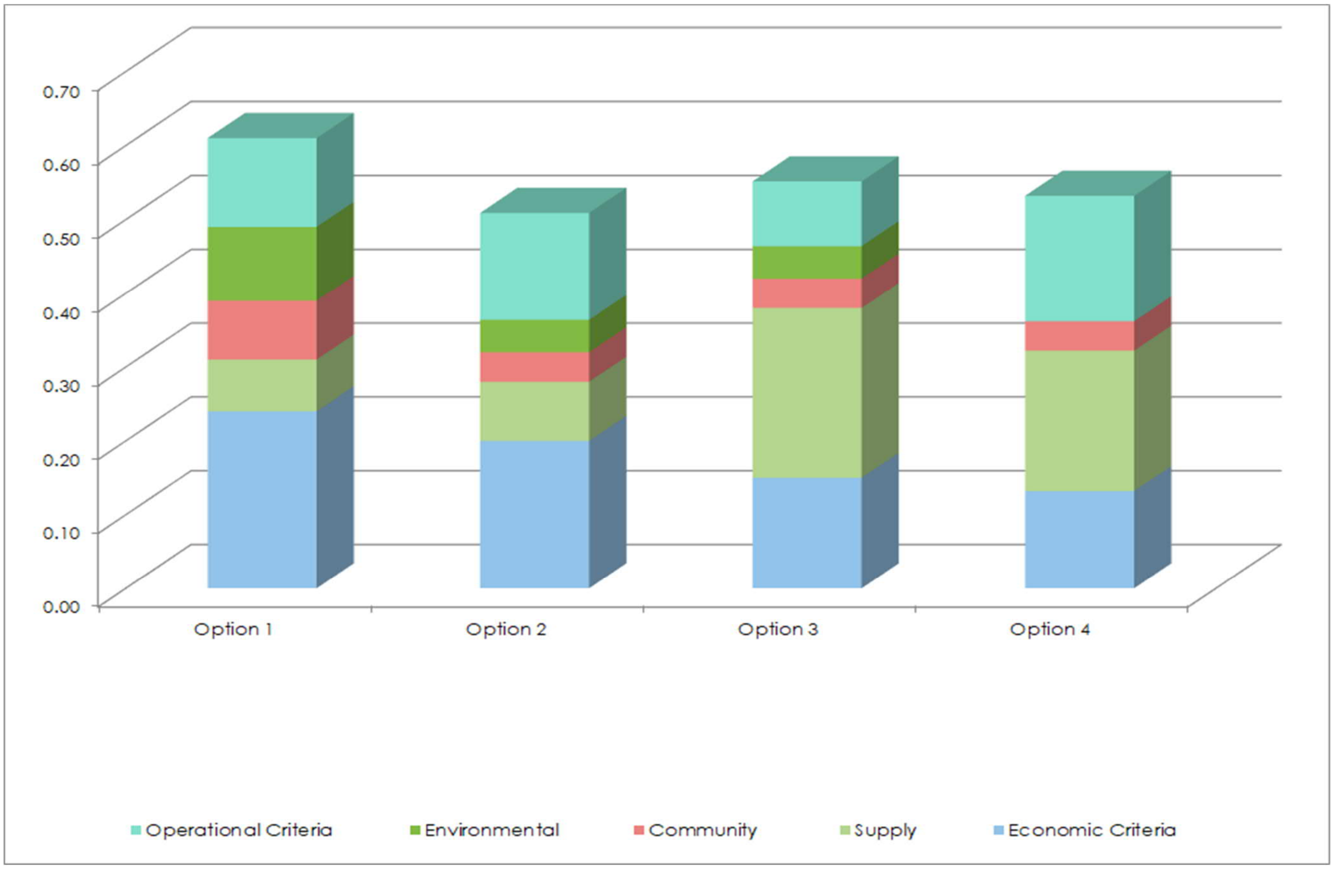


Figure 6.1-1 Results of MCA Analysis

6.1.2.1 Operational Criteria

In terms of operational criteria, the highest ranked option was Option 4. It scored highly for operability, constructability, redundancy and health and safety sub-criteria. This option was thought to have higher ease of construction as the WTP will be placed on a new site where there are fewer constraints relating to existing infrastructure. This option has scored highly for redundancy as the probable scheme features two raw water sources from both Lakes Manuwai and Waingaro.

Option 2 was the second ranked option for this category. Similar to Option 4, in terms of constructability, Option 2 would involve constructing a new WTP on a new site without the constraints involving existing infrastructure.

Options 1 and 3 were the lowest ranked options due to extensive work required to connect into existing infrastructure at the Kerikeri WTP and from the supply to the Kerikeri infrastructure.

6.1.2.2 Environmental

Option 1 scored the highest among environmental criteria. It was deemed to have the lowest environmental impact and greatest consentability, which result from continued use of the existing site and infrastructure.

Options 2 and 3 were the second ranked options, these options scored lower in both the environmental and consentability sub-criteria as these involve the development of new WTP's and also new supply pipelines from Lake Manuwai.

Option 4 was the lowest scored option.

6.1.2.3 Community

Option 1 was the highest-ranking option among sub-criteria for community. From an iwi perspective this option was thought to have the greatest favourability as it continues to use existing site and upgrade existing infrastructure. Option 1 was also thought to have the greatest improvement in meeting the requirements for level of service. All options scored the same for community acceptance.

Option 2, 3 and 4 performed equally as the lowest ranked options for this category.

6.1.2.4 Supply

Option 3 scored the highest among the sub-criteria related to the supply, it was thought to have the greatest security of supply and the greatest resilience of supply. This is due to this option receiving a raw water supply from Lake Manuwai, Puketotara stream and Lake Waingaro. The addition of the Lake Manuwai source was thought to add resilience to the quality and quantity of supply and also greater security of accessing supply for this option.

Option 4 was the second ranked option among the supply sub-criteria, it scored highly among the supply resilience and scaleability. Similar to Option 4, Option 4 also receives raw water supply from Lake Manuwai, Puketotara stream and lake Waingaro. It was thought to have the greatest scaleability, as it was comparably thought to have the greatest ease in implementing the option stages.

Options 1 and 2 were the lowest ranking criteria for this category. Option 1 was thought to have a moderate level of security of supply as it would continue to receive supply from both the Puketotara stream and Lake Waingaro.

6.1.2.5 Economic Criteria

In terms of economic criteria, Option 1 attained the highest ranking in terms of both capital and operating costs. This likely due to this option continuing to use existing WTP footprint, it always involves lower pipeline infrastructure upgrades and is only dependent on a single source of water supply. This has led to overall lower capital expenditure and construction related costs. Operating costs have not been drafted for any options yet, though most of the supply scheme for option 1 will be gravity driven this will lead to relatively lower operating costs.

Option 2 was the second in rank in terms of costs. For similar reasons as for option 1, the capital costs for this option will involve the development of a single 5000m^3/day WTP and only require the development of a pipeline from a single source of supply, Lake Manuwai.

Options 3 and 4 are the lowest ranked options in terms of cost, both involve the development of additional WTP infrastructure and also developing pipeline infrastructure for two sources of supply.

6.2 Preferred Option

The results of the MCA assessment have identified Option 1 as the preferred option.

This section;

- Sets out an indicative timeline for its implementation

- Reconciles the potential outcomes of this option with the objectives of the strategic case
- Sets out key assumptions that should be resolved before any final investment decisions are made.

6.2.1 Implementation Programme and Staging of Preferred Option

The indicative implementation programme of the preferred option (Option 1) is set out in Table 6-3 together with indicative costs. Note that the timing of Stages 2 and 3 could be delayed by reducing the rate of water demand growth through a demand management programme. Similarly, timelines can be pushed out if actual growth is lower than 2% growth rate assumed as the basis of the water demand forecasting.

Table 6-3These costs include an allowance for planning, design, construction monitoring and a 30% contingency.

Note that the timing of Stages 2 and 3 could be delayed by reducing the rate of water demand growth through a demand management programme. Similarly, timelines can be pushed out if actual growth is lower than 2% growth rate assumed as the basis of the water demand forecasting.

Table 6-3 Preferred Option Implementation Programme

Stage	Primary Focus	Activities	Timeline	Indicative Costs
1	Increasing network and WTP capacity to be able to deliver 4000m^3/day.	a) Upgrade Kerikeri WTP to 4000m^3/day b) Upgrade the inlet works and delivery line for the Puketotara source c) Relocate FNDC connection point on KIC Lake Waingaro supply line and extend FNDC supply line	2020 - 2025	$11.2M
2	Mains pipeline renewal and increasing treated water storage	a) Upgrade distribution spine in Kerikeri network b) Additional treated water storage	2025 – 2030 2030	$8.8M $1.5M
3	Renewals and increasing capacity at the Kerikeri WTP	a) Upgrade and renew Kerikeri WTP from 4000m^3/day to 5000m^3/day b) Replace existing reservoirs at Kerikeri WTP	2030 - 2035	$6.7M

6.2.2 Reconciliation of Preferred Option with Strategic Case Objectives

Table 6-4 reconciles the preferred option (Option 1) against the strategic case objectives problems identified previously.

Table 6-4 Reconciliation of Option 1 with Strategic Case Problems

	Problem	Preferred Option Performance
1	Poor historical land use and infrastructure planning integration has resulted in unplanned network and impacted on the affordability of services	Option 1 provides satisfactory level of service for the current service area and has the potential to be scaled to accommodate future expansions of this area if required.
2	Current/default rating policies and capital investment strategies for bulk water supply results in inequitable outcomes for all users	Option 1 in itself does not directly address this problem. However, Option 1 provides clarity and transparency of cost for the future development of the Kerikeri water supply scheme. This can be used to inform the development of future pricing regimes.
3	Reliance on surface water and private infrastructure is not able to meet customer expectations or provide sufficient resilience	Option 1 does not provide additional diversity to the water sources. However, this study has determined that there is significantly more allocation of water available from the Lake Waingaro reservoir than is currently available to FNDC. Furthermore, it is recommended that ground water investigations are carried out to identify supplementary water sources to provide better resilience.
4	Site constraints at existing WTP presents challenges with upgrading plant/equipment while operational resulting in ageing infrastructure that is not resilient to demand and supply issues	Option 1 provides addresses infrastructure issues at the WTP and provides for a staged increase in capacity that accommodates increasing demand whilst utilising the current site. By the end of design horizon all infrastructure in the Kerikeri WTP is completely replaced as well is the network spine watermain. The treatment process at the WTP will also be improved to cope with fluctuating water quality, to provide a consistent supply of high-quality drinking water and adding to the resiliency of the supply.

Table 6-5 discusses the reconciliation of the preferred option, Option 1 against the benefits identified in the investment logic mapping exercise.

Table 6-5 Reconciliation of Option 1 with Strategic Case Benefits

	Benefit	Preferred Option Performance
1	More confident/ optimised planning and infrastructure investment decisions	Option 1 has a three staged approach to meeting future demand progressively that provides clarity on how the scheme will evolve over time reducing the risk of redundant investments. This allows planning and investment decision to be reviewed periodically against initial assumptions and adjusted if required.
2	More transparent and equitable funding mechanism	The option provides a clear and transparent investment timeline over the next 40 years which will inform policy on funding mechanisms.
3	Improve resilience to climate change and security of supply of water	Option 1 has aims to improve the resilience improving each element of the scheme. New groundwater sources can be incorporated into Option 1 if they can be found and consents obtained.
4	A more resilient water supply for now and future.	Option 1 still relies on surface water sources only although a greater water allocation is obtained, improving ability to meet demand. However, groundwater potential should be investigated and if viable can be incorporated into this option. option to see if it is a viable freshwater source. A number of infrastructure upgrades are included which improve operational resilience.

6.2.3 Key Assumptions to be Resolved

This high level Kerikeri Water Supply Strategy has been a desktop study with some liaison with key stakeholders and supported by two workshops. As such, a number of assumptions would need to be resolved if this option was to be pursued. In doing so, various studies, tasks and agreements would need to be completed prior to committing to this option.

The following is a list of some key assumptions made for Option 1.

1) FNDC will be able to satisfactorily negotiate the required increase in water supply allocation from Lake Waingaro Reservoir with KIC.
2) KIC will satisfactorily maintain and renew their assets (specifically the main distribution pipeline from Lake Waingaro Reservoir) so that this supply is reliable and not prone to outages.
3) Algal bloom management in the Lake Waingaro Reservoir will be effective and/or the Kerikeri WTP will have the ability to satisfactorily treat raw water impacted by algal blooms.

A number of assumptions have been made in developing this option in terms of its capacity, the form and staging of the treatment process and the size and alignment of pipelines.

Some key assumptions here include;

1) Growth in demand will increase at 2%
2) Puketotara stream consent will be renewed (although this is not critical in meeting required water volumes)

3) The footprint available at the existing treatment plant will be sufficient for future upgrades (with civils work)
4) Pipeline routes approvals and consents can be secured
5) Level of treatment required is based on assumed raw water quality
6) Pipe sizes and routes are indicative and based on preliminary modelling.
7) The existing Kerikeri hydraulic network model has been used in assessing network performance – no updates or calibrations to the model were carried out prior to its use in this study

7. Conclusions

The following conclusions can be drawn from this study;

1) There is an immediate need to upgrade at least some elements of the Kerikeri WTP and a further need to increase its capacity within the next 5 years.
2) There is a need to upgrade parts of the Kerikeri distribution network over the next 5 years to meet levels of service under anticipated growth in demand.
3) It is theoretically possible, subject to satisfactory agreement with KIC, for Kerikeri's water sourcing needs to be met by the Lake Waingaro Reservoir for the next 30 years.
4) An option to implement 3) above has a total indicative cost of $27.7M (including 30% contingency) with $18M of this falling within the first 10 years.
5) No proven groundwater source available to FNDC has been identified in this study but there is merit in investigating groundwater options further to provide a more diverse and resilient range of water source options.
6) Lake Manuwai Reservoir offers a large potential alternative water source for Kerikeri which could meet the water demand well beyond 2040 but the infrastructure to access it is more costly than that for Lake Waingaro.
7) There is potential for implementation of a Water Demand Strategy to manage water demand within Kerikeri and delay the need to invest in infrastructure upgrades for its water supply scheme.

8. Recommendations

The following key recommendations are made;

1) FNDC engages with KIC to explore opportunities to increase their water allocation from Lake Waingaro Reservoir.
2) Investigation into potential new groundwater supply sources be investigated with the aim securing a water source that is not reliant on surface water.
3) Investigate opportunities for a new dammed reservoir with a hydrological review of flood frequency and identification of potential dam sites.
4) Investigation and design work is progressed for an upgrade of the Kerikeri Water Treatment Plant on its current site.
5) Investigation and design worked is progressed for an upgrade of the existing Puketotara Stream abstraction well and raw water line to the Kerikeri Water Treat Plant.
6) The existing Kerikeri network hydraulic model is updated and used to confirm performance of existing network under increasing demand and the need for any upgrades in the network.
7) A business case be prepared to support investment funding for the development of the Kerikeri water supply scheme to meet future demand requirements.

Appendix A. Network Performance

The below extracts visually demonstrate the network performance and Level of Service (LoS) summarised in Table 5-4.

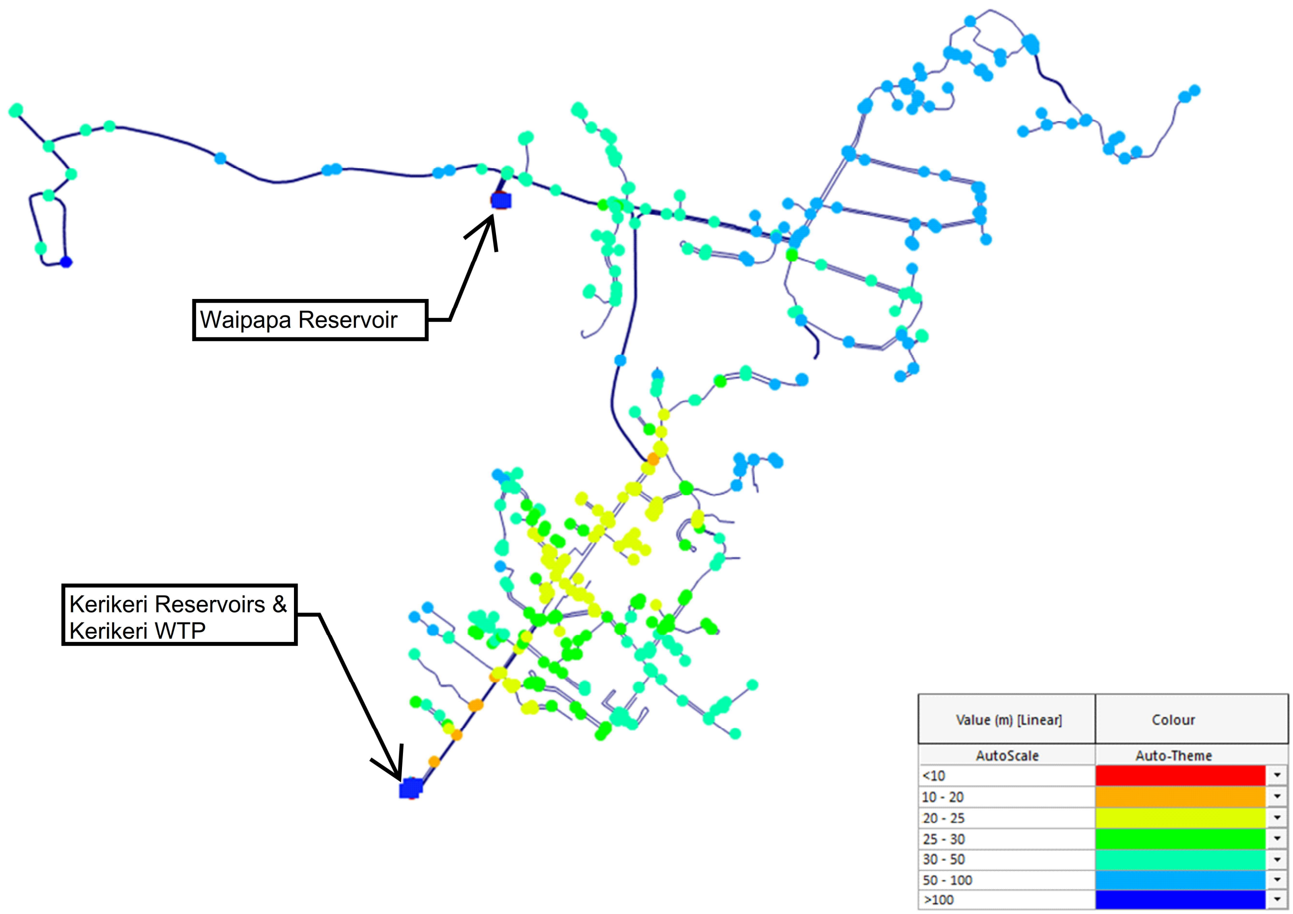


Figure 6.2-1: Scenario 1 – Current Network – Demand of 2,000 m^3/day

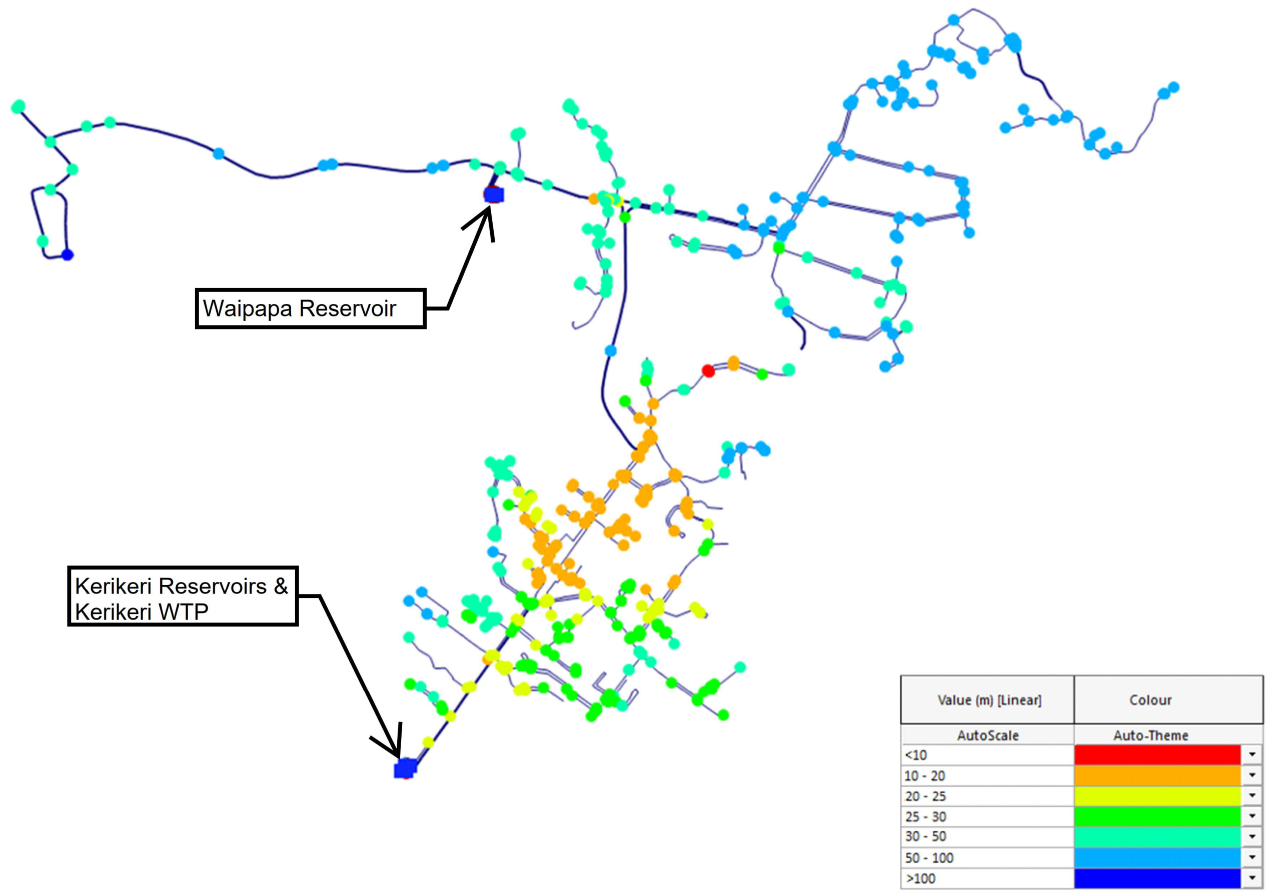


Figure 6.2-2: Scenario 2 – Current Network – Demand of 3,000 m^3/day

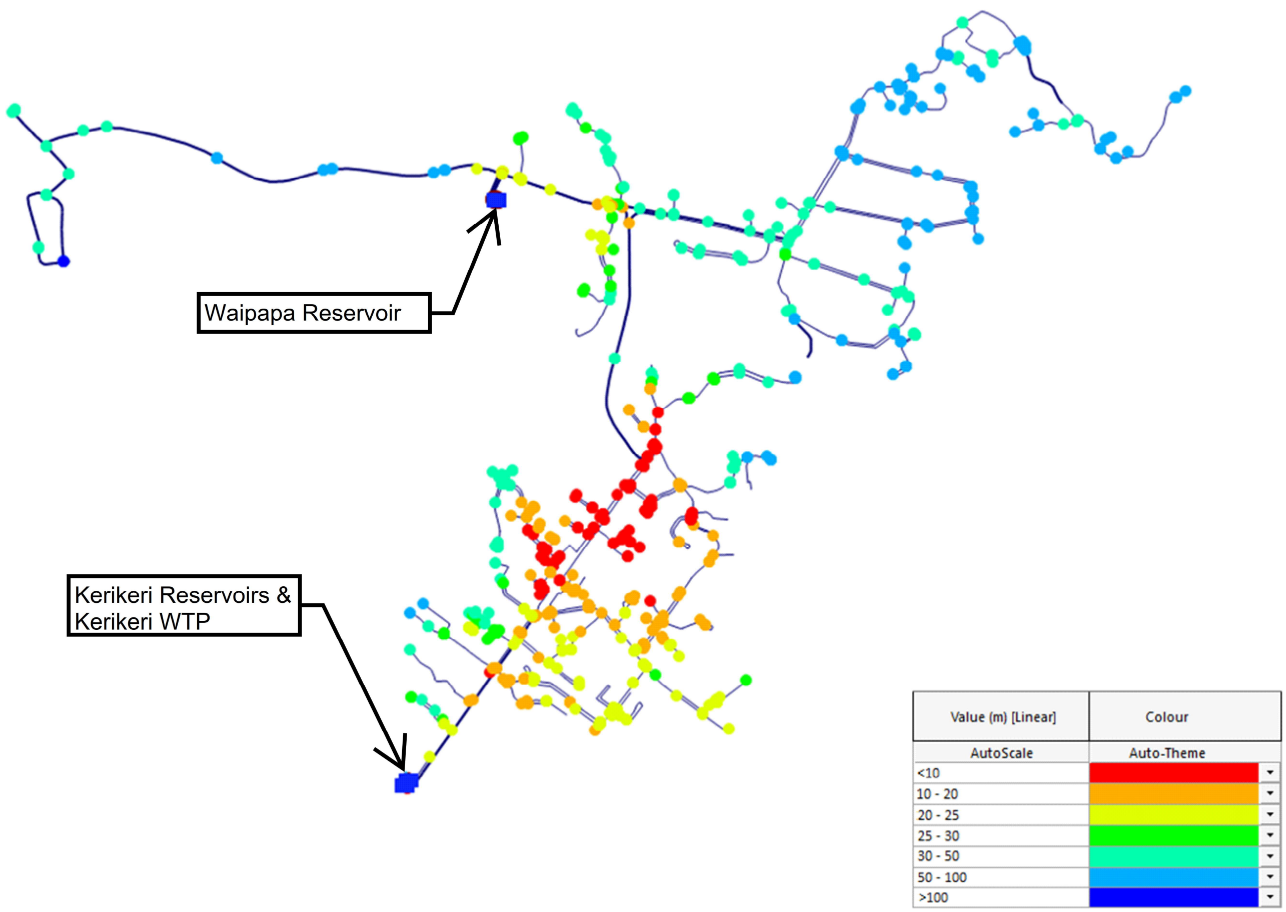


Figure 6.2-3: Scenario 3 – Current Network with modification to pump setpoints – Demand of 3,500 m^3/day

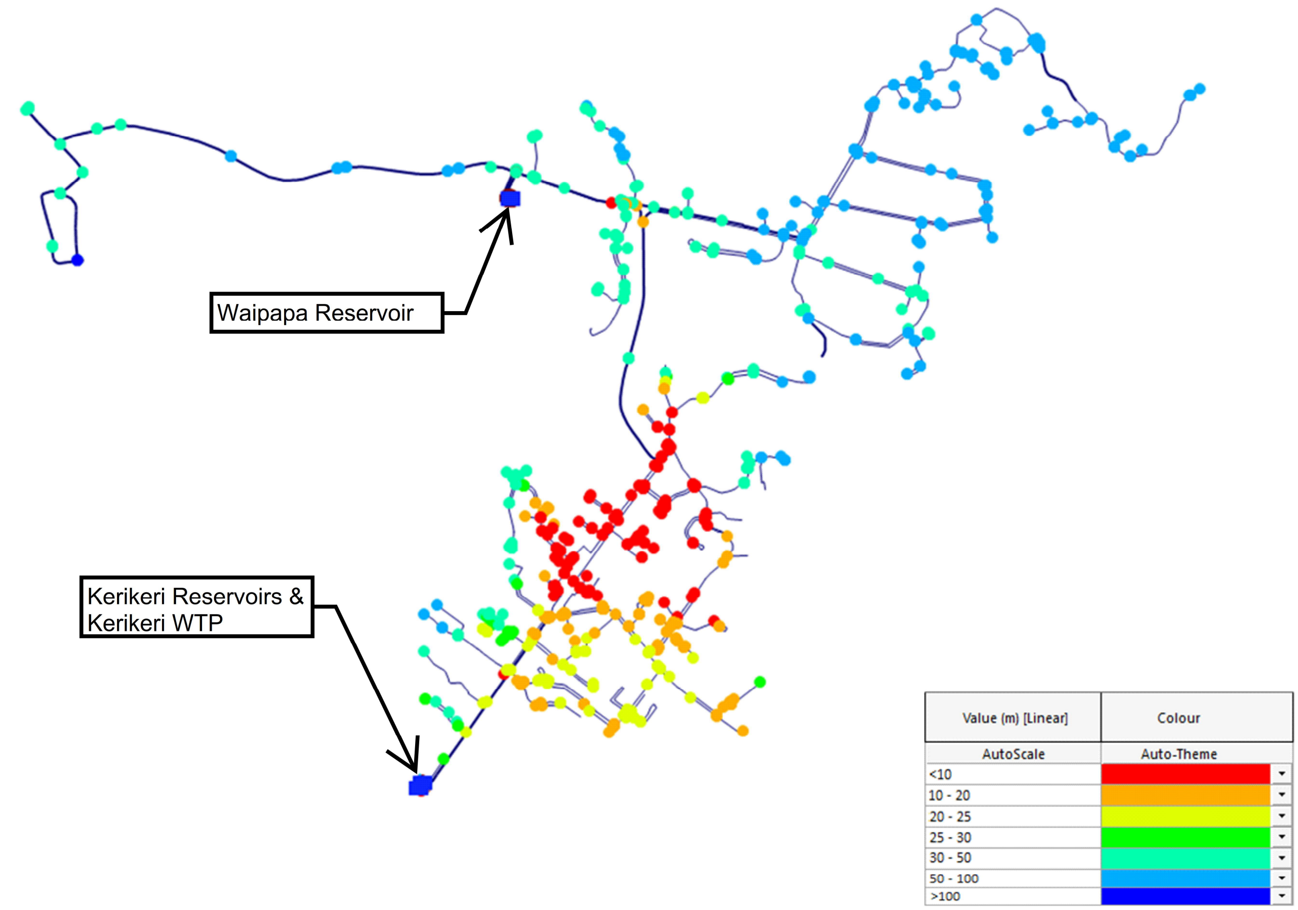


Figure 6.2-4: Scenario 4 – Current Network with upgrades to Kerikeri pumps and Riverview pumps – Demand of 4,000 m^3/day

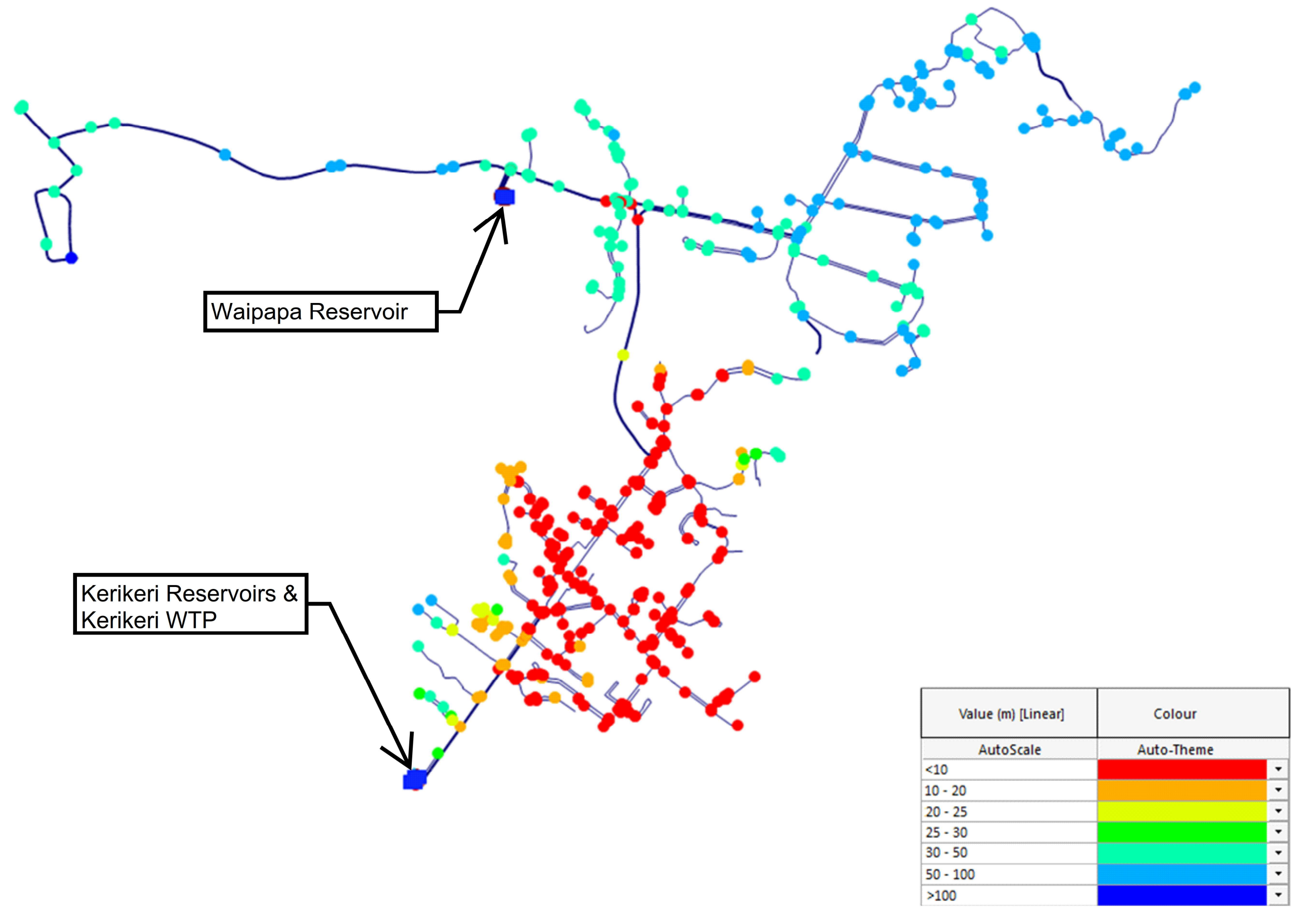


Figure 6.2-5: Scenario 5 – Current Network with upgrades to Kerikeri pumps and Riverview pumps – Demand of 5,000 m^3/day

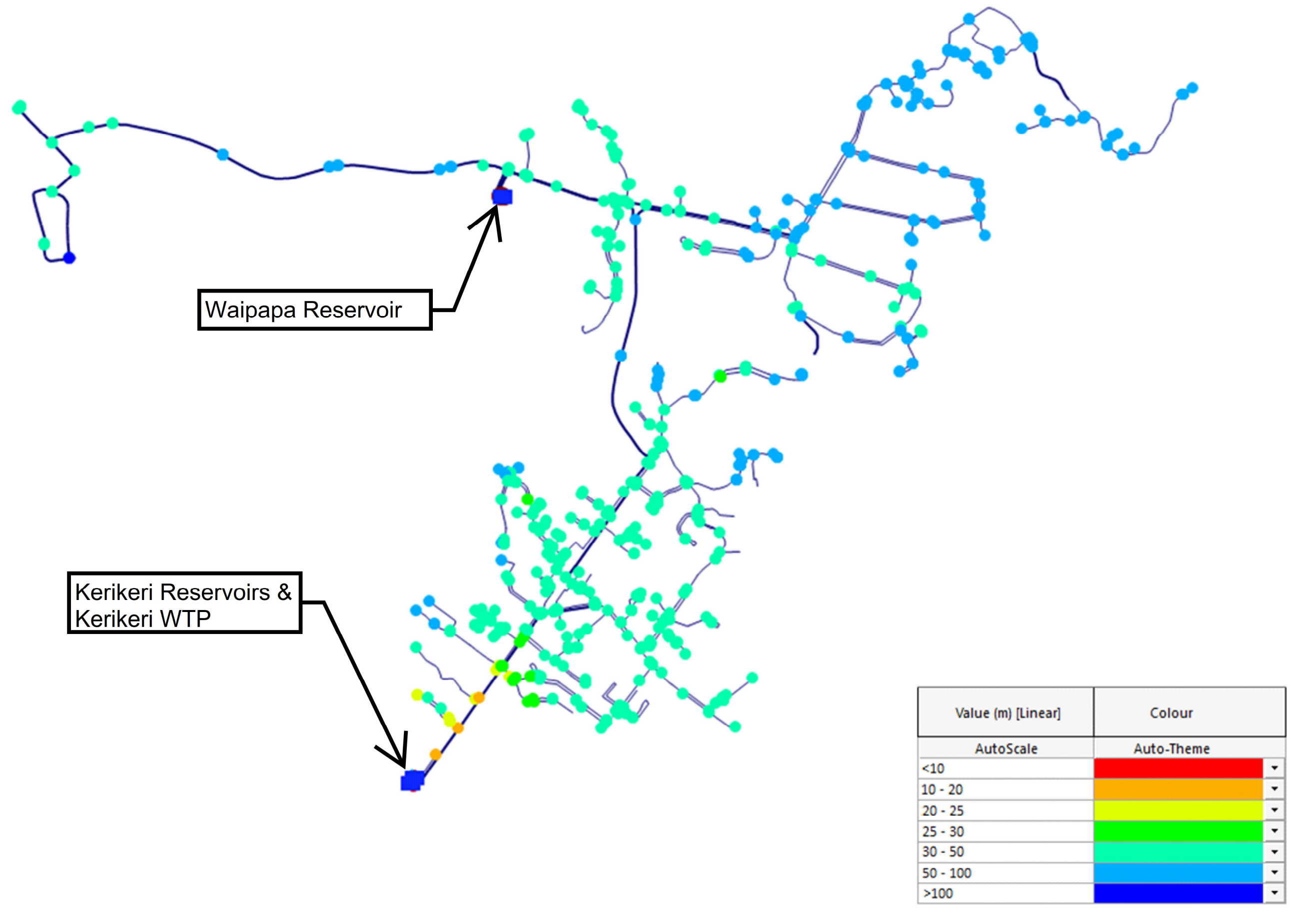


Figure 6.2-6: Scenario 6 – Upgraded network spine – Demand of 3,000 m^3/day

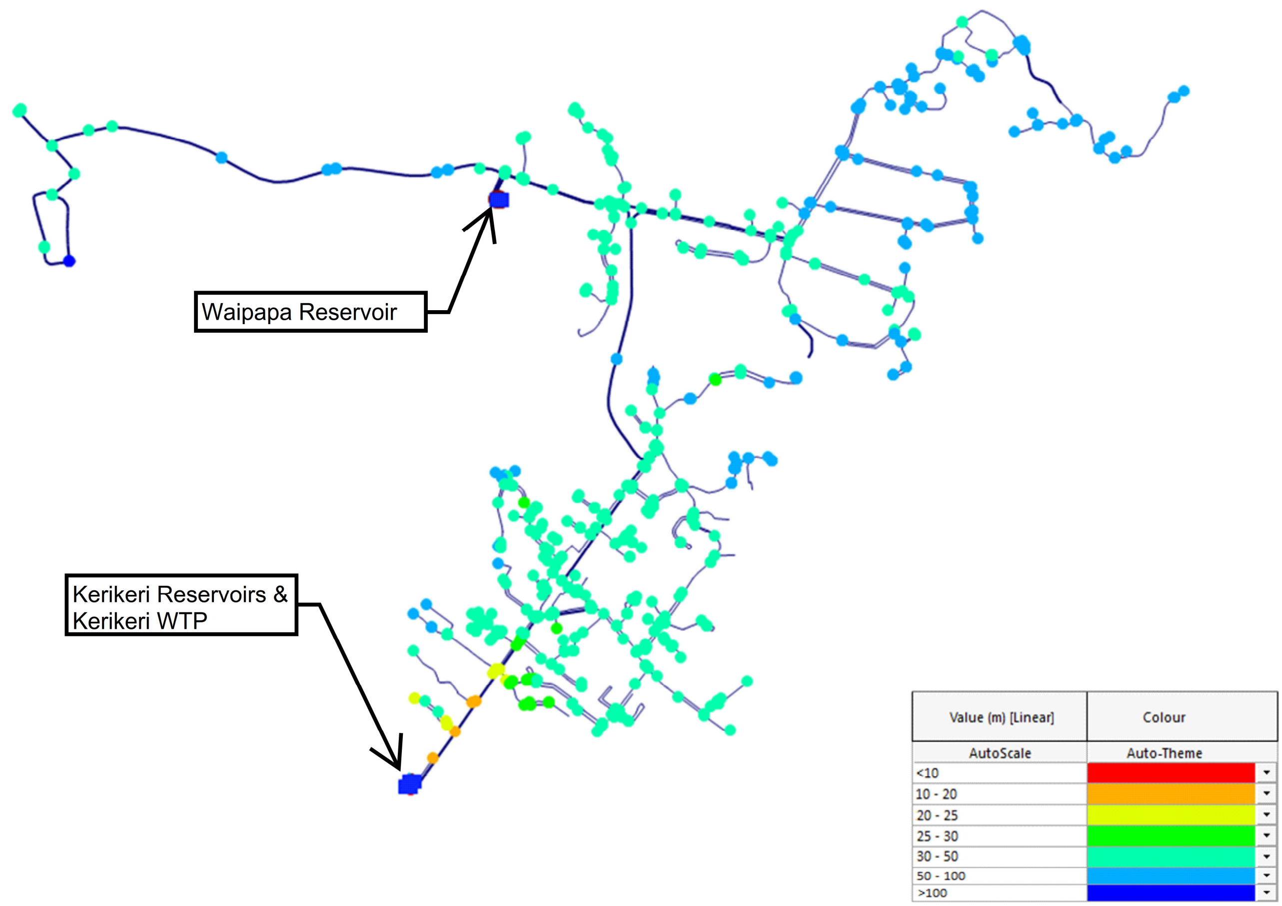


Figure 6.2-7: Scenario 7 – Upgraded network spine – Demand of 4,000 m^3/day

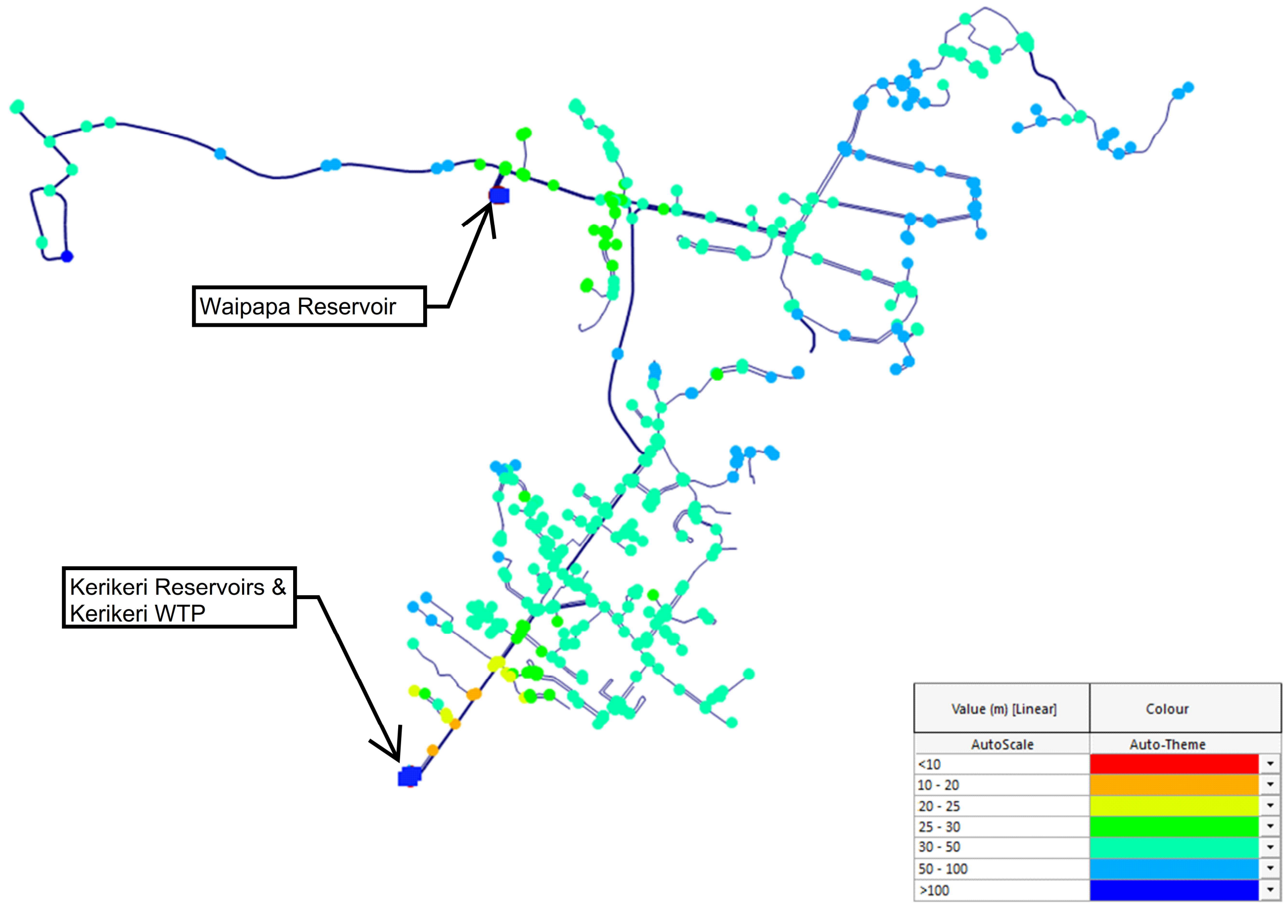


Figure 6.2-8: Scenario 8 – Upgraded network spine and upgraded Riverview pumps – Demand of 5,000 m^3/day

Appendix B. Detailed MCA Results

Table 8-1 Detailed MCA Analysis Data

Criteria	Option 1 Kerikeri WTP only	Option 2 New WTP only	Option 3 2 WTPs	Option 4 1 WTP - 2 sources	Sub-criteria	Option 1 Kerikeri WTP only	Option 2 New WTP only	Option 3 2 WTPs	Option 4 1 WTP - 2 sources
Economic Criteria	4.0	3.3	2.5	2.2	Capital Cost	5.00	3.33	3.75	0.00
					Operating and Maintenance Costs	5.00	5.00	0.00	3.00
					Project Timeline / Staging of Payments	0.00	0.00	5.00	5.00
Supply	1.4	1.6	4.6	3.8	Security of Supply - access	3.50	0.00	5.00	2.00
					Resilience - quality / quantity	0.00	2.00	5.00	5.00
					Scaleability	0.00	4.00	3.00	5.00
Community	4.0	2.0	2.0	2.0	Iwi Acceptance	5.00	0.00	0.00	0.00
					Community Acceptance	3.00	3.00	3.00	3.00
					Improved LOS (ability to meet LOS requirements)	4.00	3.00	3.00	3.00
Environmental	5.0	2.2	2.2	0.0	Environmental Impact	5.00	1.00	1.00	0.00
					Consentability / Compliance	5.00	3.00	3.00	0.00
Strategic / Operational Criteria	2.4	2.9	1.8	3.4	Operability	5.00	3.00	0.00	2.00
					Constructability	0.00	5.00	2.50	4.00
					Redundancy	0.00	0.00	5.00	3.00
					H&S	3.00	5.00	0.00	5.00

Appendix C. Options Cost Estimates

C.1 Option 1

Item Description	Amount	Rate	Cost	Subtotal	Totals	*Notes*
Stage 1						
Stage 1A - Kerikeri WTP Upgrades To 4000m^3/day Capacity						
Civil work - new platform, access, fencing, landscape	1	$100,000	$100,000			*Have assumed that contractor fees and construction will be 50% of the unit costs.*
Coagulation and floc dosing unit and mixing tank	0	$0	$0			*Assuming that we can use the existing dosing unit and mixing tanks*
Piping to new lamella separator, incl cut-in	1	$25,000	$25,000			*Allowance of $25000*
Lamella separator	2	$600,000	$1,200,000			*Filtec email cost estimate for lamella and sand filter units - $2.5 M for 3.5MLd, $3.5 M for 5.0MLd. Have interpolated the cost for 2*2MLd unit and have assumed the lamella to be a third of the total cost. Price includes ECIA.*
Piping to microfiltration pumps	1	$20,000	$20,000			*Allowance of $25000 including manifolding to MF pumps*
Microfiltration pumps	2	$50,000	$100,000			*Allowance of $50,000*
Microfiltration unit + ECIA	2	$1,200,000	$2,400,000			*Filtec email cost estimate - $1.0M for 1.5MLd and $2.0M for 5.0MLd +/- 50%. Assuming we will be using 2 trains of 2MLD capacity. Assume 2 x filters as Duty / Assist meeting design demand to provide some redundancy in event of one being offline.*
Microfiltration building	1	$50,000	$50,000			*Review whether building required*
Microfiltration waste disposal - sump, pump x 2 to sewer	1	$50,000	$50,000			
Piping to existing reservoir	1	$25,000	$25,000			*Assuming that the current unit will continue to be used.*
Piping to UV unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
UV unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Piping to chlorination unit	0	$0	$0			*Assuming that the current unit will continue to be used.*

Chlorination unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Network pump station in building	0	$0	$0			*Assuming that the current unit will continue to be used.*
Pressure main	0	$0	$0			*Existing*
Commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Decommission and remove existing treatment	1	$75,000	$75,000			*Have made an allowance of $50,000 for costs related to decommissioning*
Subtotal				$4,095,000		
Stage 1b -Puketotara stream intake pipe replacement						
Tie in to existing intake	1	$25,000	$25,000			*Allowance of $25000 for works*
DN 375 pipe in rural road	1000	$800	$800,000			*Inclusive of supply, valves, traffic management, sediment control, etc.*
Tie in to WTP site	1	$25,000	$25,000			*Have made an allowance of $25,000 for costs related to doing tie-in works*
Subtotal				$850,000		
Stage 1c - KIC pipeline extension to dn600						
Dn375 pipe in	1500	$1,000	$1,500,000			*Inclusive of supply, valves, traffic management, sediment control, etc.*
Cut in to existing pipelines	2	$25,000	$50,000			*Have made an allowance of $25,000 for costs related to doing tie-in works*
Subtotal				$1,550,000		
Total for stage 1					$6,495,000	
Stage 2a - bulk supply and distribution main upgrade, additional storage						
Spine upgrade						
Dn375 pipe in urban road	5000	$1,000	$5,000,000			*Estimated $/m inclusive of supply, valves, traffic management, sediment control, construction etc.*
Cut-in existing connection from old to new	50	$2,500	$125,000			*Placeholder as no knowledge of number or complexity of connections required*
Subtotal				$5,125,000		
Stage 2b - additional treated water storage						

New 1500 m3 storage reservoir, incl civil works, piping, access, landscaping	1	$850,000	$850,000			*2019 tender for 1500m3 reservoir and piping in Kaikoura*
Chlorination and commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Subtotal				$900,000		
Total for stage 2					$6,025,000	
Stage 3 - Upgrading Existing Kerikeri WTP to 5000m^3/Day						
Stage 3A - Kerikeri WTP Replacement To 5000 m^3 Capacity						
Civil work - new platform, access, fencing, landscape	1	$50,000	$500,000			*Allowance made for works*
Dosing unit and mixing tank	1	$100,000	$100,000			*Allowance made for unit*
2000 m3/day lamella separator	1	$600,000	$600,000			*Assumed to be an additional lamella at 2000 m3/d capacity. Filtec email cost estimate for lamella and sand filter units - $2.0 M for 1.5MLd, $2.5 M for 3.5MLd, $3.5 M for 5.0MLd. Have interpolated the cost for 1*2MLd unit and have assumed the lamella to be a third of the total cost. Price includes ECIA.*
Piping to microfiltration pumps	1	$10,000	$10,000			*Allowance of $25000*
Microfiltration pumps	1	$50,000	$50,000			*Estimated allowance*
Microfiltration unit + ECIA	1	$1,200,000	$1,200,000			*Filtec email cost estimate - $1.0M for 1.5MLd and $2.0M for 5.0MLd +/- 50%. Have interpolated for a 2000m3/day unit, assuming we will be adding one additional train.*
Microfiltration waste disposal - sump, pump x 2 to sewer	0	$0	$0			*Utilize from Stage 1 works*
Piping to Existing Reservoir	1	$10,000	$10,000			*Allowance made for works*
Piping to Existing UV Unit	1	$25,000	$25,000			*Allowance made for works*
UV units	3	$60,000	$180,000			*Assuming three trains of UV disinfection at new plant to increase redundancy and resilience of plant. The rate is a recent quote received from Xylem for the Opononi WWTP study completed by Jacobs for FNDC.*
Piping to Existing Chlorination Unit	1	$25,000	$25,000			*Allowance made for works*

Chlorination Unit - Tanks and Dosing Pump	1	$75,000	$75,000			*Estimated allowance for unit*
Connect Back into Network	1	$25,000	$25,000			*Allowance made for works*
Decommission and Remove Existing Treatment	1	$50,000	$50,000			*Allowance made for works*
Commissioning work allowance	1	$25,000	$25,000			*Allowance made for works*
Total				$2,875,000		
Stage 3B - Replacement Of 2 Existing Reservoirs (1500m^3 Total)						
Decommission, Demolish and Dispose Reservoirs	1	$75,000	$75,000			*Allowance made for works*
New 1500 m^3 Storage Reservoir, Incl Civil Works, Piping, Access, Landscaping	1	$850,000	$850,000			*Quote from a recent project for a 1500m3 reservoir, this includes the foundation development costs*
Chlorination and Commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Total				$975,000		
Total for stage 3					$3,850,000	
Base indicative construction cost					$16,370,000	
Contractor Preliminary and General and Margin	15%	$16,370,000	$2,455,500			
Total indicative construction cost					$18,825,500	
Engineering Design and Construction Management	12%	$18,825,500	$2,259,060			
Resource consenting	1%	$18,825,500	$188,255			
Land purchase	1	$0	$0			*Not required for this option*
Subtotal				$4,902,815		
Total indicative project cost					$21,272,815	

Project contingency - scope and costing uncertainty	30%	$21,272,815	$6,381,845			
Subtotal				$6,381,845		
Total project budget					$27,654,660	

C.2 Option 2

Item Description	Amount	Rate	Cost	Subtotal	Totals	*Notes*
Stage 1						
Stage 1A - Kerikeri WTP Upgrades to 4000m^3 capacity						
Civil Work - new platform, access, fencing, landscape	1	$100,000	$100,000			*Have assumed that contractor fees and construction will be 50% of the unit costs.*
Coagulation and Floc Dosing unit and mixing tank	0	$0	$0			*Assuming that we can use the existing dosing unit and mixing tanks*
Piping to new lamella separator, incl cut-in	1	$25,000	$25,000			*Allowance of $25000*
Lamella separator	2	$600,000	$1,200,000			*Filtec email cost estimate for lamella and sand filter units - $2.5 M for 3.5MLd, $3.5 M for 5.0MLd. Have interpolated the cost for 2*2MLd unit and have assumed the lamella to be a third of the total cost. Price includes ECIA.*
Piping to microfiltration pumps	1	$20,000	$20,000			*Allowance of $25000 including manifolding to MF pumps*
Microfiltration pumps	2	$50,000	$100,000			*Allowance of $50,000*
Microfiltration unit + ECIA	2	$1,200,000	$2,400,000			*Filtec email cost estimate - $1.0M for 1.5MLd and $2.0M for 5.0MLd +/- 50%. Assuming we will be using 2 trains of 2MLD capacity. Assume 2 x filters as Duty / Assist meeting design demand to provide some redundancy in event of one being offline.*
Microfiltration building	1	$50,000	$50,000			*Review whether building required*
Microfiltration waste disposal - sump, pump x 2 to sewer	1	$50,000	$50,000			
Piping to existing reservoir	1	$25,000	$25,000			*Assuming that the current unit will continue to be used.*
Piping to UV unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
UV unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Piping to chlorination unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Chlorination unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Network pump station in building	0	$0	$0			*Assuming that the current unit will continue to be used.*
Pressure main	0	$0	$0			*Existing*

Item Description	Amount	Rate	Cost	Subtotal	Totals	Notes
Commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Decommission and remove existing treatment	1	$75,000	$75,000			*Have made an allowance of $50,000 for costs related to decommissioning*
Subtotal				$4,095,000		
Stage 1B -Puketotara Stream Intake pipe replacement						
Tie in to existing intake	1	$25,000	$25,000			*Allowance of $25000 for works*
DN 375 Pipe in rural road	1000	$800	$800,000			*Inclusive of supply, valves, traffic management, sediment control, etc.*
Tie in to WTP site	1	$25,000	$25,000			*Have made an allowance of $25,000 for costs related to doing tie-in works*
Subtotal				$850,000		
Stage 1C - KIC Pipeline Extension to DN600						
DN375 Pipe in SH	1500	$1,000	$1,500,000			*Inclusive of supply, valves, traffic management, sediment control, etc.*
Cut in to existing pipelines	2	$25,000	$50,000			*Have made an allowance of $25,000 for costs related to doing tie-in works*
Subtotal				$1,550,000		
Total for Stage 1					$6,495,000	
Stage 2						
Stage 2A - Bulk Supply and Distribution Main upgrade, additional storage						
DN375 pipe in urban road	5000	$1,000	$5,000,000			*Estimated $/m inclusive of supply, valves, traffic management, sediment control, construction etc.*
Cut-in existing connection from old to new	50	$2,500	$125,000			*Placeholder as no knowledge of number or complexity of connections required*
Subtotal				$5,125,000		

Item Description	Amount	Rate	Cost	Subtotal	Totals	*Notes*
Stage 2B - Additional treated water storage						
New 1500 m3 storage reservoir, incl civil works, piping, access, landscaping	1	$850,000	$850,000			*2019 tender for 1500m3 reservoir and piping in Kaikoura*
Chlorination and commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Subtotal				$900,000		
Total for Stage 2					$6,025,000	
Stage 3						
Stage 3A - New 5000m^3 WTP						
Civil Work - new platform, access, fencing, landscape	1	$50,000	$500,000			*Allowance made for works*
Dosing unit and mixing tank	1	$100,000	$100,000			*Allowance made for unit*
2000 m3/day lamella separator	1	$600,000	$600,000			*Assumed to be an additional lamella at 2000 m3/d capacity. Filtec email cost estimate for lamella and sand filter units - $2.0 M for 1.5MLd, $2.5 M for 3.5MLd, $3.5 M for 5.0MLd. Have interpolated the cost for 1*2MLd unit and have assumed the lamella to be a third of the total cost. Price includes ECIA.*
Piping to microfiltration pumps	1	$10,000	$10,000			*Allowance of $25000*
Microfiltration pumps	1	$50,000	$50,000			*Estimated allowance*
Filtration unit building establishment	1	$250,000	$250,000			*Estimated allowance*
Microfiltration unit + ECIA	1	$1,200,000	$1,200,000			*Filtec email cost estimate - $1.0M for 1.5MLd and $2.0M for 5.0MLd +/- 50%. Have interpolated for a 2000m3/day unit, assuming we will be adding one additional train.*
Microfiltration waste disposal - sump, pump x 2 to sewer	0	$0	$0			*Utilize from Stage 1 works*
Piping to existing reservoir	1	$10,000	$10,000			*Allowance made for works*
Piping to existing UV unit	1	$25,000	$25,000			*Allowance made for works*
UV units	3	$60,000	$180,000			*Assuming three trains of UV disinfection at new plant to increase redundancy and resilience of plant. The rate is a*

Item Description	Amount	Rate	Cost	Subtotal	Totals	*Notes*
						recent quote received from Xylem for the Opononi WWTP study completed by Jacobs for FNDC.
Piping to existing chlorination unit	1	$25,000	$25,000			*Allowance made for works*
Chlorination unit - tanks and dosing pump	1	$75,000	$75,000			*Estimated allowance for unit*
Connect back into network	1	$25,000	$25,000			*Allowance made for works*
Decommission and remove existing treatment	1	$50,000	$50,000			*Allowance made for works*
Commissioning work allowance	1	$25,000	$25,000			*Allowance made for works*
Total				$3,125,000		
Stage 3B - New Transmission Pipeline from Lake Manuwai						
Rising main establishment	1	$25,000	$25,000			*Rising main and inlet screen works at Lake Manuwai*
DN375 pipe in rural road	500	$800	$400,000			*Assuming plant is placed 500m from Lake Manuwai source*
Tie-in to WTP	1	$25,000	$25,000			*Allowance made for works*
Total				$450,000		
Stage 3C - Replacement of 2 existing reservoirs (1500m3 total)						
Decommission, demolish and dispose reservoirs	1	$75,000	$75,000			*Allowance made for works*
New 1500 m3 storage reservoir, incl civil works, piping, access, landscaping	1	$850,000	$850,000			*Quote from a recent project for a 1500m3 reservoir, this includes the foundation development costs*
Chlorination and commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Total				$975,000		
Pumping requirements from Waipapa reservoir to Kerikeri storage facility						
Tie-in to pumps	1	$25,000	$25,000			*Allowance made for works*
Pump station incl civil, building, mechanical and electrical	1	$400,000	$400,000			*Estimated allowance for unit*
Tie-in to Kerikeri storage	1	$25,000	$25,000			*Allowance made for works*
Total				$450,000		
Total for Stage 3					$5,000,000	

Item Description	Amount	Rate	Cost	Subtotal	Totals	*Notes*
Base indicative construction cost					$17,520,000	
Contractor Preliminary and General and margin	15%	$17,520,000	$2,628,000			
Total indicative construction cost					$20,148,000	
Engineering design and construction management	12%	$20,148,000	$2,417,760			
Resource consenting	1%	$20,148,000	$201,480			
Land purchase	1	$500,000	$500,000			*Allowance assumed for new WTP*
Subtotal				$5,747,240		
Total indicative project cost					$23,267,240	
Project contingency - scope and costing uncertainty	30%	$23,267,240	$6,980,172			
Subtotal				$6,980,172		
Total project budget					$30,247,412	

C.3 Option 3

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Stage 1						
Stage 1A - Kerikeri WTP Upgrades to 4000m^3 capacity						
Civil Work - new platform, access, fencing, landscape	1	$100,000	$100,000			*Have assumed that contractor fees and construction will be 50% of the unit costs.*
Coagulation and Floc Dosing unit and mixing tank	0	$0	$0			*Assuming that we can use the existing dosing unit and mixing tanks*
Piping to new lamella separator, incl cut-in	1	$25,000	$25,000			*Allowance of $25000*
Lamella separator	2	$600,000	$1,200,000			*Filtec email cost estimate for lamella and sand filter units - $2.5 M for 3.5MLd, $3.5 M for 5.0MLd. Have interpolated the cost for 2*2MLd unit and have assumed the lamella to be a third of the total cost. Price includes ECIA.*
Piping to microfiltration pumps	1	$20,000	$20,000			*Allowance of $25000 including manifolding to MF pumps*
Microfiltration pumps	2	$50,000	$100,000			*Allowance of $50,000*
Microfiltration unit + ECIA	2	$1,200,000	$2,400,000			*Filtec email cost estimate - $1.0M for 1.5MLd and $2.0M for 5.0MLd +/- 50%. Assuming we will be using 2 trains of 2MLD capacity. Assume 2 x filters as Duty / Assist meeting design demand to provide some redundancy in event of one being offline.*
Microfiltration building	1	$50,000	$50,000			*Review whether building required*
Microfiltration waste disposal - sump, pump x 2 to sewer	1	$50,000	$50,000			
Piping to existing reservoir	1	$25,000	$25,000			*Assuming that the current unit will continue to be used.*
Piping to UV unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
UV unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Piping to chlorination unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Chlorination unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Network pump station in building	0	$0	$0			*Assuming that the current unit will continue to be used.*

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Pressure main	0	$0	$0			*Existing*
Commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Decommission and remove existing treatment	1	$75,000	$75,000			*Have made an allowance of $50,000 for costs related to decommissioning*
Subtotal				$4,095,000		
Stage 1B -Puketotara Stream Intake pipe replacement						
Tie in to existing intake	1	$25,000	$25,000			*Allowance of $25000 for works*
DN 375 Pipe in rural road	1000	$800	$800,000			*Inclusive of supply, valves, traffic management, sediment control, etc.*
Tie in to WTP site	1	$25,000	$25,000			*Have made an allowance of $25,000 for costs related to doing tie-in works*
Subtotal				$850,000		
Stage 1C - KIC Pipeline Extension to DN600						
DN375 Pipe in SH	1500	$1,000	$1,500,000			*Inclusive of supply, valves, traffic management, sediment control, etc.*
Cut in to existing pipelines	2	$25,000	$50,000			*Have made an allowance of $25,000 for costs related to doing tie-in works*
Subtotal				$1,550,000		
Total for Stage 1					$6,495,000	
Stage 2						
Stage 2A - Bulk Supply and Distribution Main upgrade, additional storage						
DN375 pipe in urban road	5000	$1,000	$5,000,000			*Estimated $/m inclusive of supply, valves, traffic management, sediment control, construction etc.*
Cut-in existing connection from old to new	50	$2,500	$125,000			*Placeholder as no knowledge of number or complexity of connections required*
Subtotal				$5,125,000		

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Stage 2B - Additional treated water storage						
New 1500 m^3 storage reservoir, incl civil works, piping, access, landscaping	1	$850,000	$850,000			*2019 tender for 1500m3 reservoir and piping in Kaikoura*
Chlorination and commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Subtotal				$900,000		
Total for Stage 2					$6,025,000	
Stage 3						
Stage 3A - New 1000m^3 WTP						
Tie-in to container WTP unit	1	$25,000	$25,000			*Allowance made for works*
Containerised WTP unit	1	$800,000	$800,000			*Quote from Hydroflux for a MENA water containerised unit, includes shipping and delivery to site, civils, foundations, power supply, install and commissioning*
Pump to network	1	$50,000	$50,000			*Allowance made for unit*
Connect back into network	1	$25,000	$25,000			*Allowance made for works*
Commissioning work allowance	1	$25,000	$25,000			*Allowance made for works*
Total				$925,000		
Stage 3B - New Transmission Pipeline from Lake Manuwai						
Rising main establishment	1	$25,000	$25,000			*Rising main and inlet screen works at Lake Manuwai*
DN375 pipe in rural road	9000	$800	$7,200,000			*Assuming plant is placed 500m from Lake Manuwai source*
Tie-in to WTP	1	$25,000	$25,000			*Allowance made for works*
Total				$7,250,000		
Stage 3C - Kerikeri WTP Renewal						
Civil Work - new platform, access, fencing, landscape	1	$50,000	$500,000			*Allowance made for works*

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Dosing unit and mixing tank	1	$100,000	$100,000			*Allowance made for unit*
2000 m3/day lamella separator	0	$0	$0			*Assuming that the unit replaced in Stage 1 will continue to be used.*
Piping to microfiltration pumps	0	$0	$0			*Assuming that the unit replaced in Stage 1 will continue to be used.*
Microfiltration pumps	0	$0	$0			*Assuming that the unit replaced in Stage 1 will continue to be used.*
Microfiltration unit + ECIA	0	$0	$0			*Assuming that the unit replaced in Stage 1 will continue to be used.*
Microfiltration waste disposal - sump, pump x 2 to sewer	0	$0	$0			*Assuming that the unit replaced in Stage 1 will continue to be used.*
Piping to existing reservoir	1	$10,000	$10,000			*Allowance made for works*
Piping to existing UV unit	1	$25,000	$25,000			*Allowance made for works*
UV units	3	$60,000	$180,000			*Assuming three trains of UV disinfection at new plant to increase redundancy and resilience of plant. The rate is a recent quote received from Xylem for the Opononi WWTP study completed by Jacobs for FNDC.*
Piping to existing chlorination unit	1	$25,000	$25,000			*Allowance made for works*
Chlorination unit - tanks and dosing pump	1	$75,000	$75,000			*Estimated allowance for unit*
Connect back into network	1	$25,000	$25,000			*Allowance made for works*
Decommission and remove existing treatment	1	$50,000	$50,000			*Allowance made for works*
Commissioning work allowance	1	$25,000	$25,000			*Allowance made for works*
Total				$1,015,000		
Stage 3D - Replacement of 2 existing reservoirs (1500m3 total)						
Decommission, demolish and dispose reservoirs	1	$75,000	$75,000			*Allowance made for works*
New 1500 m^3 storage reservoir, incl civil works, piping, access, landscaping	1	$850,000	$850,000			*Quote from a recent project for a 1500m3 reservoir, this includes the foundation development costs*
Chlorination and commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Total				$975,000		
Total for Stage 3					$10,165,000	
Base indicative construction cost					$22,685,000	
Contractor Preliminary and General and margin	15%	$22,685,000	$3,402,750			
Total indicative construction cost					$26,087,750	
Engineering design and construction Management	12%	$26,087,750	$3,130,530			
Resource consenting	1%	$26,087,750	$260,878			
Land purchase	1	$500,000	$500,000			*Allowance assumed for new WTP*
Subtotal				$7,294,158		
Total indicative project cost					$29,979,158	
Project contingency - scope and costing uncertainty	30%	$29,979,158	$8,993,747			
Subtotal				$8,993,747		
Total project budget					$38,972,905	

C.4 Option 4

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Stage 1						
Stage 1A - Kerikeri WTP Upgrades to 4000m^3 capacity						
Civil Work - new platform, access, fencing, landscape	1	$100,000	$100,000			*Have assumed that contractor fees and construction will be 50% of the unit costs.*
Coagulation and Floc Dosing unit and mixing tank	0	$0	$0			*Assuming that we can use the existing dosing unit and mixing tanks*
Piping to new lamella separator, incl cut-in	1	$25,000	$25,000			*Allowance of $25000*
Lamella separator	2	$600,000	$1,200,000			*Filtec email cost estimate for lamella and sand filter units - $2.5 M for 3.5MLd, $3.5 M for 5.0MLd. Have interpolated the cost for 2*2MLd unit and have assumed the lamella to be a third of the total cost. Price includes ECIA.*
Piping to microfiltration pumps	1	$20,000	$20,000			*Allowance of $25000 including manifolding to MF pumps*
Microfiltration pumps	2	$50,000	$100,000			*Allowance of $50,000*
Microfiltration unit + ECIA	2	$1,200,000	$2,400,000			*Filtec email cost estimate - $1.0M for 1.5MLd and $2.0M for 5.0MLd +/- 50%. Assuming we will be using 2 trains of 2MLD capacity. Assume 2 x filters as Duty / Assist meeting design demand to provide some redundancy in event of one being offline.*
Microfiltration building	1	$50,000	$50,000			*Review whether building required*
Microfiltration waste disposal - sump, pump x 2 to sewer	1	$50,000	$50,000			
Piping to existing reservoir	1	$25,000	$25,000			*Assuming that the current unit will continue to be used.*
Piping to UV unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
UV unit	0	$0	$0			*Assuming that the current unit will continue to be used.*

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Piping to chlorination unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Chlorination unit	0	$0	$0			*Assuming that the current unit will continue to be used.*
Network pump station in building	0	$0	$0			*Assuming that the current unit will continue to be used.*
Pressure main	0	$0	$0			*Existing*
Commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Decommission and remove existing treatment	1	$75,000	$75,000			*Have made an allowance of $50,000 for costs related to decommissioning*
Subtotal				$4,095,000		
Stage 1B -Puketotara Stream Intake pipe replacement						
Tie in to existing intake	1	$25,000	$25,000			*Allowance of $25000 for works*
DN 375 Pipe in rural road	1000	$800	$800,000			*Inclusive of supply, valves, traffic management, sediment control, etc.*
Tie in to WTP site	1	$25,000	$25,000			*Have made an allowance of $25,000 for costs related to doing tie-in works*
Subtotal				$850,000		
Stage 1C - KIC Pipeline Extension to DN600						
DN375 Pipe in SH	1500	$1,000	$1,500,000			*Inclusive of supply, valves, traffic management, sediment control, etc.*
Cut in to existing pipelines	2	$25,000	$50,000			*Have made an allowance of $25,000 for costs related to doing tie-in works*
Subtotal				$1,550,000		
Total for Stage 1					$6,495,000	
Stage 2						

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Stage 2A - Bulk Supply and Distribution Main upgrade, additional storage						
DN375 pipe in urban road	5000	$1,000	$5,000,000			*Estimated $/m inclusive of supply, valves, traffic management, sediment control, construction etc.*
Cut-in existing connection from old to new	50	$2,500	$125,000			*Placeholder as no knowledge of number or complexity of connections required*
Subtotal				$5,125,000		
Stage 2B - Additional treated water storage						
New 1500 m^3 storage reservoir, incl civil works, piping, access, landscaping	1	$850,000	$850,000			*2019 tender for 1500m3 reservoir and piping in Kaikoura*
Chlorination and commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Subtotal				$900,000		
Total for Stage 2					$6,025,000	
Stage 3						
Stage 3A - New 5000m^3 WTP						
Civil Work - new platform, access, fencing, landscape	1	$50,000	$500,000			*Allowance made for works*
Dosing unit and mixing tank	1	$100,000	$100,000			*Allowance made for unit*
2000 m3/day lamella separator	1	$600,000	$600,000			*Assumed to be an additional lamella at 2000 m3/d capacity. Filtec email cost estimate for lamella and sand filter units - $2.0 M for 1.5MLd, $2.5 M for 3.5MLd, $3.5 M for 5.0MLd. Have interpolated the cost for 1*2MLd unit and have assumed the lamella to be a third of the total cost. Price includes ECIA.*
Piping to microfiltration pumps	1	$10,000	$10,000			*Allowance of $25000*
Microfiltration pumps	1	$50,000	$50,000			*Estimated allowance*
Filtration unit building establishment	1	$250,000	$250,000			*Estimated allowance*
Microfiltration unit + ECIA	1	$1,200,000	$1,200,000			*Filtec email cost estimate - $1.0M for 1.5MLd and $2.0M for 5.0MLd +/- 50%. Have interpolated for a*

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
						2000m3/day unit, assuming we will be adding one additional train.
Microfiltration waste disposal - sump, pump x 2 to sewer	0	$0	$0			*Utilize from Stage 1 works*
Piping to existing reservoir	1	$10,000	$10,000			*Allowance made for works*
Piping to existing UV unit	1	$25,000	$25,000			*Allowance made for works*
UV units	3	$60,000	$180,000			*Assuming three trains of UV disinfection at new plant to increase redundancy and resilience of plant. The rate is a recent quote received from Xylem for the Opononi WWTP study completed by Jacobs for FNDC.*
Piping to existing chlorination unit	1	$25,000	$25,000			*Allowance made for works*
Chlorination unit - tanks and dosing pump	1	$75,000	$75,000			*Estimated allowance for unit*
Connect back into network	1	$25,000	$25,000			*Allowance made for works*
Decommission and remove existing treatment	1	$50,000	$50,000			*Allowance made for works*
Commissioning work allowance	1	$25,000	$25,000			*Allowance made for works*
Total				$3,125,000		
Stage 3B - New Transmission Pipeline from Lake Manuwai						
Rising main establishment	1	$25,000	$25,000			*Rising main and inlet screen works at Lake Manuwai*
DN375 pipe in rural road	9000	$800	$7,200,000			*Assuming plant is placed 500m from Lake Manuwai source*
Tie-in to WTP	1	$25,000	$25,000			*Allowance made for works*
Total				$7,250,000		
Stage 3C - Decommissioning Kerikeri WTP and replacement of 2 existing reservoirs (1500m3 total)						
Decommission, demolish and dispose reservoirs	1	$75,000	$75,000			*Allowance made for works*
New 1500 m^3 storage reservoir, incl civil works, piping, access, landscaping	1	$850,000	$850,000			*Quote from a recent project for a 1500m3 reservoir, this includes the foundation development costs*
Chlorination and commissioning	1	$50,000	$50,000			*Have made an allowance of $50,000 for costs related to commissioning*
Total				$975,000		

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Stage 3D - New pipeline from Lake Waingaro to new WTP						
Tie-in to existing main	1	$25,000	$25,000			*Allowance made for works*
DN375 pipe in rural road	9000	$750	$6,750,000			*Assuming plant is placed 9km from Lake Waingaro source. Costs include instrumentation and civil works*
Tie-in to WTP	1	$25,000	$25,000			*Allowance made for works*
Total				$6,800,000		
Pumping requirements from Waipapa reservoir to Kerikeri storage facility						
Tie-in to pumps	1	$25,000	$25,000			*Allowance made for works*
Pump station incl civil, building, mechanical and electrical	1	$400,000	$400,000			*Estimated allowance for unit*
Tie-in to Kerikeri storage	1	$25,000	$25,000			*Allowance made for works*
Total				$450,000		
Total for Stage 3					$18,600,000	
Base indicative construction cost					$31,120,000	
Contractor Preliminary and General and margin	15%	$31,120,000	$4,668,000			
Total indicative construction cost					$35,788,000	
Engineering design and construction Management	12%	$35,788,000	$4,294,560			
Resource consenting	1%	$35,788,000	$357,880			
Land purchase	1	$500,000	$500,000			*Allowance assumed for new WTP*
Subtotal				$9,820,440		
Total indicative project cost					$40,940,440	

Item Description	Amount	Rate	Cost	Subtotals	Totals	*Notes*
Project contingency - scope and costing uncertainty	30%	$40,940,440	$12,282,132			
Subtotal				$12,282,132		
Total project budget					$53,222,572	