Erewhon Rural Water Supply Scheme

Technical Assessment

Version 1.0 : 4 April 2023

CONTENTS

INTRODUCTION

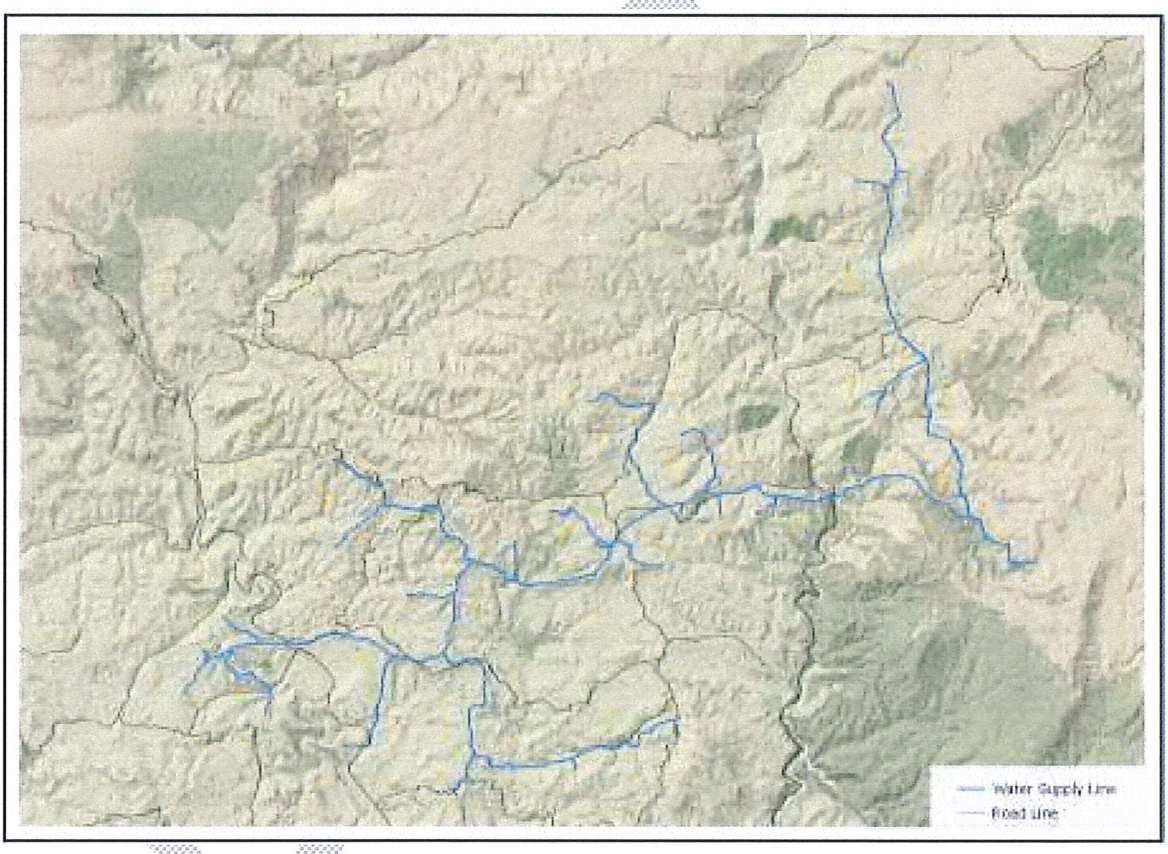
The Erewhon Rural Water Supply Scheme is a wide spread rural water scheme located east of Taihape within the Rangitikei District.

The Scheme Committee wish to confirm the state of the Scheme with a view to confirming that sufficient capital is available for Scheme renewals and for potential scheme growth.

The Scheme supports agricultural production, particularly by providing water for stock to drink, particularly in dry summer periods and droughts.

Background

The Erewhon Scheme was installed in the early 1980s and currently supplies 28 farms with stock water. The impact of this has been to allow farmers to optimise their operations through stocking rates, better drought management and better stock performance.



Purpose

The purpose of this report is to review the operations and performance of the Scheme committee to make better informed decisions about the direction of the Scheme.

To do this the following tasks have been undertaken;

- The maintenance records have been reviewed
- The Erewhon chapter in the Rangitikei District Council 3 Waters Asset Management Plan has been reviewed
- A site visit on 22 March 2023 was undertaken
- A hydraulic model to indicate scheme performance has been developed

- A critical risk table has been developed.

MAINTENANCE RECORDS

Recent maintenance records for the Scheme have been kept by the Scheme Operator (Taihape Plumbing Ltd). These are subsequently been added to the 'AssetFinda' which is the web-based asset life-cycle tracking and work order management System used by Rangitikei District Council.

The records are in excellent condition and are complemented by flow and pressure readings taken at quarterly intervals.

The renewals proposed to the Scheme committee closely align with the mains breakages and leaks recorded.

ASSET MANAGEMENT PLAN

The Rangitikei District Council 3 Waters Asset Management Plan provides a brief overview and summary of the Scheme consistent with the oversight given to water schemes in the Plan.

The AMP suggests a 'business as usual' approach to the Scheme which reflects the Council overview of the Scheme at the time the AMP was developed.

However this does not take into account the potential impact of the Governments '3 Waters Reform' legislation and the desire of the Scheme committee to better understand the capabilities of the scheme and the re-investment requirements of the Scheme.

A copy of the Erewhon chapter of the AMP is appended.

SITE VISIT

A site visit was undertaken on 22 March 2023.

This has proven invaluable in assisting with the development of this report.

Some observations from the site visit are;

- The remoteness of the Scheme has a significant impact of costs and resources required to operate the scheme
- The Scheme is well maintained and is in good condition overall. Recent renewals, maintenance activities and repairs have resulted in improvements in overall Scheme condition
- The proposed renewal programme is fit for purpose and will result in less maintenance and a more reliable Scheme operation overall
- Some parts of the Scheme have particular risks that need to be managed
- The operation of the scour valve at the pipe bridge gave an indication of what flow can be extracted from the weir
- The topography of the scheme with the height differences impact the design and operations of the scheme significantly

- More scour tees and isolation valves will allow repairs and subsequent scheme re-pressurisation to be achieved more quckly

- The economic importance of the Scheme to the local farming community and to the Rangitikei District is understated.

HYDRAULIC MODEL

A hydraulic model of the scheme has been developed.

Model assumptions and data

The model is based on the following data:

- Pipe lengths, diameters, and elevations (where noted) from the RDC GIS system
- Missing elevations were estimated using Google Earth
- A Hazen- Williams 'c' factor of 140 was assumed for all pipes except for the steel pipes for which a factor of 100 was used
- Minor losses of 10% of the friction loses were also added for each pipe length

The model flows were allocated at the branch points of the network on the basis of the measured split at the Mangaohane tee, and on the basis of relative pipe cross-sectional areas thereafter.

Two pipe flow scenarios were developed, one using the flow measured in February 2022, with a daily flow of 1354 m^3/day and one using the maximum abstraction consented of 1800 m^3/day.

The results of the 1354 m^3/day indicate that there is sufficient pressure throughout out the network at this level of demand.

When the higher flow of 1800 m^3/day is applied to the model the following pripes need to be resized.

Model results and discussion

The results of the model are roughly in-line with pressure observations within the scheme.

Further work could be undertaken to refine the model but this is not thought likely to change the observations and conclusions from the model.

At the time of the site visit the scour valve was open at the pipe bridge and a flow of 77 m^3/hr or the equivalent of 1848 m^3/day was observed.

Anecdotal evidence from previous drought periods indicated that flows had to be physically managed at the Mangaohane Tee to meet high demand.

This was reflected in the model with high head losses shown between nodes WN094- WN095 and WN95-WN096 when a higher daily flow rate was apportioned to the Mangaohane Line. Elsewhere the Scheme appears to be able to supply the allocated amounts of water.

One point of interest is the Anstiss Line is larger than the main line immediately downstream of the branch. (150mm nominal bore to 80mm). This means that in the model more water flows into this line but is then constricted further along this line.

When the higher flow of 1800 m^3/day is applied to the model some lines are restricted due to pipe sizes. This results in water not being able to be fully distrusted using the current network sizing.

However some initial work on the model indicates that some pipes can be resized to deliver extra water to where demand is wanted.

It is intended to update this work once the location of the extra demand is better known.

CRITICAL RISKS

From the review of the AMP, the site visit and discussions with the Operations Manager a critical risk table has been developed.

Critical Risk Identification – Erewhon Water Supply Scheme				
Date of Assessment	**March 2023**			
Assessment Conducted By	**Senior Technical Engineer**			
Critical Risk Identified		**Effectiveness of Controls**		
Critical Risk	**Risk Description**	**Current Control(s)**	**Control Rating**	**Analysis and Evaluation**
Rangitikei River pipe bridge	*A large proportion of the Scheme is dependent upon the pipe bridge crossing the Rangitikei River.* *Access to the pipe on the bridge poses some Health & Safety issues, and the structural capacity and condition of the bridge needs to be confirmed.*	*Reliance on observations undertaken on regular visits to the site.*	*Medium*	*A formal bridge inspection should be carried out with recommendations on the following:* • *Whether the bridge is fit-for-purpose according to current standards* • *Confirm flood and earthquake resilience* • *Identify any maintenance and improvement requirements* • *Establish future inspection and reporting needs* *Consideration needs to be given to a Scheme response in the event of a catastrophic bridge failure so that an appropriate response (if required) an be developed.* *It is expected that Control rating will increase to 'High' as the Scheme operator will be able to undertake inspections as recommended.*
Intake structure	*The intake structure enables water to be abstracted at a constant rate from the Reporoa Stream.* *The site is remote and a major failure would be difficult to repair and cause a scheme outage of some weeks.*	*Reliance on observations undertaken on regular visits to the site.*	*Medium*	*A formal weir inspection should be carried out with recommendations on the following:* • *Confirm flood and geotechnical resilience* • *Identify any maintenance and improvement requirements* • *Establish future inspection and reporting needs* *Consideration needs to be given to a Scheme response in the event of a catastrophic dam failure so that an appropriate response (if required) an be developed.* *It is expected that Control rating will increase to 'High' as the Scheme operator will be able to undertake inspections as recommended.*

Resource consent and land access to intake	*The intake and associated weir are located on a piece of land owned by the Aorangi Awarua Trust.* *The weir is located on the Reporoa Stream which is the outlet for the Reporoa Bog.* *The Trust land is reliant on access through Mangaohane Station and this is a point of discussion as part of the Mokai Patea Te Tiriti settlement claims.* *These historic issues with the Crown are expected to impact on the consent renewal process.*	*Some members of the Trust are also members of the Erewhon committee. However these issues are not currently discussed as part of the Scheme committee work structure.*	*Medium*	*The Scheme is dependent upon on-going consent renewals.* *The attempted sale of Mangaohane Station has emphasised iwi concerns and grievances which have persisted for decades. It is important that Scheme members are aware of these issues.* *The Scheme is vital to maintaining economically viable farming in the area. The alternative to this is most likely plantation forestry across large parts of the Scheme area. This comes with its own issues in terms of community and scheme viability, and impacts of harvesting and harvest residues.* *It is suggested that the Scheme committee inform themselves of the detail of how the Treaty settlement process works and engage formally with the relevant parties and key stakeholders to ensure that the purposes and benefits of the Scheme are understood.* *Further work should be undertaken on defining the economic and environmental benefits of the scheme and the impacts of alternatives.* *It is imperative that a consent application be made 6 month prior to the consent expiry to preserve existing consent conditions while a new consent process is underway. Although not urgent, some thought needs to be given to the costs associated with an extended consenting process.*
Large scale pipe material failure	*The scheme network is 40 years old, and static pressures within the network are very high.* *This means the cyclic pressure changes are higher that generally designed for, and will therefore impact on pipe life.* *The buried unlined steel pipes are also more vulnerable to corrosion.* *Lengths of pipe at risk of failure have been identified.*	*The record keeping on the Scheme is excellent. A trigger point of say 3 pipe breaks over a five year period should be an indicator that a pipe length should be placed on a renewal list.* *The Scheme committee should be informed of these multiple failures at the Scheme meetings and the renewals list updated accordingly.*	*High*	*The vulnerable parts of the network have been identified for renewals.* *It is suggested that an annualised renewal cost of the remaining original pipe network be developed and funded for renewal over the next 30 years. This assumes that these remaining pipes will progressively fail over this time frame.* *It is anticipated that a renewals fund be developed to develop a reserve to be used over time. The best industry practice is to review this every 3 years.* *A renewals programme accounting for likely future demand should be used as the basis to estimate the annualised renewal cost.*

Operational Resources	*Access to day to day resources to undertake Operations and Maintenance activities is difficult to maintain given the distance of the Scheme from available resources. As a result of this the scheme is dependent on key individuals to manage the Scheme.*	*A major failure at the peak demand times could*	*High*	*It is unlikely that the Operations Manager and the Scheme Manager will fail to respond to any incidents or to organise adequate back up. The Rangitikei Water Operations teams has staff on call at all times.*
Scheme finances	*TBA by scheme committee*	.	*Low*	*The Rangitikei District Council has indicated to the Scheme Committee that it will no longer provide support to the Scheme .* *A transparent long term cost and funding plan needs to developed.*
Asset Management plan	*Maintaining an up to date AMP may become difficult as the Rangitikei District Council has indicated to the Scheme Committee that it will no longer provide support to the Scheme .*	*Keeping an AMP up to date becomes difficult*	*Low*	*See comment on scheme finances above.* *Developing a separate AMP for the Scheme is required.*

PIPE MATERIALS

There are 4 types of pipe materials used within the Scheme network – asbestos cement, steel, polyethylene, and PVC. The pros and cons of each material are discussed below.

Asbestos cement

Asbestos cement is a pipe material that was widely used within water networks at the time the scheme was first constructed. The use of this pipe material has been superseded by the use of plastic pipes over the last 30 years or so.

The various brands of AC pipe used in New Zealand have had various issues which have impacted upon the originally expected life spans of this pipe type.

The most common of these issues are;

- Erosion of pipe wall thickness from the inside as a result of the chemical interaction of the water in the pipe with the cement in the pipe wall
- Structural pipe failure due to the pipe wall becoming saturated and losing strength
- Brittle failure from pipe overloading or crack propagation. Unreinforced concrete is prone to brittle failure.

The failed AC pipe inspected on 22 March had a longitudinal crack and the failure mode was clearly from crack propagation. In this case it appeared that the crack originated in the pipe joint.

Given the high pressure variations that occur in the scheme network it is inevitable that cracks will self-generate over time and eventually produce a brittle failure as observed. The pipes at the lowest elevations have the greatest cyclic pressures and therefore should fail earlier.

In this context the AC pipe from the weir to Mangaohane tee is not expected to exhibit signs of failure compared to AC pipes elsewhere in the network as the static pressure in this length of pipe is significantly less along this section of pipe.

Steel pipes

Steel pipes have been used in parts of the network primarily where the static pressures are high. Generally these pipes are unlined and uncoated. This has led to corrosion failures over time.

Where the pipe has been galvanised, such as the pipe on the pipe bridge these pipes are in much better condition.

The friction losses in these pipes are also significantly higher than the AC and plastic pipes.

PVC and PE pipes

These pipes have also been significantly used within the network.

The PVC pipe used is PUC-u, which is significantly more brittle then the current PVC plastic mixes used for plastic pipe manufacture. This pipe dates from the original installation of the Scheme. The PVC pipes within the Scheme do not appear to have any problems with maintenance and failures. PVC pipes are relatively easy to repair with off the shelf fittings.

The use of High Density Polyethylene (HDPE) has become more prevalent in the Scheme. HDPE is an extremely robust pipe, with the American Water Works Association (AWWA) suggesting that the pipes when properly installed, can work for extended periods at twice the nominal pipe pressure

with no noticeable extra degradation over time. The pipe comes in rolls or long lengths (up to 15 metres) that results in fewer pipe joints.

The only potential downside to this material is the relative difficulty of undertaking pipe repairs. This in turn is offset by having fewer repairs to undertake given the robustness of the material.

Maric valves

The Maric valves have rubber inserts which may be susceptible to movement given the potential for large pressure variations during scheme operations.

These valves should be replaced if there is any indication that the required flow rates are not being met.

RECOMMENDATIONS

To be discussed with Operations Manager/Scheme committee

- Complete renewals programme as recommended by Operations Manager
- Update model to show how extra demand can be delivered
- Develop a long term capital programme including renewals, potential capacity upgrades and consent renewal costs
- Develop a detail risk management plan including contingency plans

Erewhon Water Scheme – Asset Management Plan

1. General

Oversight of this Rural Water Supply is by a Sub-Committee of Council, with representatives from the farmers on the scheme. Erewhon was established in 1980. The financial and strategic planning oversight is handled by Council staff at the committee's direction. All aspects of the scheme from revenue setting, maintenance and renewal expenditure are directed by the committee.

The Rural Water Supply is designed to deliver supply to each property at a constant flow rate 24 hours a day. To achieve this, the supply is delivered through a Marrick restrictor, which is sized to maintain the required constant flow over a range of water pressures.

Erewhon is a gravity system. Working pressures in sections of pipe network are high (up to 600 m head) due to changes in elevation. This necessitates the use of a significant quantity of steel pipe where the working pressures are typically in the range of 200-300 m. Pipes and fittings need to be appropriately rated for pressure, and maintained in good condition, for reliable operation. The scheme traverses steep variable terrain.

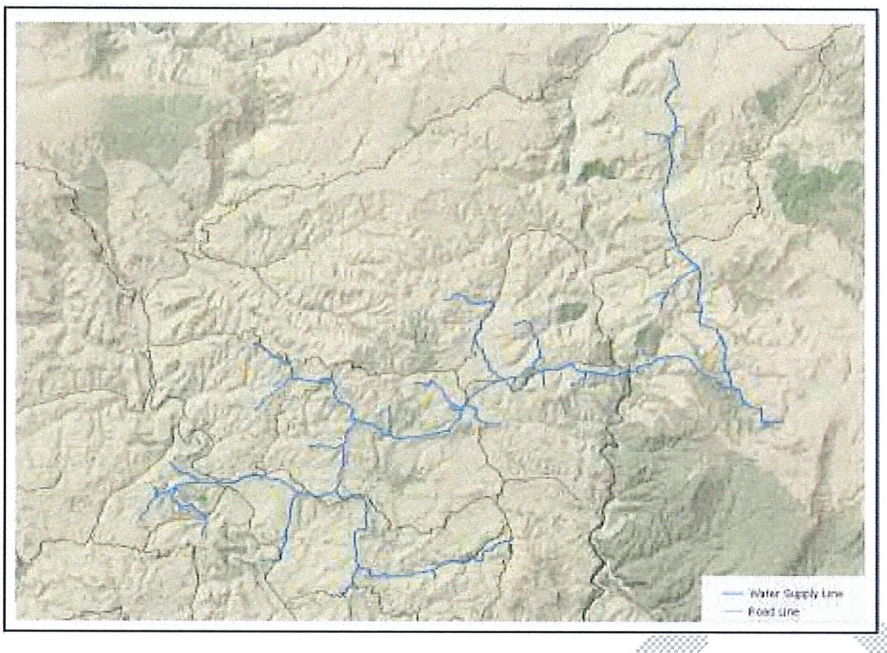
Most of the reticulation is laid in rural farm land, although sections do run alongside rail or road corridors. Renewals in these corridors should be programmed in conjunction with other works to reduce costs.

The Erewhon rural water network and treatment facilities are managed day to day by contractors based in Taihape. Contractors perform routine maintenance and monitoring, attending to customer requests for service. Major repairs or capital work is undertaken by the contractors.

Maintenance on the Erewhon Rural Water Supply is contracted privately. The tank service connections are checked regularly to ensure correct operation and condition.

The extent of the scheme is shown in Figure 26.

Figure 26: Erewhon Rural Water Supply

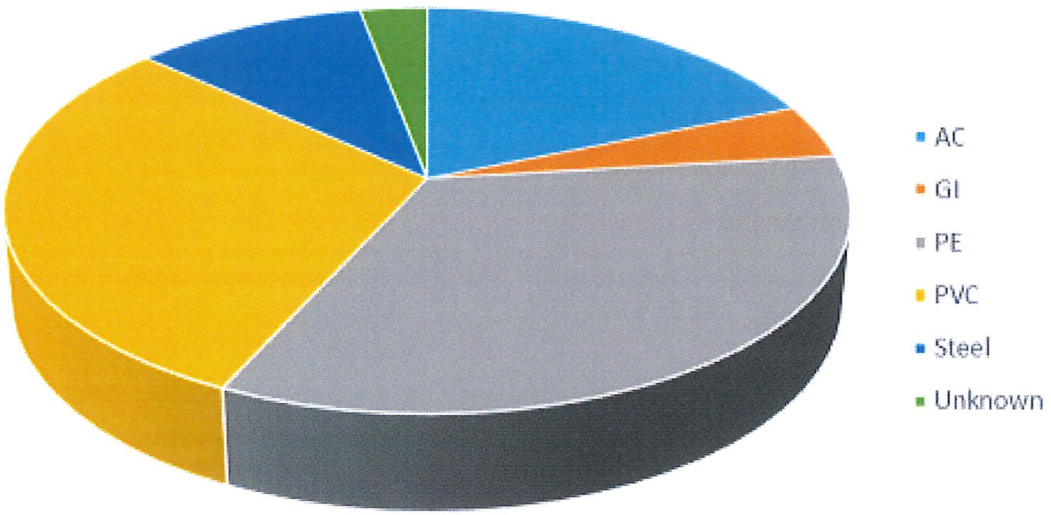


The Erewhon rural water network comprises constant flow pressure mains ranging up to 200 mm diameter. It was originally constructed with Asbestos Cement and steel pipes, with PVC used in the smaller diameters in the 1980s. The original steel pipe has shown over the years that it is susceptible to corrosion. An investment to replace this material with suitable pressure rated plastic alternatives means there is only 16% steel remaining.

Most of the water pipes on the Erewhon scheme are made from plastic (PVC or PE), as seen in Figure 27. There are a number of Asbestos Cement pipes and steel pipes as well.

Figure 27: Pipe Material – Erewhon Rural Water

Figure 27: Pipe Material – Erewhon Rural Water



2. Condition

Headworks are generally in good condition, but need to be regularly inspected and cleaned, as they are open to the elements and accessible by a track.

Mangaohane A Tank is in very good structural condition, however the inlet, outlet and overflow pipes and overflow channels need to be modified to reduce exposure to damage. Mangaohane B Tank is in good structural condition at present.

High maintenance costs are being incurred for the repair of leaks mainly within the lengths of buried steel pipe. The proactive renewal programme is addressing these issues.

There are ongoing maintenance needs associated with protecting pipelines from cattle damage and erosion at a number of locations. There is a planned renewal programme in place.

The stream crossings are currently in a satisfactory condition but require regular monitoring.

The pipe bridge crossing the Rangitīkei River Gorge is generally in sound structural condition with paintwork in good condition.

3. Capacity

The capacity of the Erewhon Rural Water Supply is described in Table 21.

Table 21: Asset Capacity - Erewhon Rural Water

Parameter	Comments	Data
Population connected	Population not yet confirmed	54 supply tanks 28 farms
Consent Limit	Reporoa Bog	1,800 m^3/day
Consumption (2015-2016)	Average daily demand	1,176 m^3/day
	Peak daily demand	1,323 m^3/day
Storage	A Reservoir –concrete	23 m^3
	B Dam - concrete	28 m^3
	Total	51 m^3

4. Performance

Water supplied is not suitable for domestic supply without the installation of treatment and filtration processes. The capital and operating costs of doing this are beyond the scheme's ability to fund and there is no intention to upgrade to provide a domestic supply.

Although the Reporoa Stream generally runs clear, in periods of heavy rainfall the water can be discoloured due to a fine sediment loam. The entry of fine sediments into the pipe reticulation affects water quality, as does the entry of organic matter that grows in the streambed.

There are the following issues with reliability:

- The flow meters and restrictor valves regularly become blocked or jammed with organic material, which needs to be cleared.

• The weir is in a very remote location and difficult to access. Any problems that may arise would be difficult to fix immediately.