



PROOF OF CONCEPT SCOPING STUDY

Tangihanga Water Storage Scheme

12 November 2025



MITCHELL
DAYSH

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GLOSSARY OF ACRONYMS

Term	Meaning
ARI	Average Return Interval
AEP	Annual Exceedance Probability
BA	Building Act 2004
DSAP	Dam safety assurance programme
DSR	Dam Safety Regulations 2022
ESI	Earth Sciences New Zealand
EPA	Environmental Protection Authority
FDS	Gisborne District Council's Future Development Strategy
FTAA	Fast-track Approvals Act 2024
GDC	Gisborne District Council
IDF	Inflow Design Flood
KRTA	Kingston Reynolds Thom & Allardice
LTP	Long Term Plan
MALF	Mean Annual Low Flow
MAR	Managed Aquifer Recharge
MBIE	Ministry of Business, Innovation and Employment
MOWL	Minimum operating water level
MWD	Ministry of Works and Development
NGOs	Non-Government Organisations
NPV	Net Present Value
NTWL	Normal Top Water Level

Term	Meaning
OBE	Operating Basis Earthquake
PAR	Population at Risk
PIC	Potential Impact Classification
PLL	Potential Lives Lost
PMF	Probable Maximum Flood
RFR	Right of First Refusal
RMA	Resource Management Act 1991
SEE	Safety Evaluation Earthquake
T&T	Tonkin and Taylor
The dam site	Pouarua Dam Site
TRMP	Tairāwhiti Resource Management Plan
TWSS	Tangihanga Water Storage Scheme (the Scheme)
WCFWMU	Waipaoa Catchment Fresh Water Management Units
WCPAG	Waipaoa Catchment Planning Advisory Group
WPT	Wi Pere Trust
NZDSG	New Zealand Dam Safety Guidelines 2024

REPORT INFORMATION

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This report has been prepared collaboratively by Mitchell Daysh, Damwatch and Aqualinc (the Contributors), each responsible solely for the content and conclusions of their respective areas of expertise. The Contributors have prepared this report solely for Wi Pere Trust (Client) to use for the purpose for which it is intended in accordance with their individual agreed scope of work. Any use or reliance by a third party is at that person’s own risk. Each of the Contributors are not responsible or liable for any loss, damages, costs or claims that a party other than the Client has suffered or incurred from relying on this advice. No liability or responsibility is accepted by the Contributors for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

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EXECUTIVE SUMMARY

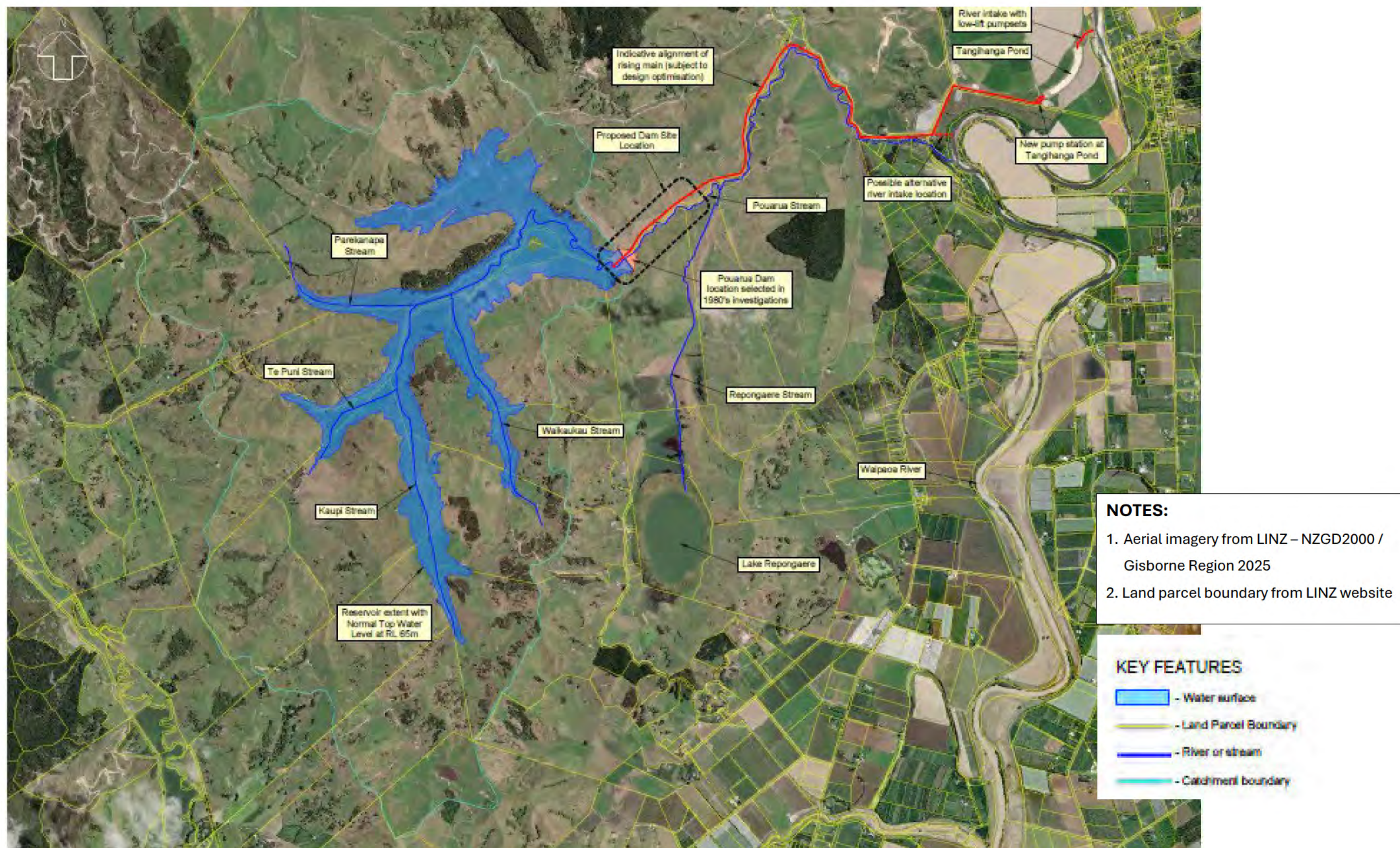
Purpose

In the early to mid-1980s, the Ministry of Works and Development (“**MWD**”) and Kingston Reynolds Thom & Allardice (“**KRTA**”) assessed a range of water storage options for the Gisborne region. The findings of this were that the Pouarua Dam site concept was the preferred option for further investigation. Due to a range of circumstances, including the disestablishment of MWD, the report findings were not pursued at that time.

Wi Pere Trust (“**WPT**”) has engaged Mitchell Daysh, Damwatch, and Aqualinc to confirm if the Pouarua Dam site concept based at Tangihanga Station, Gisborne, still has merit for potential development from an environmental, economic and engineering perspective.

This report provides a high-level review of the MWD and KRTA concept for the Pouarua Dam site (location shown below). The review was necessary given the:

- > Advancement of dam engineering since the 1980s;
- > Change in economic climate; and
- > Likely changes to water allocation planning.



Key Findings

The key findings of this report are summarised below:

> Dam Design and Technical Specifications

The preferred dam configuration consists of a zoned earth embankment structure with heights ranging from 34 to 37 metres and crest lengths between 190 to 230 metres. The Normal Top Water Level (“**NWTL**”) ranges from 60 to 65 metres above sea level, creating reservoir storage capacity between 25.1 and 38.6 million cubic metres respectively. The reservoir extends up to 5.0 kilometres upstream from the dam site, covering surface areas of 240 to 300 hectares. A zoned earth-fill dam with an impervious clay core remains the most viable option due to foundation compatibility with weak Papa foundations, potential utilisation of locally available materials, superior seismic resistance, and established construction methods. All proposed construction materials require further investigation and laboratory testing to confirm suitability.

> Water Harvesting and Hydrology Assessment

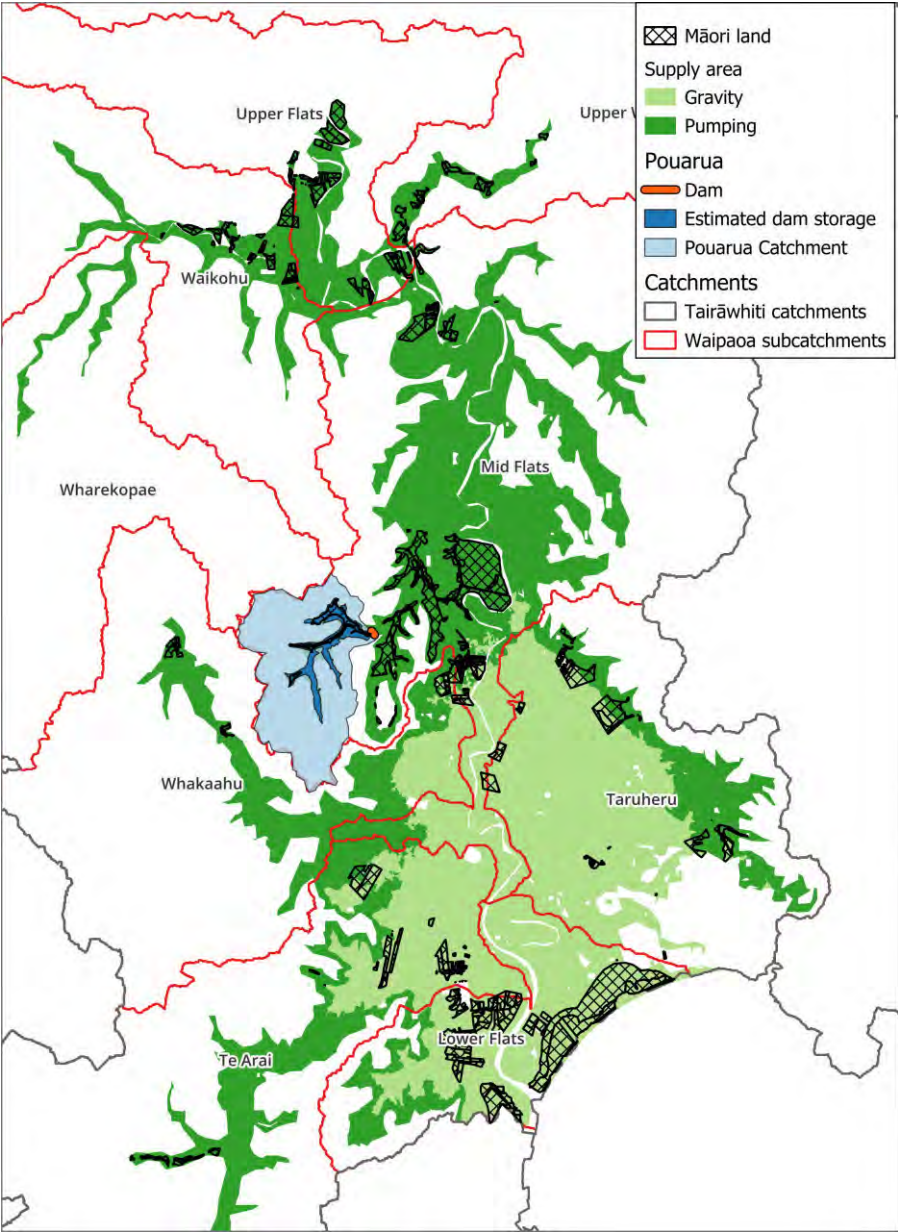
The natural Pouarua Stream catchment provides an estimated mean annual inflow of 8.3million cubic metres, representing approximately one-third of the proposed reservoir capacity. This estimate is based on a high-level assessment with no gauging information available from the catchment, and climate change adaptation would also need to be added in future. Even without these refinements however, the available data is sufficient to indicate that natural catchment inflows alone cannot reliably refill the reservoir annually for any economic dam size considered.

Water harvesting infrastructure from the Waipaoa River B Block allocation becomes essential, requiring pumping capacity utilising the available unallocated B Block (high flow) water from the Waipaoa river of 1,255 litres per second over a 3.5-kilometre (approx.) distance. The B Block allocation provides sufficient water to augment natural catchment inflows for reservoir sizes up to approximately 62 metres NTWL. Above this level, the reservoir would only achieve full capacity during wetter years, which gives an indication of the practical upper limit for a reservoir storage combining the maximum achievable natural catchment and B Block allocation inflows.

> Water Supply Capacity and Demand Modelling

Supply-demand modelling demonstrates the scheme's ability to meet multiple water demands and significant growth across the region. The system we have scoped can supplement supply to existing Waipaoa River A Block irrigators during restriction periods (which will be particularly important when minimum flows on the Waipaoa River are

increased in the future), provide new irrigation for up to 9,600 hectares on Poverty Bay flats, and enhance municipal supply resilience for Gisborne District Council (“**GDC**”). The supply-demand model simulated the operation of the NTWL 60 m dam with up to 1,255 of Waipaoa B block water harvested, over a 30-year period, showing the hydrological feasibility of using the scheme to meet water demands for both irrigation (at 95% reliability) and municipal supply. The exact area able to be irrigated from the scheme will depend on the supply reliability required, future allocation rules, and the volume of water required for municipal supply resilience (all to be refined in subsequent design stages). The image below shows the broader command area that is being considered. Approximately 24% of this command area is Māori Land.



> **Planning Assessment**

The concept for the scheme demonstrates general consistency with statutory documents including the Resource Management Act, national policy statements, national environmental standards, and the Tairāwhiti Resource Management Plan. Alignment with relevant iwi management plans would be achieved through ongoing mana whenua engagement and commercial participation. The statutory framework will be reviewed again once technical reports are prepared to assist the consenting process. It is recommended that WPT discusses consenting options with GDC in detail before confirming which consenting pathway is best suited to this project.

> **Key Cost Estimates**

Preliminary dam cost estimates range from \$89.8 million for the smallest dam configuration to \$155.3 million for the largest, including both dam construction and water harvesting infrastructure. These Class 5 estimates included 30% contingency for the dam component but excluded land acquisition and distribution network costs, as they were made initially for purposes of screening a range of dam and storage sizes irrespective of water demand.

Economic analysis using a simplified NPV method at 7% discount rate over 30 years with averaged water pricing at 65 cents per cubic metre (based on the current cost of water from the Patutahi pipeline) indicated positive economic merit for the larger dam sizes (NTWL 60-65 metres) when coupled with water harvesting. Smaller dam options relying solely on natural catchment inflows were found to be economically unattractive. The analysis demonstrated that water harvesting must be coupled with large reservoir storage to justify investment, as B Block water availability varies seasonally.

Distribution costs were estimated for a system capable of delivering the larger storage scenario modelled with NTWL of 60 metres and a 25.1 million cubic metres reservoir. The direct cost was estimated at \$37.1 million which increased to \$66.6 million once other project costs and a 25% contingency were added.

The estimated total cost of the dam and water harvesting infrastructure for the corresponding dam option was \$137.2 million. Combining the costs for all works including the distribution infrastructure on a common basis gave an overall estimated cost of \$203.8 million.

Given that the large component of water must be pumped, pumping costs are a significant contribution to the overall economic equation. For a system with installed pump capacity of approximately 0.9 MW the present value (or capitalised cost) of power consumed over the assumed payback period was \$12.6 million.

For present purposes the simplified economic metric of unit cost per cubic metre was not applied to the overall scheme cost (as it was for the dam height comparison), as there are several different demand scenarios (such as a component for municipal water supply) that would significantly influence and likely improve the overall economic merits if accounted for.

The combined preliminary cost estimate for all scheme components for the NTWL 60 storage option are shown below.

Scheme Component	Cost (M NZD)
Dam and reservoir	\$124.6
Water harvesting system	\$12.6
Distribution system	\$66.6
Total (incl. contingency)	\$203.8

The cost of consenting the scheme could be up to \$2.4 million. These costs will be refined once the consenting approach is confirmed in further discussion with GDC.

> Key Revenue Estimates

If irrigation water is priced on a similar basis to existing irrigation supplies, average annual revenue from water supplied by the scheme is approximately \$20M. Potential high-value horticultural land uses in the command area have the ability to sustain water charges higher than this. Pricing of municipal supply water has not been factored in at this stage; this is a potential upside for the scheme's revenue.

The present value of the estimated revenue at this early stage is \$250.5 million (ignoring municipal supply revenue, as above). On this basis, the scheme has a positive Net Present Value (“NPV”) of approximately \$47 million, indicating overall financial viability at the current level of investigation.

Economic findings within this report are based on pre-feasibility level findings and would require further commercial advice to WPT to confirm and refine.

Conclusion

The key findings on this report illustrate that the Tangihanga Water Storage Scheme, based on the Pouarua Dam site concept identified in the mid-1980s, continues to demonstrate

significant merit for development in 2025, with water harvesting being a key requirement for viability.

With water harvesting, the scheme can supply land with water for irrigation and provide additional resilience to the Gisborne community potable water supply.

From review of the scheme at a concept level, no issues were identified relating to technical feasibility.

Recommended Next Steps

If WPT decides to advance the scheme, through to preliminary design and consenting in collaboration with regional stakeholders, the next steps include the following actions:

- > Continue open consultation, including with key regional and central government funding providers;
- > Discuss consenting pathways with GDC;
- > Apply to GDC for a high flow water take consent from the Waipio River B Block;
- > Prepare a comprehensive project description;
- > Arrange technical inputs to support consent applications; and
- > Prepare and lodge consent applications.

1. INTRODUCTION

1.1 PURPOSE OF REPORT

Through the early to mid-1980s, the MWD and KRTA undertook studies of potential water storage options for Tairāwhiti, Gisborne. The findings of these studies indicated that the Pouarua Dam site, located on WPT land at Tangihanga Station was the preferred option.

The purpose of this report is to confirm if the Pouarua Dam site concept at Tangihanga Station still has merit for potential development from an environmental, economic and engineering perspective. A high-level review of the 1980s findings in relation to the Pouarua Dam site concept is necessary given the:

- > Advancement of dam engineering since the 1980s;
- > Change in economic climate; and
- > Likely changes to water allocation planning.

The analysis provided within this report also considers what potential options that are available for its implementation, with a review of likely costs, returns and consenting timeframes.

If WPT decides to proceed to preliminary design and consenting indicative costs, timeframes and recommended actions have been provided in this report to guide the next preliminary steps in this process.

1.2 SCOPE

To assess the merit of the Pouarua Dam site concept, the report has included:

- > The drivers and benefits of water storage;
- > An overview of historic report findings relating to possible dam options;
- > A description of the environment of the Pouarua Dam site;
- > An overview of the land ownership;
- > Zoning and overlays applicable to the site;
- > Consideration of statutory documents relevant to future consenting;
- > An assessment of water/irrigation demands, revenue potential and likelihood of integration with existing irrigation and GDC potable water supply;

- > An assessment of the dam concept in terms of engineering requirements including the Potential Impact Classification (“**PIC**”) and cost estimates; and
- > A summary of findings, recommendations and next steps.

1.3 EXCLUSIONS AND ASSUMPTIONS

Specific exclusions or assumptions in the report include:

- > Alternative schemes or additional components to augment the current scheme have not been considered;
- > Water demand or distribution at a property scale has not been considered;
- > While all due care and professional judgement has been applied to the hydrological assessment made in this report, it is to be considered initial and not to be relied on as representing actual conditions at the dam site. This is mainly because there is no measured hydrological or other relevant data available for the dam site, the Pouarua Stream or its natural catchment. In addition, the catchment characteristics of the available flow records from other regional catchments used for this assessment are different from the dam site catchment. Recommendations are accordingly made in this report relation to collecting site-based data for future studies;
- > For this level of study, the hydrological assessment does not include provision for climate change adaptation;
- > High level cost estimates are provided for the dam and water harvesting works cost components. The level of cost estimation is Class 5 as defined in AACE Practice Note 69R-12 (Hydropower industry) which is considered applicable for new earthworks and civil-based infrastructure projects investigated to concept screening level with minimal design inputs. This level of estimate is not intended or suitable for establishing project budgets or investment decisions. Refer to Section 5.7.1 for full description of estimate basis, methodology and exclusions from the cost estimate; and
- > A simplistic economic assessment of water supply infrastructure options was made to provide a comparison of different options and to help inform decisions about proceeding further with the scheme. This analysis does not represent a rigorous economic assessment of the scheme, noting that the maturity level of the scheme concept and cost estimation are insufficient for this purpose. Refer to Section 5.8.1 for further details on the assumptions made in relation to the simplified economic assessment.

Other exclusions and assumptions are noted in the body of the report.

1.4 INFORMATION AVAILABLE

To inform the information and finding within this report, a site visit has been completed, a range of consultative meetings undertaken and information resources reviewed.

The full list of information that has been reviewed to inform this report is provided in a **Reference List** at the end of this report, with the key reports of relevance listed below:

- > KRTA. 1984. City of Gisborne Water Supply Study Interim Main Report;
- > MWD. 1985. Waipaoa Plains Irrigation Summary Progress Report on Storage Dams Investigations. Special Projects Report 1985/23; and
- > Tonkin and Taylor. 2025. Waipaoa Catchment Water Storage Technical Scoping Study Report.

2. BASIS OF THIS SCOPING REPORT

2.1 OVERVIEW

This scoping report reviews the findings of the MWD and KRTA investigations through the early to mid-1980s. The findings of these key reports require review from an engineering, economic and regulatory standpoint, as there have been relevant changes to all of these matters over the 40 years since these investigations were undertaken.

The key findings of the KRTA and MWD investigations are summarised below alongside the more recent desk top analyses that Tonkin and Taylor (“**T&T**”) have produced for GDC.

2.2 KEY FINDINGS OF MWD REPORT 1985

The MWD prepared the Waipaoa Plains Irrigation Summary Progress Report on Storage Dam Investigations in November 1985. Five potential dam sites were investigated, with each location illustrated in **Figure 1**.

Pre-feasibility studies were carried out for dams in the Graham, Bond and Papatu Catchments and more detailed feasibility studies were undertaken for Pouarua and Waingake Catchments. Earth dams constructed of recompacted soft rock was considered for all dam sites, as other forms of dams were not considered feasible.



Figure 1: Five water storage option locations investigated, with Pouarua Dam site shown (red square (Source: MWD, 1985)

The site investigations for full feasibility of the Pouarua and Waingake Catchments included two stages:

- > **Stage 1:** Determined the most promising dam site in the catchment. This included a study of the previous geological investigations, an examination of the surface exposures of the various soil and rock materials at the site and the mapping of the important geological features.
- > **Stage 2:** Examined in detail the behaviour of both the dam construction and foundation materials and the dam foundation conditions. This detailed information was used to identify and develop economic solutions to all the major technical problems.

Table 1 summarises some of the key findings of the comparison made between the five sites investigated and illustrates the location of the Pouarua Dam Site within the Tangihanga Station. It is noted that costs included the dam and spillway structures but not the cost of water intakes or distribution systems.

Table 1: Summary of the comparison of the five storage sites

Dam	Height (m)	Capital Cost (\$ million)	Storage Capacity (ML)	Possible Irrigation (ha)	Irrigation Cost (\$ thousand / ha)
Pouarua	25 - 35	8.9 – 13.8	13,700 – 37,100	1,250 – 1,670	7.1 – 8.3
Waingake	8 - 20	1.3 – 4.5	95 – 1,170	50 - 180	23 – 26
Papatu	19 - 34	2.1 – 6.6	350 - 2450	90 - 220	23 – 30
Graham	7 - 15	1.5 – 5.1	220 – 1,270	60 - 103	25 – 50
Bond	6 - 8	1.9 – 2.5	185 - 330	40 - 50	48 - 50

The report identified the Pouarua Dam site at Tangihanga Station as the preferred water storage dam location. The specific dam proposals ranged from 25-35m in height could hold a significantly greater volume of water than the four other sites investigated, at a substantially lower price per cubic metre of water stored.

2.3 KEY FINDINGS OF KRTA REPORT 1984

KRTA prepared the City of Gisborne Water Supply Study Interim Main Report in June 1984 as instructed by the City of Gisborne.

The work was broken into 3 phases, the first to predict the future city demand, the second to assess all available options and select a favoured short-list, and the third to determine a strategy of development.

The existing water supply system was deemed inadequate based on two major points:

- > There is insufficient usable stored water available in the summer months to meet the City demand due to stratification of the existing reservoirs which causes deterioration in lower water quality
- > During periods of low bush catchment flow the pipeline from the dams does not have sufficient capacity to meet average weekday summer demand.

It was found that if the existing water supply system is upgraded and leakage progressively reduced to the target value as outlined, commissioning of the second major scheme would be required in about the year 1990 to provide a system adequate to cope with 1 in 30-year drought conditions. At that point a second major water supply scheme is required for long term security of supply.

As a long-term solution to water supply, four options were considered including the Pungia Scheme, Waimata Scheme, Pouarua Scheme and the Waipaoa Scheme.

The selection of the most suitable scheme in overall terms took into account the following elements:

- > Capital and running costs - at present and discounted values;
- > Planning approaches - especially where there may be competing interest (WASP) for a site;
- > Risk factor - as determined by the degree to which the second scheme strengthens the security and reliability of supply to the city;
- > Ease of operation in conjunction with the existing sources; and
- > Extendibility beyond 2016 and attendant costs.

It was recommended that the Pouarua Scheme option be adopted as the next major scheme with the Waipaoa Scheme as a second choice to be used if planning difficulties arise for a Pouarua scheme. The Waimata Scheme was ranked third option and the Pungia Scheme ranked fourth.

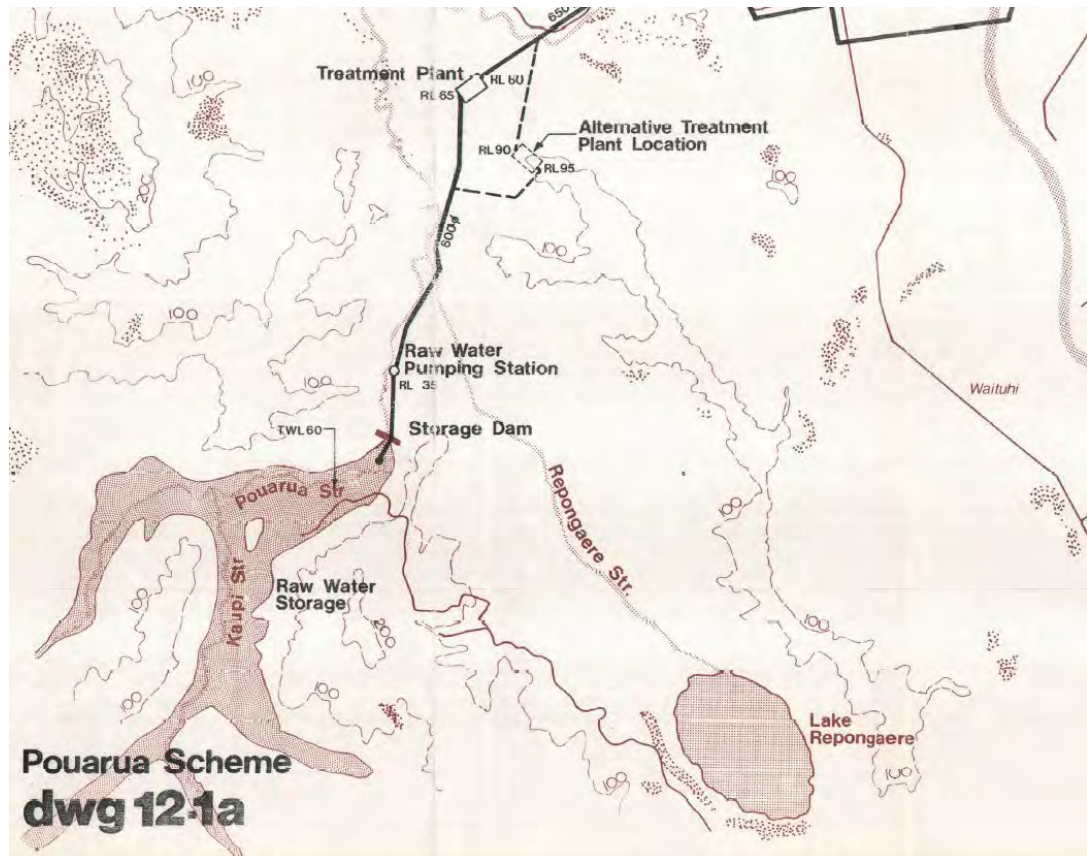


Figure 2: Pouarua Dam site (Source: KRTA, 1984)

The Pouarua Option was found to offer the following benefits:

- > Lowest capital cost of all the options (at \$32.36 million);
- > Lowest impact on city rating;
- > Located clear of geological anomaly and faulting;
- > Pipeline route for distribution is generally level and mainly on existing roads for ease of construction and maintenance;
- > Provides diversity of supply with relatively low risk factor;
- > Could potentially be extended for additional supply (subject to confirmation of yield); and
- > Offers conjunctive operation of the Pouarua, Waingake and Mangapoike sources to meet total water demand.

It was noted that careful selection of abstraction periods corresponding to river flows with lower sediment load would be necessary, to minimise reservoir siltation and loss of storage capacity.

The report concluded that further detailed investigation work would be needed to confirm the results of the preliminary work carried out in this study. This included:

- > Investigation of geology, particularly with regard to local faulting and stability of slopes in the storage area;
- > Undertaking borehole investigations to identify the types and properties of soils in the storage area;
- > Obtain rainfall and stream flow data in the Pouarua Catchment to check annual yield and develop a catchment model to determine reliability of runoff; and
- > Establish a water quality monitoring programme to assess seasonal variations in the quality of the Pouarua Stream flow.

Wi Pere received a letter from the City of Gisborne in September 1984 that their land was wanted for this dam (refer to Appendix 2).

2.4 KEY FINDINGS OF T&T INVESTIGATIONS 2025

In 2025, a high-level desktop technical study was prepared by T&T for GDC to identify and shortlist potential water storage (dam / reservoir) sites within the boundary of the Waipaoa Catchment Fresh Water Management Units (“**WCFWMU**”).

Twenty-eight dam and reservoir sites were identified for consideration within this report, including one site located outside of the WCFWMU. The purpose of the study was to inform GDCs early discussions about long-term water supply and demand management.

One of the sites identified by T&T was termed as the Pouarua Site No. 1, which is located nearby the Tangihanga site that is being investigated in this report. The Pouarua Site No. 1 was identified in both the 3Mm³ and 12 Mm³ storage categories and ranked second to lowest in both categories. As such, it was not shortlisted for further assessment.

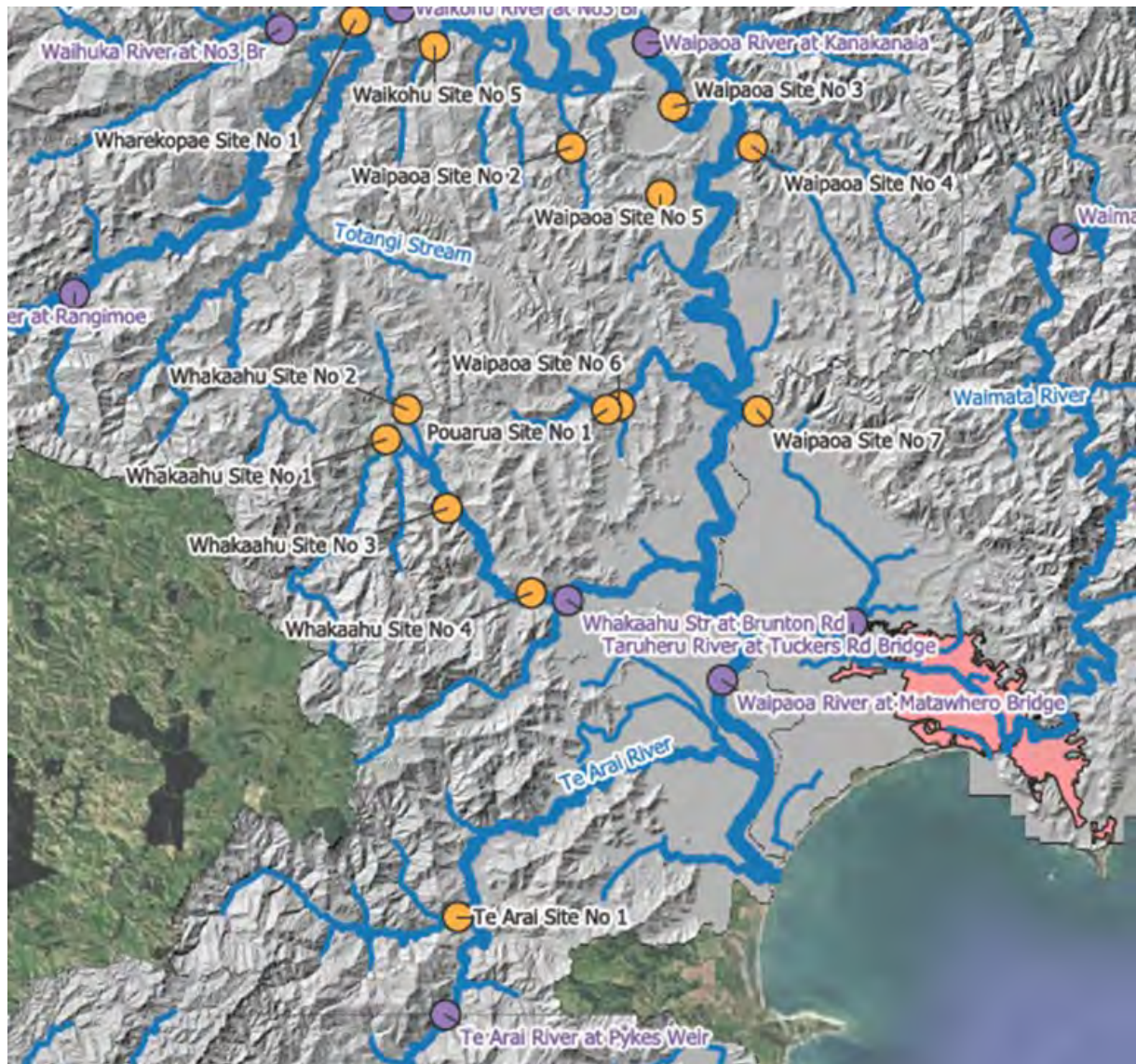


Figure 3: Map showing Pouarua Site No. 1 location

Appendix B of the T&T report outlines some of the reasons for this ranking determination at the Pouarua Site No.1. In summary these included:

- > Small inflows and external refill required;
- > Cost of harvesting and distribution works was considered to be high;
- > Low score for flood flow and spillway costs;
- > Landslide risk and proximity to fault;
- > Moderately high land value inundated;
- > Wetland or water bodies affected; and
- > PIC (dam safety) may be high due to proximity of dwellings.

The findings of this T&T report, while given due consideration, do not reflect the location of the catchment of the dam site considered in both this report and the MWD studies. The T&T report considered another catchment, the Repongaere Stream Catchment (which included Lake Repongaere) and not the one considered by MWD and in this report. Given the characteristics of the Repongaere Catchment, it is agreed this is not a good location for water storage in terms of potential environmental and cultural impacts.

While some of the summarised points bulleted above hold true for the Tangihanga site, others do not, and the findings of this scoping study are considered more comprehensive and accurate.

2.5 DRIVERS AND BENEFITS OF WATER STORAGE

2.5.1 Imminent Changes to Waipaoa Minimum Flows

The operative Tairāwhiti Resource Management Plan (“**TRMP**”) Part D currently sets allocation limits and minimum flows to provide for instream values such as ecosystem health. There is a two-tier system for issuing water take permits:

- > Waipaoa A Block water take permits which allow water to be taken until the river reaches the minimum flow requirement (current minimum flow is 1300 l/s with an allocation cap of 2000 l/s). A Block takes provides greater reliability for irrigators; and
- > Waipaoa B Block water take permits which allow water to be taken during high river flows (current minimum flow is 4000 l/s with an allocation cap of 2000 l/s). B Block takes provide less reliability for irrigators.

Abstraction from the Waipaoa A Block remains fully allocated, which is likely due to a move towards higher value and more water-demanding crops such as kiwifruit and apples on the Poverty Bay flats. This significantly limits the potential for additional high-value land use development, hindering economic growth and job creation opportunities for the wider region opportunities (including for Māori landowners).

As part of the TRMP review, the Waipaoa Catchment Planning Advisory Group (“**WCPAG**”) have been actively working on this issue to determine appropriate new minimum flows for the Waipaoa River.

Recent analysis (reported in Hui 11 of the WCPAG) shows the Mean Annual Low Flow (“**MALF**”) is higher than previously thought at 2,550 l/s instead of the 2,000 l/s that is currently estimated in the 2015 Catchment Plan. This new understanding shifts the proposed minimum flow from 65% of MALF to approximately 51% of the actual MALF, highlighting the need for updated minimum flow values to better support the river's environmental values.

The minimum flow for A Block, currently set at 1300 l/s will need to increase significantly to provide for ecological flows in the river.

Any future increase to minimum flows will put additional pressures on current water users, including irrigators. This is because any increase in minimum flow will decrease the reliability of water takes from the river and increase the frequency of time period when irrigation is on ban and water cannot be taken from the Waipaoa River.

2.5.2 Managed Aquifer Recharge

One of the options for additional water storage in this area is to undertake Managed Aquifer Recharge (“**MAR**”). MAR is designed to help manage the overall water balance for catchments, restoring groundwater that has been drawn upon during periods of peak demand.

The Makauri aquifer is the largest aquifer underneath the Poverty Bay Flats, extending from Kaiteratahi down to Makaraka and spanning both sides of the Waipaoa River. It has very little natural recharge from rainwater and river water because of changes to the land such as flood control and vegetation clearance, rainfall and climate changes.

Recharge of the Makauri aquifer could reverse the declining levels of the aquifer, address saline intrusion, and provide water surety for irrigation, cultural and environmental needs. According to the GDC website, currently about 1 million cubic metres is taken from the aquifer each year, and irrigation would need to be reduced by two thirds of current use to equal natural recharge.

A MAR trial has been completed by GDC. Makauri aquifer MAR trial aimed to inject water from the Waipaoa River into the Makauri aquifer to ensure its ongoing use for irrigation of 3000 hectares of horticultural farmland. The results of the first trial showed positive indications of increasing groundwater levels without degrading the quality of water.

On the basis of Stage 1 results, further MAR trials were carried out in 2019 (being the Stage 2 trial) and 2020 (being Stage 3 trial). At the end of the Stage 3 trial an independent review of all data was completed in February 2021. This report confirmed that the Makauri aquifer is suitable for recharge of around 600,000m³ per annum.

The Regional Infrastructure Fund has supported MAR and other small scale water storage projects recently as part of a broader effort to improve water storage and resilience in the East Coast¹. The purpose of the funding was to deliver a more reliable water supply for primary production on fertile flats, near the Waipaoa River.

The storage volume offered by the MAR is relatively small in terms of volume. With additional storage at the Tangihanga site, the water supply needs of the Poverty Bay Flats could be better supported.

2.5.3 Resilience and Social Wellbeing

Gisborne City's water supply currently relies on a 40km long and sometimes vulnerable pipeline from the Waingake catchment, which was compromised following Cyclone Gabrielle.

Developing additional water storage closer to Gisborne township and the surrounding rural settlements will add resilience to the water supply network, particularly in the wake of climate change and recent large flood events. It would provide a reliable backup during emergencies and lessen the risk of further supply disruptions. This could assist in mitigating the risk associated with the existing infrastructure.

A more reliable and resilient water supply would strengthen the local community by providing reliable access to essential resources and providing security against future disruptions. This added resilience will improve the overall health and well-being of the local residents.

¹ <https://www.growregions.govt.nz/about-us/news/east-coast-receives-24-62m-funding-for-infrastructure>

2.5.4 Economic Development

Access to a reliable supply of irrigation water is a significant barrier to successfully developing agricultural and horticultural land.

Increased water availability would unlock significant economic potential, creating jobs across various sectors, from infrastructure development to high-tech agricultural/horticultural management.

Increasing the irrigation water available for allocation will allow a wider range of higher value crops to be produced by landowners, which in turn provides resilience in responding to changes in food product markets. This would have a particularly positive impact on Māori communities by providing employment and training opportunities for whānau.

We are aware that Trust Tairāwhiti has received a Draft *Assessment of Economic Potential of Irrigation Water* report from the Agribusiness Group, however this is not currently publicly available. Once available, this report will be helpful in making informed decisions about progressing the TWSS.

2.5.5 Summary

Based on the information outlined here, there is a clear need for water storage and supply in this area. The demands for the water supply offered by this project are likely to intensify as a result of these upcoming changes to minimum flows in Waipaoa A Block (and potentially the Waipaoa B Block also).

The scheme has the potential to help with MAR by providing a stable supply of water for artificial recharge which in turn replenishes the Makauri aquifer used for irrigation and potential emergency water supply.

The scheme could provide a range of economic and social benefits, including water for irrigation and resilience of potable water supply.

3. SCHEME ENVIRONMENT

3.1 DESCRIPTION OF THE SITE

3.1.1 Pouarua Dam Site at Tangihanga Station, Gisborne

The Pouarua Dam site is located on the Pouarua Stream within the Tangihanga Station in Gisborne. Tangihanga Station is owned and managed by WPT and comprises a 1450 ha rural property located off Lavenham Road, near Patutahi. The site is approximately 30 km inland from central Gisborne.

The Pouarua Dam site refers to the proposed dam axis or centreline investigated by KRTA (1984) and MWD (1985) as shown in **Figures 4** and **5** below.

No other sites were reported as being considered for the Pouarua Dam, although it is possible site screening was covered in prior investigations for which reporting was not available. Geotechnical investigations were carried out at the preferred location in the mid-1980's and given the focus of the earlier reporting the same site is retained as the site of interest for this current study.

With the benefits of recent and much more accurate topographical survey data, other geospatial tools, and the site inspection (refer below), other potential dam site options have been located nearby. These are briefly covered in Section 5.4.1. However, review of the 1980's reporting on the site preferred at the time indicated no over-riding reasons to consider alternative locations for purposes of the current study.



Figure 4: Location of Pouarua Dam Site within the Pouarua Catchment (Source: Damwatch)



Figure 5: Pouarua Dam Site location (Source: Google Earth and Damwatch)

The land area surrounding the Pouarua Dam site is owned and managed by WPT and is currently utilised as a sheep and beef farm, with approximately 243.5 ha of land utilised for forestry. The land is undulating and contains farm dwellings and buildings, including a woolshed.

The adjoining landowners to the south and south-west of the Pouarua Dam site, in the reservoir area are similarly rural in nature, comprising of sheep and/or beef farms on rolling hill country, with gullies.

The Waipaoa River lies approximately 3km away from the Pouarua Dam site to the east, beyond which lies State Highway 2. Around the Waipaoa River on the flats is the rural settlement of Ormond and expanses of horticultural land. Lake Repongaere is located approximately 1.8km to the south of the site.

3.1.2 Pouarua Catchment

The Pouarua Stream Catchment is located 2km north of Lake Repongaere, on the western boundary of the Gisborne flats. The extent of this catchment is shown in **Figure 6** and encompasses an area of approximately 20km².

MWD described the catchment above the Pouarua Dam site as grazing land, predominantly in grass, defined in the upper reaches by the Kaupi and Parekanapa Streams. Drainage from the catchment joins with the Repongaere Stream, then drains to the north-east, into the Waipaoa River (approximately 3km from the Pouarua Dam site). The land use in 2025 has not changed.

3.1.3 Waipaoa Catchment

The Waipaoa Catchment incorporates twelve major sub-catchment areas and covers an area of 2,205km². The catchment is extensively farmed and represents some of the most versatile and productive soils in the region. Most surface water use and virtually all groundwater use in the region occur here and are essential to the region's economy.

Some of the sub-catchments are particularly susceptible to soil erosion, notably in the Waingaromia and Mangatu areas. As a result, the bed in the upper and lower reaches of the catchment is building up due to sediment and gravel deposition. Annual suspended sediment load for the Waipaoa catchment is approximately 15 million tonnes.

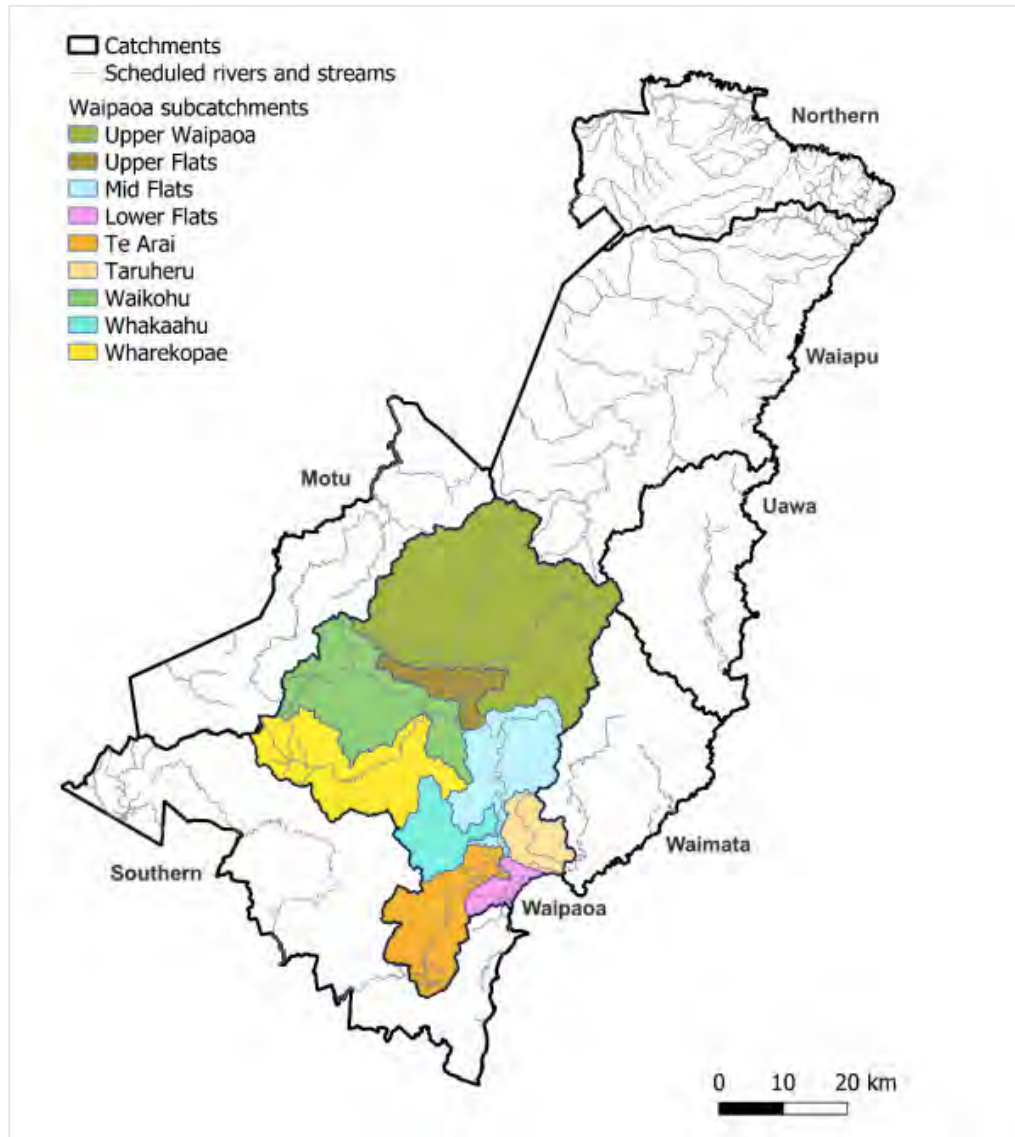


Figure 6: Waipaoa Catchment Area (Source: Gisborne Regional Water Assessment, 2023)

3.2 SITE VISIT

A site visit was carried out on August 5, 2025, by:

- > Stephen Daysh - Mitchell Daysh Project Manager;
- > Andrew Dark – Aqualinc Technical Director;
- > Graeme Boyd - Damwatch Team Lead and Dam Engineering Specialist;
- > Matthew Knox – Damwatch Associate Principal Engineering Geologist;
- > Tim Rhodes – WPT Agribusiness Manager; and
- > Richard Briant – BDO Director.

The purpose of the visit was to familiarise the team with the scheme area and visually assess ground and river conditions where practicable. Site access was by 4WD along farm tracks; however, wet and muddy conditions restricted access within the reservoir area.

Key areas inspected and summary observations are outlined below:

- > **Proposed Reservoir Area** – Access was limited to the downstream ~1.5 km of the reservoir. Surficial landsliding was particularly evident on the moderately steep northern valley slopes, with evidence of historic landslides having altered sections of the Pouarua Stream’s course.
- > **Proposed Dam Site** – Graeme, Matt, and Tim reached a point within ~100 m upstream of the proposed dam site by foot and farm ATV. This vantage provided clear views of the site, but wet conditions prevented direct inspection. Observations were generally consistent with descriptions from KRTA (1984) and MWD (1985). Surficial landsliding was again notable on the northern (true left) slopes at and around the proposed dam site.
- > **Tangihanga Farm Red Metal Quarry** – Located ~3.5 km northwest (downstream) of the proposed dam site, the quarry provides “red metal” (Matatoki Gravel of the Mangatuna Formation) for farm roads. Both the quarry face and material stockpiles were inspected. A nearby stockpile of processed limestone was also inspected. This limestone was sourced from a limestone quarry on the Tangihanga and transported to the stockpile location.
- > **Pouarua Stream** - A farm road along the Pouarua Stream was traversed to within ~1 km downstream of the proposed dam site.
- > **Tangihanga farm pond** – the large pond beside the Waipaoa River was inspected as a potential holding pond for water harvested from the Waipaoa River and pumped to the proposed reservoir. At present, the pond is used for storing water from the Waipaoa River for local farm irrigation.

Inspection locations are shown in **Figure 7** below. Inspection results and photographs are incorporated into the relevant sections of this report.



Figure 7: Site Visit Locations. Extent of visit & access path shown in yellow

3.3 LAND OWNERSHIP

The WPT Board own land within which the Pouarua dam wall and reservoir would be located (irrespective of the reservoir option chosen):

- > 1797.73ha, legally described as Part Tangihanga 1A Block GS2A;
- > 6.9ha, legally described as Lot 1 DP 2405 GS2B/1218; and
- > 344.2ha, legally described as Part Repongaere 4B Block.

Other WPT Board owned land at Tangihanga which could be used in association with the scheme (i.e. for access, ponds, pump station and distribution of water) are set out below:

- > 573.19ha, legally described as Lots 1-6 DP 8533 PT Tangihanga GS5D/697;
- > 4ha, legally described as Tangihanga 1D Block GS3B/1247;
- > 26.8ha, legally described as Lot 1 DP 5229 GS2B/145;
- > 5.5ha, legally described as Lot 1 DP 5229 GS1D/806; and
- > 0.8ha, legally described as Lot 1 DP 4831 GS125/22.

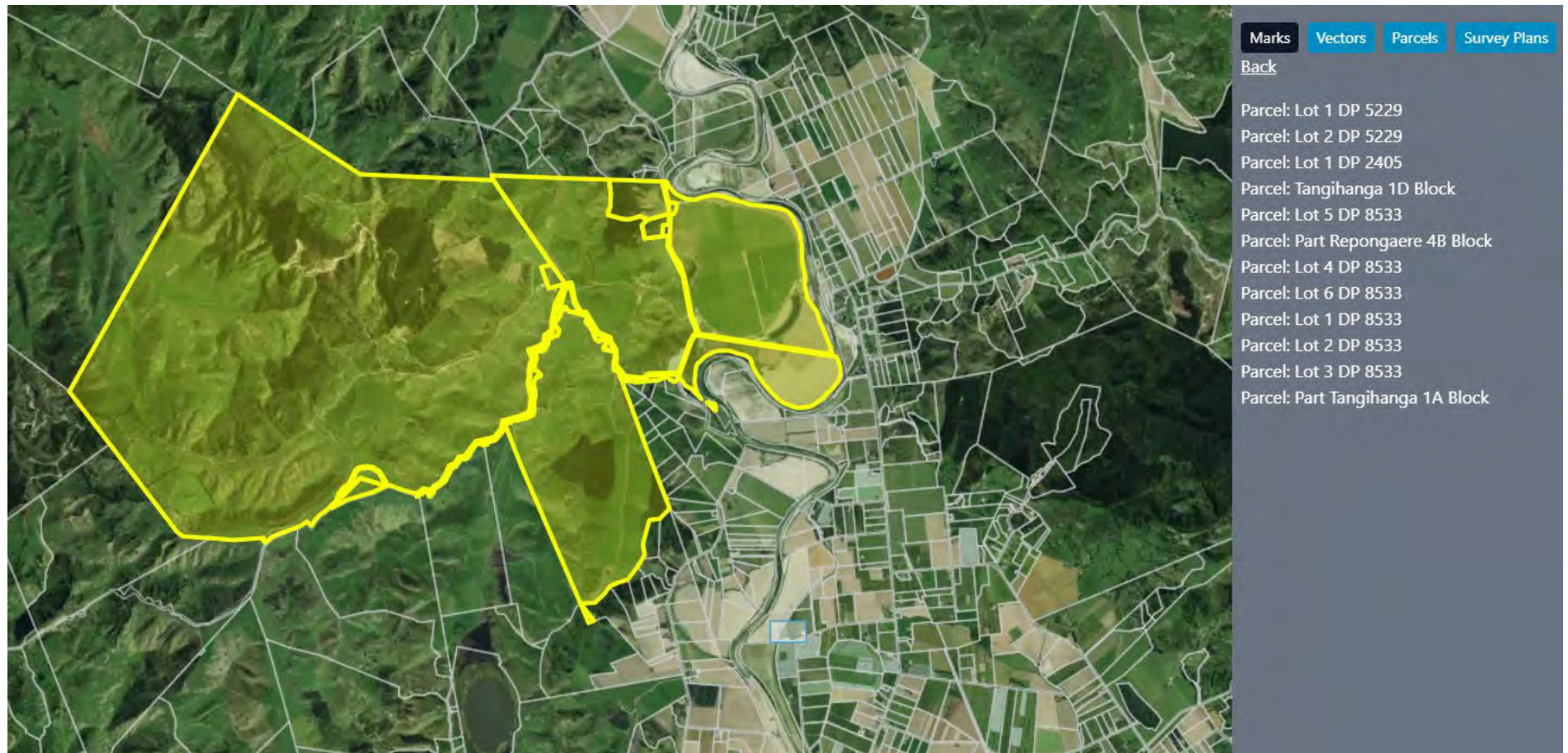


Figure 8: WPT owned and managed land at Tangihanga Station (Source: GRIP)

Much of the WPT Board owned land has the status as Maori freehold land under Schedule 3 of the Maori Purposes Act 2017. The management structure of the land is a Maori Trust, with 589 owners. The Maori Trust is governed by the Maori Purposes (Wi Pere Trust) Act 1991.²

3.3.1 Surrounding Landowners

There are a number of surrounding landowners within which parts of the reservoir may need to occupy, with variations of extent depending on the height of the dam and reservoir top level (refer to Figure 9 and Appendix 7). These would include:

- > Tahurua Farming Limited (Section 12S Repongaere SETT);
- > Hickling (Section 11S Repongaere SETT);
- > Bruce Farming Limited (Section 15S Repongaere SETT);
- > Gunson (being Lot 1 DP 3147); and
- > Rapongaere 4H3 Block³ (Maori Trustee).

Discussion with some of the owners (refer to Section 4.2) of these properties was initiated on the 2nd of October 2025 and is ongoing.

² <https://legislation.govt.nz/act/public/1991/0038/latest/whole.html>

³ This land is Maori freehold land under Schedule 3 of the Maori Purposes Act 2017.

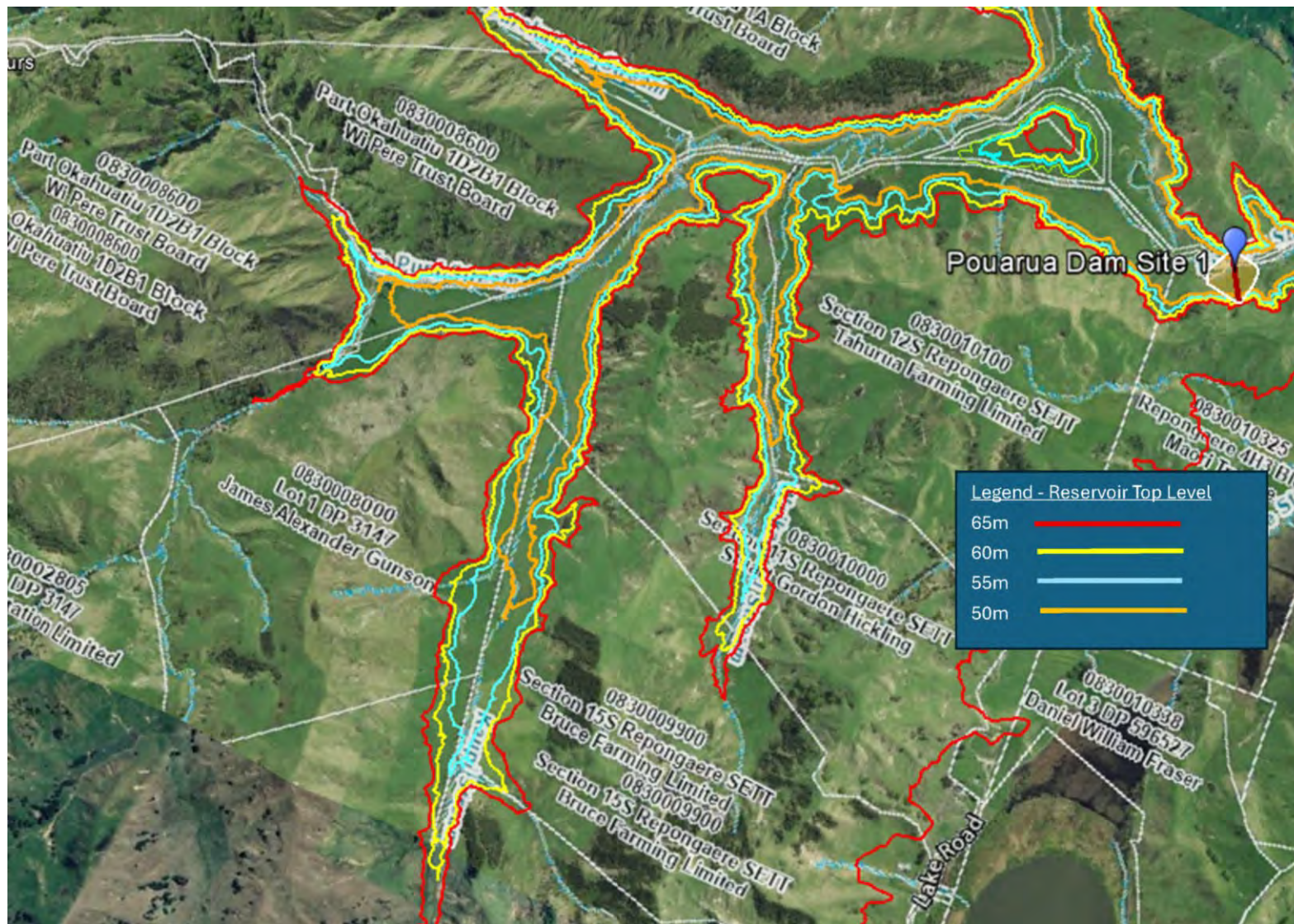


Figure 9: Various reservoir extents modelled across neighbouring land (Source: Damwatch)

3.4 GEOLOGY

3.4.1 Regional Geologic Setting

The Tairāwhiti Gisborne region features a geological landscape largely dominated by deformed marine sedimentary rocks overlain by younger unconsolidated alluvial and volcanic sediments. The geological history and context of the region are summarised below, focusing on aspects relevant to the proposed Pouarua dam site.

Tectonic processes have played a dominate roles in shaping the present-day geology and landscape of the Tairāwhiti Gisborne region. New Zealand lies within the deforming boundary zone between the Australia and Pacific tectonic plates. The plate boundary zone is made up of three major components – The Hikurangi Subduction Zone, the Alpine Fault and the Puysegur Subduction Zone. The Tairāwhiti Gisborne region lies within the northern part of the Hikurangi Subduction Zone, where the Pacific Plate is being forced (subducted) beneath the Australian Plate at the Hikurangi Trough, which lies 70 – 120 km offshore of the east coast. Further discussions on the seismic setting are provided in Section 3.6.1.2.

Subduction (sliding) of the Pacific Plate beneath the Australian plate began in the Miocene period, approximately 25 million years ago, created a large marine basin which filled primarily with thick sequences of fine-grained marine sediments (mudstones and sandstones) washed in from the surrounding land. Deposits of limestone also occurred within the basin and periods of volcanic activity resulted in volcanic ash being incorporated into some sedimentary sequences. During this period, a sequence of predominantly mudstones mixed with sandstones, conglomerates, and occasional volcanic ash, known as the Tolaga Bay Group, were deposited by deep marine currents and underwater landslides. Across the eastern North Island, numerous formations of Miocene-aged interbedded sandstone and mudstone of marine origin are present. These rocks are widely called 'Papa' rocks, and because they experienced limited burial depths, they are generally considered to be weak or poorly indurated rocks (commonly referred to as 'soft' rock). The term Papa is used throughout this report to refer to the Tolaga Bay Formation rocks which form the bedrock at the proposed Pouarua dam site.

Tectonic activity intensified in the late Miocene (~11 Ma) causing uplift and associated folding, faulting and buckling of the marine basin sediments. By approximately 3 million years ago much of what is now the Tairāwhiti region had emerged from the ocean. Geologic deposits of the Mangatuna Formation, comprising by fluvial gravels, sands and muds, capture the transition from a shallow marine to terrestrial environment.

Since the Quaternary Period began around 2.6 million years ago, geological processes have continuously shaped the Tairāwhiti landscape we see today. These processes have been most influential during the past 12,000 years. Key processes include:

- > **Tectonic processes:** Ongoing uplift and seismic deformation within the active subduction zone
- > **Fluvial processes:** Waipaoa River system development, creating extensive alluvial plains including Poverty Bay flats
- > **Volcanic processes:** Periodic volcanic ash (tephra) deposition from Taupo Volcanic Zone eruptions
- > **Erosion and landsliding:** Active erosion and landsliding in steep terrain within both unconsolidated Quaternary sediments and weak, fractured bedrock

3.4.2 Project Site Geology

3.4.2.1 Previous Investigations and Studies

The following discussions on geological conditions at the dam site and surrounding reservoir area is primarily based on previous investigations and studies summarised in Table 2 below.

In addition to these studies, regional geological mapping (Mazengarb, et.al., 2000) and publicly available satellite and aerial imagery have been reviewed. A site walkover was also completed by a Damwatch Engineering Geologist on August 5, 2025 (Section 3.2).

Table 2: Summary of previous geological investigations and studies

Author/Year	Study/Investigation Details
KRTA Ltd, 1984	The study summarises and discusses the geological conditions and associated engineering consideration of the proposed dam site and surrounding area. It includes a geological map and summary geological sections across the proposed dam centre line based on the results of: > Walkover survey by a KRTA engineering geologist > 2 drilled boreholes > 4 surface seismic refraction surveys No raw investigation data i.e., drill hole geological logs, test result data etc) is provided in the report.
Ministry of Works and Development, 1985	The study evaluated foundation conditions across the footprint of a proposed dam footprint and included the following investigations:

Author/Year	Study/Investigation Details
	> 5 cored drill holes > Laboratory testing of select soil and rock samples > Foundation water pressure testing within drill holes > Down hole geophysical testing (within drill holes) > Surface seismic geophysical surveys The report provides a discussion of investigation results, summary geological cross-sections, summary of investigation results and site plans. Raw investigation data is not provided in the report.
Berryman et al, 2009	The ~4.5 km active surface trace Repongaere fault runs through the proposed reservoir within ~350 m of the proposed dam site. This fault study included: > Surface mapping of the fault trace > 3 geologically logged paleoseismic trenches across the fault (approximately 1 km west and 2 km east of the dam site) > A desktop review of local geologic conditions The results of the fault mapping and trenching were used to assess the seismic hazard posed by the Repongaere fault.
Land Vision, 2022	An integrated farm plan was commissioned by Wi Pere for it's Tangihanga Finishing Farm, which includes the area of and immediately adjacent to the proposed dam site. The purpose of the study was to help understand the land characteristics, resources and capabilities to support future farming activities and land management. Of value to the geological review the study included mapping of the soil conditions (including test pitting) and slope erosion conditions across the property.

3.4.2.2 Dam Site Geology

This section describes the geological materials and conditions at the proposed Pouarua dam site based on the information outlined in Section 3.4.2.1. The proposed dam site refers to the proposed dam centreline investigated by KRTA (1984) and MWD (1985). Other potential dam locations are identified in Section 5.3.1, which are all downstream of the originally identified location. Whilst no investigations have been completed on these other dam alignments it is assumed that the materials and general geological profile are the same for all alignments.

However, the depths and extent of deposits and the topographical profile will vary between locations. As such, the geotechnical and engineering considerations discussed are inferred to be valid for all dam site locations. Further investigations will be required to determine if any of the sites have more favourable geological conditions.

The topographic profile across the proposed dam site is typical of the surrounding area - moderately steep hills typically 50 – 100 m in height above the valley bottom and low valley low gradient valley floor. At the dam site the valley bottom is ~50 m wide whilst the valley broadens to up to 500 m or more in places within the reservoir area. Remnant river terraces are present at some locations.

The geological profile of the proposed of the proposed Pouarua dam site is summarised by MWD (1985) as follows and illustrated in **Figure 10**: *“The bedrock is composed of soft rock, either siltstone or sandstone (commonly known as ‘Papa’). The soft rock is covered by a layer of weak compressible surface soils”*.

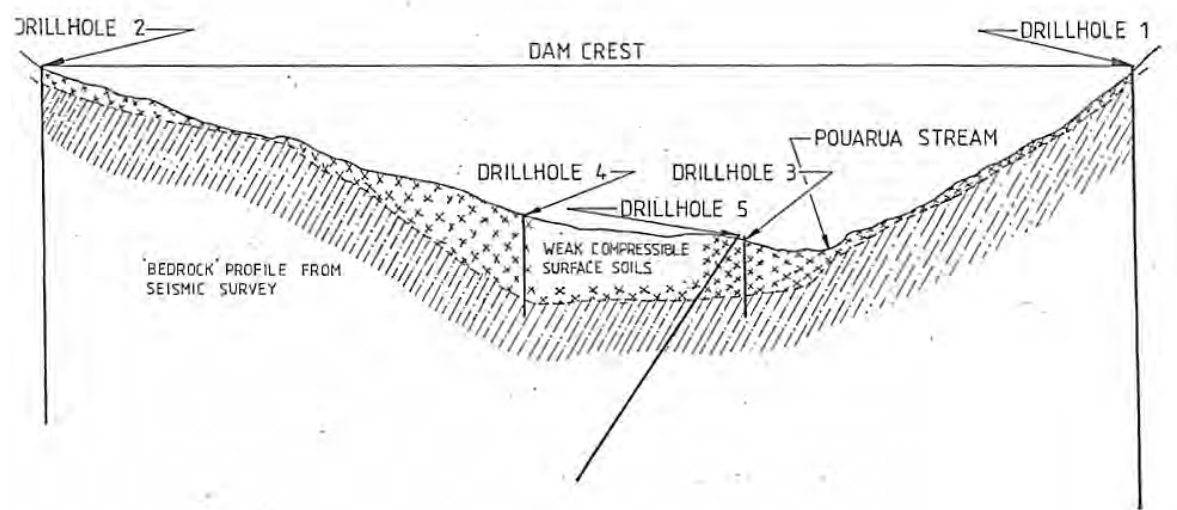


Figure 10: Geological profile across proposed dam alignment from MWD (1985) investigations. This general geological profile of Quaternary sediments ('weak compressible surface soils') overlying Tolaga Bay Formation ('Papa') bedrock is consistent with the updated assessment.

A more detailed summary of the geologic materials and profile is provided below.

Bedrock

Bedrock at the dam site comprises Middle Miocene Tolaga Bay Group mudstone and sandstone. Regional mapping indicates this mudstone unit includes interbedded sandstone, conglomerate, and volcanic tuff of varying thickness. Investigations at the dam site indicate the following material are present across the valley:

- > True-left (northern) side: predominantly blue-grey silty mudstone.
- > True-right (southern) side: dominated by grey-brown silty sandstone.

Whilst detailed borehole logs and lab/in-situ test results were not provided in KRTA (1984) and MWD (1985) qualitative descriptions of both mudstone and sandstone bedrock include:

- > Soft and fractured rock.
- > Permeable conditions (based on water pressure testing).
- > 'Weathered' (though the degree and profile of weathering are not described).

Seismic refraction surveys completed by KRTA (1984) recorded seismic velocities, assumed to represent P-wave velocities, ranging from 1.3 km/s to 1.7 km/s across the foundation. Although the original survey details and data are not available, these values are consistent with weak or weathered rock rather than competent intact rock. Furthermore, Land Vision (2022) observed the bedrock in shallow test pits nearby the dam site as *"very weak to weak, heavily jointed mudstone and weakly consolidated sandstone."*

The structure and nature of rock mass defects are critical factors in evaluating permeability, rock quality, and susceptibility to slope instability and landsliding. While the bedrock has been described as 'fractured' and 'permeable', no detailed characterization of these defects or the rock mass structure is included in previous studies.

Regional mapping shows that Tolaga Bay Group bedding planes in the dam site area dip very steeply (83°) to the south-east. This steep dip orientation is favourable for slope stability because it minimizes the potential for sliding along bedding planes that daylight in the slope face. Conversely, shallower dips oriented parallel to the valley slopes would create less favourable stability conditions.

The characteristics, intensity, and orientation of rock mass defects are likely significantly influenced by the active Repongaere fault, which runs within 500 m upstream of the proposed dam site. Further discussion of the Repongaere fault is provided in Section 3.6.1.3.

Quaternary Sediments

Quaternary sediments deposited by alluvial and slope processes, along with periodic volcanic activity from the Taupo Volcanic Zone, overlie bedrock across the dam site.

Valley slope sediments consist primarily of recent soils, volcanic ash fall deposits (tephra), and highly weathered bedrock. Sediment thickness in the upper slopes is inferred to range from 1-3 m, though local variations occur due to slope processes such as erosion and sliding. In landslide source areas on the upper and mid-slopes, sediments are likely stripped to bedrock, whereas lower slope depositional zones may contain several metres of sediment comprising a chaotic mixture of the materials described above.

The Pouarua Stream occupies a low-gradient valley bottom characterized by a meandering system with a sinuous channel and a history of channel migration within the floodplain. Aerial photographs show evidence of channel cut-offs and subsequent migration events caused by landsliding from adjacent slopes. Valley bottom sediments should reflect this dynamic fluvial environment and are expected to include fine floodplain clays, riverbed sands and gravels, sandy silts from natural levees, and organic material from backswamps and oxbow lakes. Landslide-derived colluvium and volcanic ash fall deposits are expected to be intermixed within valley bottom sediments.

MWD (1985) investigations at the dam site indicate valley bottom sediments reach 10-15 m thickness. The materials described in both MWD studies align with those expected in the depositional environment outlined above: *“interbedded sandy silty clays and clayey silty sands that are generally weak, compressible, and exhibit limited lateral continuity of individual layers”*.

MWD (1985) also identified two remnant river terraces at different elevations on the valley slopes, though no details regarding terrace materials or their extent were provided. *Regional studies by Berryman et al. (2009) describe similar remnant terrace deposits as “poorly sorted to moderately sorted gravel with minor sand and mud overlain by airfall tephra”*.

Landsliding within the Quaternary sediments is prevalent throughout the valley slopes of the scheme area, including the slopes adjacent to the proposed dam site. Landslide hazard is discussed further in Section 3.6.2.

Groundwater

The groundwater-related information from previous KRTA (1984) and MWD (1985) investigations included:

- > Borehole pressure testing indicated the Papa bedrock at the dam site was fractured and permeable.
- > The valley bottom water table at the time of drilling was 0.7m below ground level.

Groundwater observations from the August 5 site visit are summarised below and illustrated in **Figure 11**:

- > The flat ground adjacent to the Pouarua River (i.e., the floodplain) was generally saturated, indicating a high water table. This is consistent with the wet winter weather that preceded the visit
- > Localised areas of rushes were observed growing on the valley slopes, typically on ground that appears to have failed/slipped. The localised presence of water loving rushes indicates areas that are frequently saturated



Figure 11: View of northern abutment of proposed dam. Approximate dam centreline shown in yellow and areas of rushes circled red. Pouarua River meander in foreground.

Based on these observations and a review of the geological environment, the groundwater conditions at the proposed dam site are interpreted as follows:

- > Within the Papa bedrock permeability contrasts are anticipated between the less permeable mudstone units and more permeable sandstone units and zones of fractured

rock. These permeability contrasts are expected to result in perched ground water conditions, localized artesian pressures and associated groundwater discharge at the surface. Groundwater seepage on the valley slopes saturate the overlying soils and contribute to slope instability.

- > Groundwater within the valley bottom alluvium will likely be similar to stream levels and vary accordingly. Localized artesian conditions in the valley slope may exist where more permeable layers (sands/gravels) are confined by overlying less permeable layers (clays/silts) and hydraulically connected to higher-head groundwater systems within the underlying Papa bedrock.

3.4.2.3 Reservoir Geology

A review of regional geological mapping and previous work outlined in Section 3.4.2.1 indicates that the geological environment and units present across the reservoir area are very similar to those at the dam site described in Section 3.4.2.2. Specifically, the reservoir area is underlain by Tolaga Bay Group bedrock overlain by Quaternary sediments. The composition, distribution, and thickness of Quaternary sediments will vary locally within the reservoir area, predominantly because of dynamic fluvial and slope processes.

Whilst mudstone and sandstone are the dominant lithologies within the Tolaga Bay Group bedrock, it is possible that some of the group's minor units, such as conglomerates or limestones, are also present within the reservoir area. However, previous studies have not identified specific locations where these other bedrock lithologies occur.

The active Repongaere fault cuts south-west to north-east through the reservoir to within 350 m of the proposed dam site. A more detailed discussion of the Repongaere fault is provided in Section 3.6.1.3.

3.5 CATCHMENT AND HYDROLOGY

3.5.1 Purpose of Hydrological Assessment

An understanding of the hydrology and related climate characteristics of the dam site catchment is fundamental for assessment of the following aspects of the TWSS development:

- > The quantity of water available for storage and subsequent release from natural catchment inflows.
- > The low flow regime, for future assessments of environmental and residual flow.
- > Evaporation rates from the reservoir surface (i.e. as distinct from normal evapo-transpiration processes).

- > Flood flows that need to be accommodated by the scheme.

This section sets out the review, data, methodology and results of the hydrological assessment undertaken for the Scheme concept development. The focus at this stage of study is on understanding the amount of water available for storage, and its long-term and seasonal variability. The results are then applied (in later parts of this report) to modelling and analysis of reservoir size, dynamics, and availability to meet various water demands.

For this level of study, flood flows are not assessed as the catchment is small and flood flow management is not expected to significantly impact overall feasibility.

3.5.2 Review of Previous Hydrological Reporting

Hydrological assessments were reported in both KRTA (1984) and MWD (1986) for the purposes of evaluating the Pouarua dam site. The commentary available in both reports is very limited. Both studies relied on two regional rainfall records to estimate long-term average reservoir inflows. These inflows were estimated by assuming the proportion of rainfall over the catchment that is retained in the watercourse as runoff (the 'runoff coefficient').

There was no reported basis for the assumed runoff coefficient, and no actual flow data from this or adjacent catchments were reported as being available.

The conclusions from the available reporting regarding natural catchment inflows are summarised as follows:

- > KRTA (1984) reported an average rainfall of 970 mm/yr with an estimated average annual runoff of 450mm mostly occurring in winter yielding an estimated 9.0 Mm³ reservoir inflow per year. A more conservative estimate of 7.0 Mm³ was also suggested (basis not given).
- > From MWD (1986) preliminary water balance calculations reported an assumed average annual rainfall runoff of 500mm, which implies an average annual runoff volume of about 10.0 Mm³ (although this figure was not explicitly stated).
- > Both reports recommended immediate establishment of hydrological data recording equipment, although there is no record of this being implemented. During the 2025 site inspection, a small structure resembling a weir was noticed in the Pouarua Stream, which might have been an earlier attempt to gauge stream flows. However, no record has been found that could confirm this.

Neither report discussed the opportunity of harvesting water from the Waipaoa River to augment natural inflows to the reservoir, although the potential is briefly mentioned as a

possibility to pump water from the river direct to a treatment plant in KRTA (1984). This aspect was therefore not initially considered in the scoping for the current study and was first addressed after the scope, timing and budget parameters of the current study had been established.

In essence, there was essentially no substantively useful hydrological information available from the earlier dam studies. Accordingly, the hydrological assessment presented in this report is a new assessment (as opposed to updated), as reported in the following sub-sections. The reporting on water harvesting is therefore an innovation introduced by the current project engineering team, the importance of which was appreciated further after the August 2025 site visit provided the opportunity to meet with landowners, local engineering/contracting companies, GDC and other stakeholders. The reporting scope has therefore been adjusted to accommodate this potential innovation.

As identified later in this report, the capacity to pump and therefore store available water from the Waipaoa River to the dam site was found to be an essential component of the feasibility of constructing a large dam to service the region's ongoing water demands. This is possibly the most significant hydrological finding as regards viability and value of the TWSS in updating the original 1980's studies.

3.5.3 The Catchment

The catchment above the proposed dam comprises 20.5 km² (2,050 ha) of grazing land, some 96% of which is in grass, defined in the upper reaches by the contributing Kaupi and Parekanapa Streams. The valley floor above the dam is relatively flat for 2 km and widens to an extensive area in the upper reaches. Valley slopes are typically 1 in 3 (horizontal) but some steep areas exist with evidence of surface slumping in parts.

Drainage from the catchment joins with the Pouarua Stream through the dam site, which then confluences with the Repongaere Stream 1.1 km downstream of the dam site, then drains to the north-east into the Waipaoa River. The dam is located 3.5 km from the Waipaoa River.

Most of the land is in good farming condition, at the time of the inspection being lightly stocked in sheep and beef.

3.5.4 Data Available

3.5.4.1 Streamflow and Rainfall Data

As noted earlier there is no stream gauging information available in the Pouarua catchment. There is, however, a large and comprehensive database of hydrological data retained by

GDC, key parts of which were willingly made available on request (for which the authors express their gratitude).

Selected data from flow and rainfall gauges of regionally nearby catchments was obtained, reviewed and analysed. **Table 3** presents the characteristics of the river catchments at the flow gauging sites. **Table 4** provides the specifications of the rainfall gauge sites. **Figures 12** and **13** show the geospatial locations of the flow and rainfall gauges, respectively.

Table 3: Flow Gauge and Dam Site Summary Catchment Characteristics

Gauging Site Name	Grid Reference (NZTM)		Catchment Area (km ²)	Record span	Record length (full yrs)
	Easting	Northing			
Te Arai River at Pykes Weir	2018685	5698879	84.3	1984-2025	41
Waihuka River at No3 Br	2013110	5732161	80.5	2015-2025	14
Whakaahu Str at Brunton Rd	2022916	5712950	102.2	2013-2025	12
Wharekopae River at Rangimoe	2006141	5723215	174.5	1983-2025	42
Dam Site	2020925	5718770	20.5	-	-

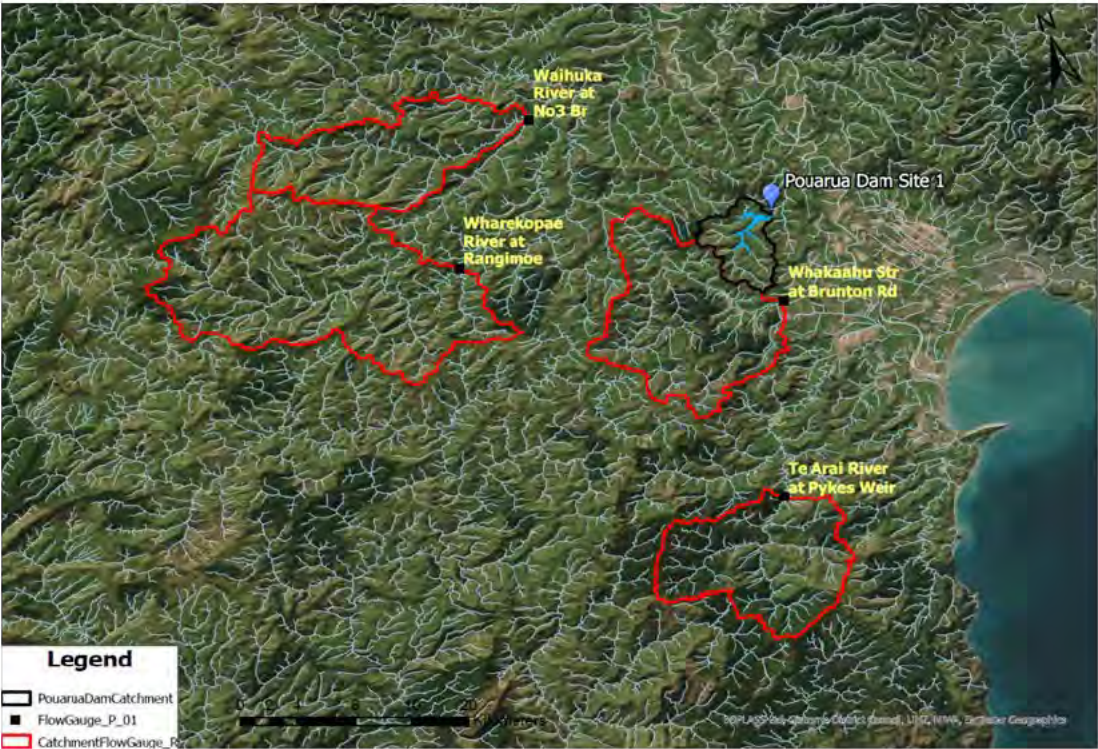


Figure 12: Flow gauged catchment locations.

Table 4: Rainfall gauge Data

Site Name	Length of Record (years)	Measurement Frequency	Elevation (m a.s.l.)
Caesar Rd No1 Bore GPG058	13	Daily	15
Hika No1 Bore Ferry Road GPE032	12	Daily	14
Ngatapa School	15	Daily	54
Te Arai River at Pykes Weir	37	Daily	41
Waerenga-O-Kuri	9	Daily	339
Waerenga-O-Kuri (historic)	32	Daily	339
Waikohu River at No3 Br	11	Daily	41
Waipaoa River at Matawhero Bridge	22	Daily	
Wharekopae River at Rangimoe	32	Daily	106



Figure 13: Rainfall gauge locations

3.5.4.2 Evaporation Data

Evaporation data is required to account for evaporation losses from the reservoir, which are significant due to the large reservoir surface area compared with the total storage volume.

Pan evaporation data is available from Earth Sciences New Zealand (“**ESI**”) website⁴. The record from climate station Ruatoria 2 (1976 – 1996) was considered suitable as a regional representation for this level of study. However, the dataset could be updated in future stages with more recent and closer data if available.

The data was reduced to long-term monthly average values for use in the study as presented in **Figure 14**. The long-term average pan evaporation is 1,060 mm/year, which (coincidentally) is similar to the average annual rainfall in Tairāwhiti. Of note in **Figure 14** however, (and distinguishing it from rainfall) is that evaporation is significantly higher in summer (up to 7x higher than in June). This characteristic has a notable influence on reservoir storage in the summer months when natural inflows are at their lowest. The monthly average evaporation values shown can be visualised as a direct loss of the equivalent depth of water from the reservoir surface.

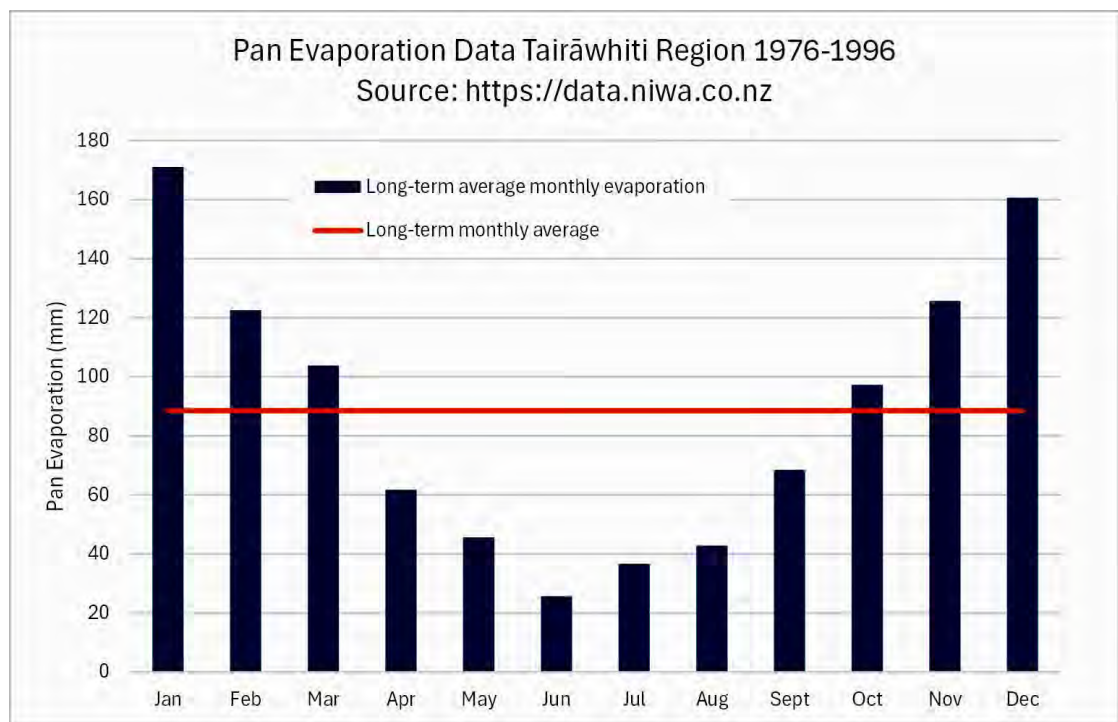


Figure 14: Monthly average pan evaporation data used for study

⁴ ESI is a recent merger of NIWA and GNS Science, however the website address retained the term “niwa”.

3.5.5 Assessment Methodology

The input data were provided in daily time-step format, from which monthly mean time series were derived for each gauging site. The main objective was to transfer measured data from one catchment to the dam site catchment of interest. For the transposition to be valid the following checks were required:

- > The measured data being utilised must be reliable and representative of actual conditions, and
- > The catchment characteristics of each catchment under consideration must be understood in terms of their 'runoff coefficient'. Where the characteristics of the catchments with reliable flow data are different to the subject catchment, appropriate adjustments need to be made in re-proportioning the measured data to represent conditions at the dam site.

Following the above checks and derivation of some necessary correction factors, a synthetic monthly time series of Pouarua Stream inflows at the dam site location was produced. The monthly inflow series (in m³/s) was converted to Mm³/mth for convenience of comparison with reservoir storage volumes.

To evaluate water volumes available for release and subsequent use, deductions were made from the monthly time series inflow data as follows:

- > Evaporation losses using the monthly pan evaporation data noted above, converted to a volume lost by assuming average reservoir surface areas applicable to each reservoir scenario tested.
- > An allowance for residual flows assumed to be unavailable for distribution, being the 7-day MALF released as a minimum through the year as further reported in Section 3.5.7.

The long-term monthly series of net reservoir volumes (i.e. with losses deducted) was then used to estimate long-term yield, long-term annual and seasonal variability, and provided as input data for demand modelling as reported in Section 6. The assessment results are reported in the followings sections.

3.5.6 Development of Synthetic Flow Data for the Dam Site

The gauged level and flow data were reviewed and assessed as to their validity for transposing to dam site inflows. The main conclusions are summarised as follows:

- > The sites at Te Arai and Wharekopae have notably longer periods of record, exceeding 40 years, is a highly desirable characteristic for the Tairāwhiti region which is particularly prone to extremes of drought and cyclonic weather patterns. These sites were selected as the preferred sites for transferring to the dam site.
- > Conversely, the records of the other two sites (Waihuka and Whakaahu) are significantly shorter, with analysis showing that their respective mean flows are about 10% higher than the longer-term record. This is explained by two recent particularly wet years – 2022 and 2023 – which tend to dominate the shorter record.
- > The catchment upstream of the Whakaahu site does however have the most similar characteristics to the dam site catchment. The Whakaahu data was therefore used as a check on the longer records, accounting as necessary for the shorter record length and influence of the two wet years noted above.
- > The GDC information package noted that all sites were intended mainly for low flow assessment, with only Wharekopae intended for both low and high flows. The uncertainty at higher flows is generally due to challenges in measuring accurate level/flow relationships at high flows. Uncertainties at some sites were also noted by GDC due to the type of equipment used for flow profiling being prone to error in sediment-laden flow conditions.
- > The daily data series for all sites were largely complete, with a few small gaps only in the Te Arai and Whakaahu records.

Overall, the datasets used were of good quality and suitable for the intended purpose. The opportunity is taken to commend the GDC hydrology group.

Catchment Characteristics Comparison

The land use characteristics of each flow-gauged catchment were assessed as summarised in Table 5 below. Forested catchments typically have lower runoff due to higher evapo-transpiration. The proportion of runoff is also influenced by the prevailing soil type and average gradient for each catchment. For current purposes the larger proportion of each catchment was taken to be in low permeability materials (mainly silty clays), with the pastoral surfaces assumed to have a higher ‘loam’ (organic topsoil) content – which will typically tend to absorb more rainfall. A more rigorous analysis utilising recognised ‘time of concentration’ methods will be possible (and is recommended) in subsequent study stages once detailed assessment of dominant soil characteristics for each catchment can be made.

The above data were used in conjunction with the rainfall and inflow data for each site to estimate an effective overall runoff coefficient, which is also summarised in Table 3.

Table 5: Flow Gauge and Dam Site Catchment Characteristics

Catchment	Area (km ²)	Elev Mean (m)	Land Use – Forest (%)	Land Use Grass (%)	Land Use Crop (%)	Land Use Other (%)	Estimated Runoff Coefficient
Te Arai River @ Pykes Weir	84.3	326	64	36	0	0.0	0.51
Waihuka River @ No3 Br	80.5	395	11	89	0	0.0	0.56
Whakaahu Str @ Brunton	102.2	199	26	70	4	0.3	0.43
Wharekopae @ Rangimoe	174.5	479	13	87	0	0.2	0.56
Dam Site (Pouarua)	20.5	123	4	96	0	0.3	0.37

Notably the dam site catchment was assessed to have a lower runoff coefficient than all other catchments with available data. This is largely because of its flatter average gradient and largely pastoral land use. This is a significant source of uncertainty and reinforces the earlier (1980's) recommendations to implement flow gauging on the Pouarua Stream as soon as possible.

Adjustment for Rainfall Variation

An adjustment was also made for rainfall variation that may apply from a gauged catchment to the Pouarua catchment. This was a relatively simplistic assessment for current purposes based on comparing long-term mean rainfall at climate stations close to the flow gauging sites with the stations closest to the dam site. The Hika No. 1 Bore and Caesar Rd No. 1 Bore rainfall records were taken to represent the dam site, with a mean annual rainfall of 990 mm and 1020 mm respectively. There was a reasonable degree of variation between sites with Wharekopae among the lowest at 960 mm and Ngatapa School and Te Arai somewhat higher at 1120 mm and 1180 mm respectively.

Low Flow Assessment

A low flow assessment was undertaken on the site-transposed data to account for potential losses from available stored water due to residual flow releases to the Pouarua Stream. For current purposes, the commonly referenced parameter of 7-day MALF was adopted.

The assessment yielded a long-term 7-day MALF of just over 13 L/s (i.e. a small flowrate), which amounts to 420,000 m³ of inflow annually. This volume was deducted as a loss from useable stored flows.

It should be noted that this assessment is not based on any environmental parameter or study and will need to be revisited in future study stages once residual flow requirements can be realistically assessed.

After applying the various catchment runoff coefficients and rainfall adjustments to the two flow records of interest (Te Arai and Wharekopae) a synthetic monthly inflow series spanning from 1984 to 2024 was able to be developed for the dam site location (Pouarua Stream). The inflow series was converted to units of Mm³/mth and adjusted to useable (or available) stored water by deducting the evaporation losses and residual flow releases as above. The monthly series can be summed to give Mm³/year, which helps to compare against an annual stored volume of water available for release.

3.5.7 Results of Natural Catchment Inflow Assessment

Annual Inflow and Storage Variation

Due to the length of record available, it was possible to evaluate what dry years would look like compared to average years. For current purposes, dry years were assessed based on their probability of exceedance for the 90%, 95% and 98% exceedance levels. These measures can also be visualised as the 1 in 10, 1 in 20 and 1 in 50 Average Return Interval (ARI) dry years. However, as with all similar event-based statistics, these measures are more realistically visualised as an annual exceedance probability, i.e. the 90% exceedance year has a 10% chance of occurring for any year (it does not necessarily occur once every 10 years).

Exceedance probabilities in this sense should also not be confused with the term 'reliability', as used in the irrigation industry, which is a measure of long-term water use annual variability that combines both water supply and demand aspects. That concept is further addressed in Section 6.

From the 1984-2024 synthetic series, the following long-term mean annual stored volumes available for release were estimated, along with the year in which the value most closely occurred:

Table 6: Synthetic series of annual storage volumes available for release from 1984 to 2024 (assuming there is no constraint on reservoir size)

	Mean	90% Exc.	95% Exc.	98% Exc.
Annual stored volume in Mm ³	8.30	4.62	3.63	3.22
Year in which value most closely occurred	2017	1994	1998	2007

Figure 15 plots the synthetic series of annual storage volumes available for release from 1984 to 2024, assuming there is no constraint on reservoir size. The mean, 90%, 95% and 98% values are also shown.

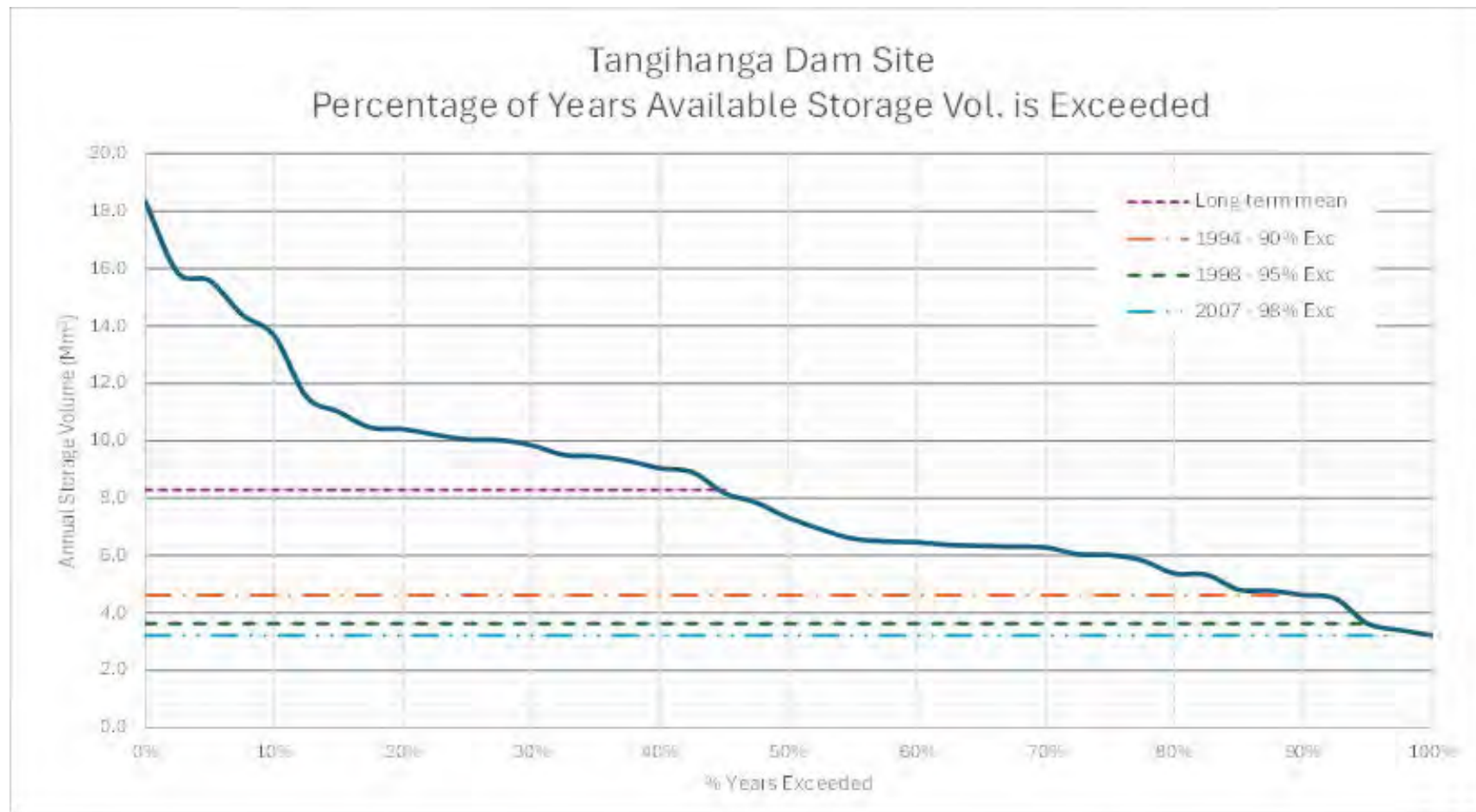


Figure 15: Synthetic series of annual storage volumes available for release from 1984 to 2024

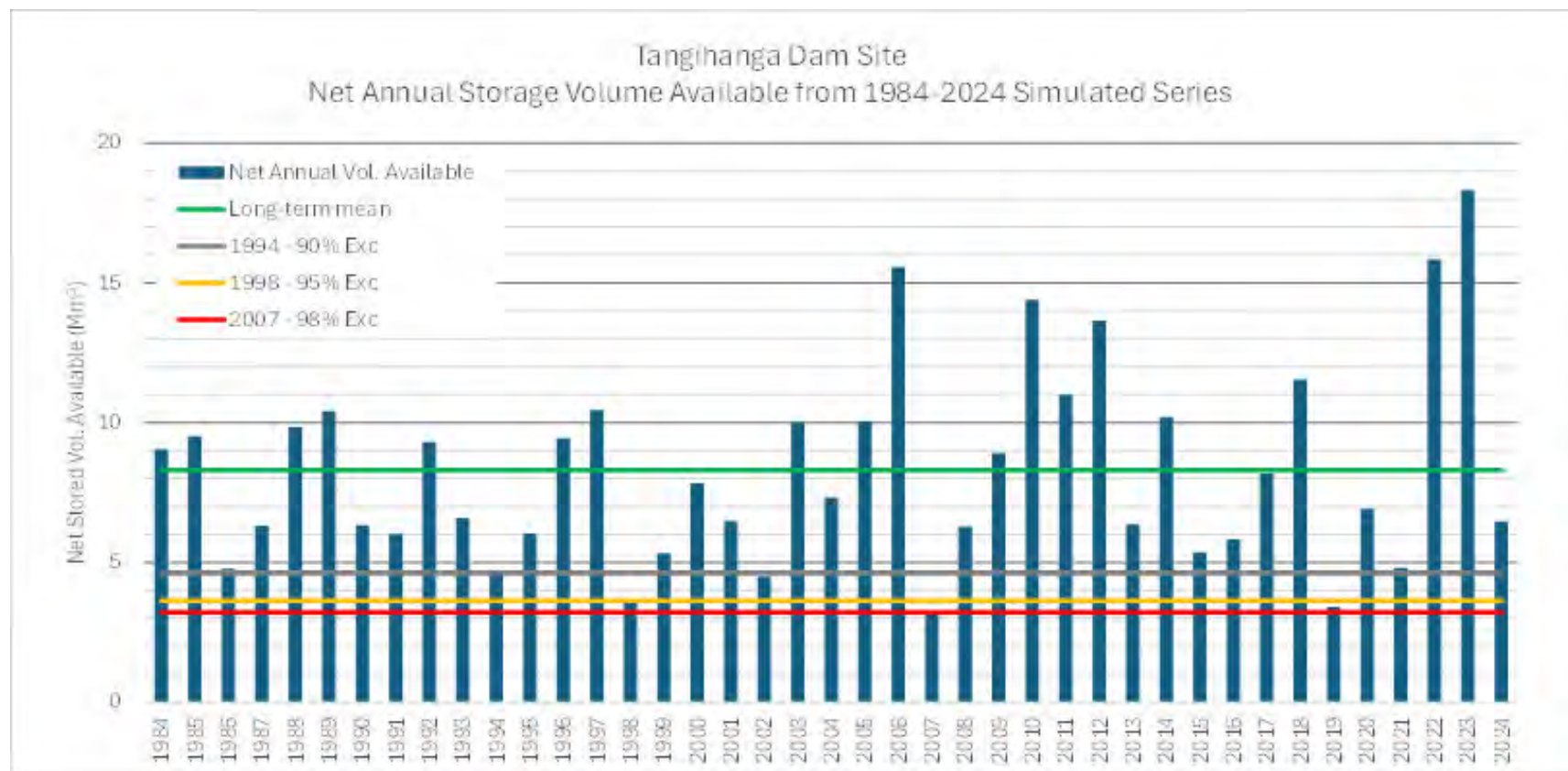


Figure 16: Synthetic series of annual storage volumes available for release from 1984-2024 (assuming no constraint on available reservoir storage)

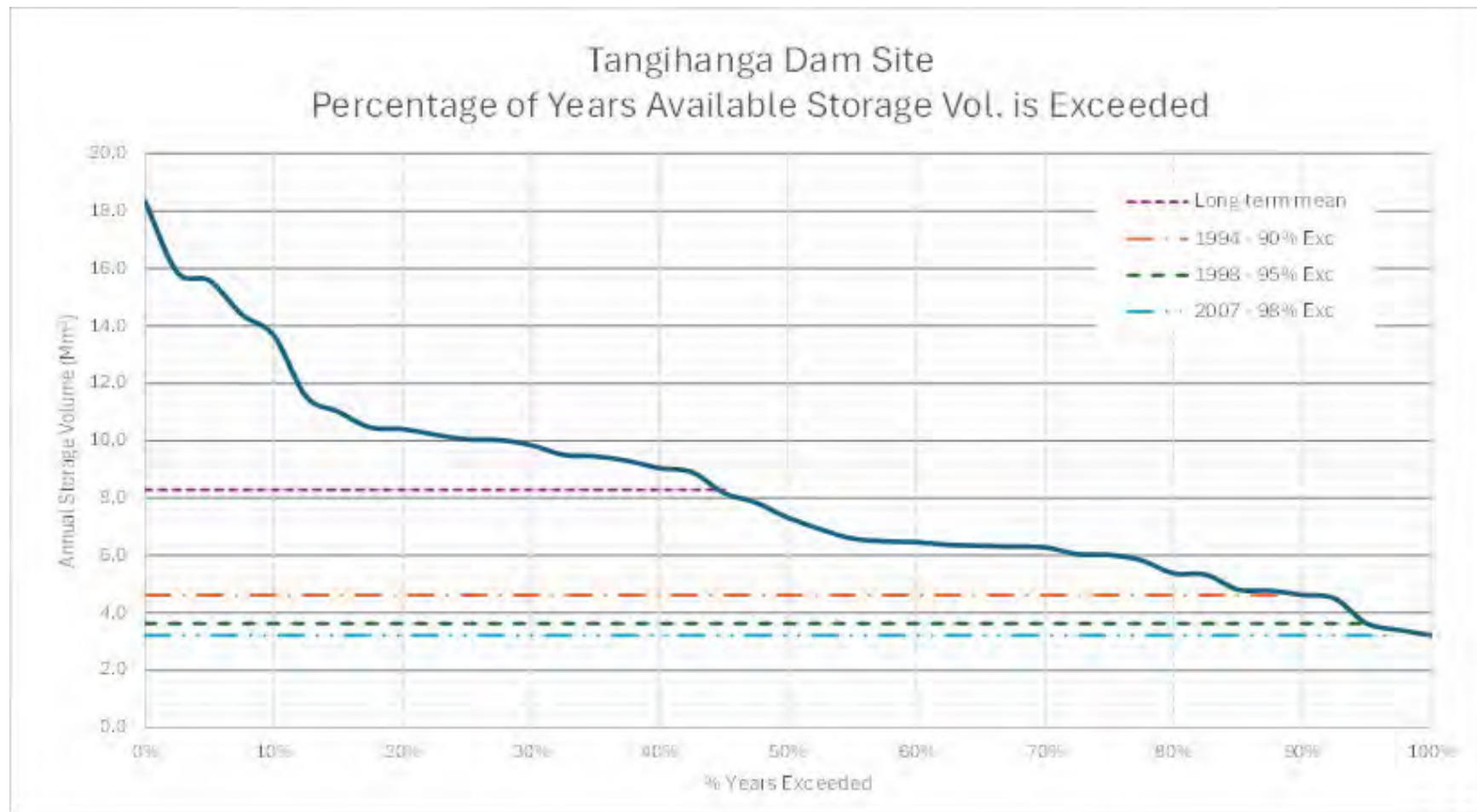


Figure 17: Annual storage volumes available in terms of a volume duration curve

The above data shows a relatively high variation from year to year, with the wettest year (2023 – Cyclone Gabrielle) being almost 6 times wetter than the driest year. This is reflective of recognised typical climatic conditions in the Tairāwhiti Region with wide swings between drought and cyclonic weather patterns.

Average Monthly Series Results

This section presents information about the expected monthly variation of inflows that can be expected at the dam site. **Figure 18** shows the mean monthly variation of water available for release, along with the monthly mean components for evaporation and residual flow losses.

Figure 19 shows the long-term mean monthly variation of available (stored) water plotted against various individual years representing the average year (2017), 90% exceeded (1994), 95% exceeded (1998) and 98% exceeded (2007). The reason for showing representative years in this form is to illustrate the high degree of seasonal variability (month to month) that can also occur.

Figure 20 shows the monthly variation of inflows (in m³/s) for all years of the synthetic record from 1984 to 2024. This also illustrates the high degree of seasonal variability from year to year.

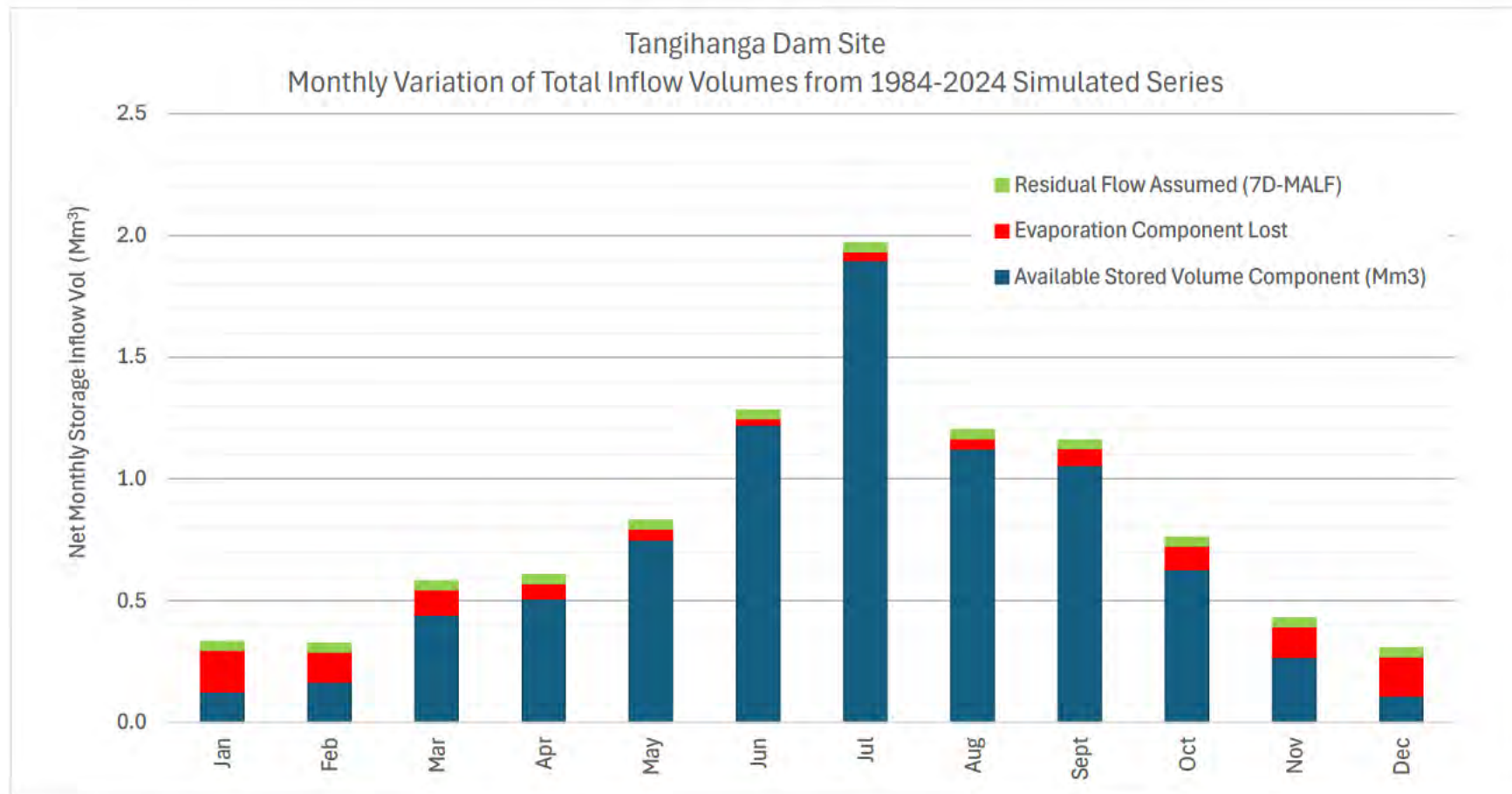


Figure 18: Mean monthly variation of stored volume and system losses from synthetic 1984-2024 flow series.

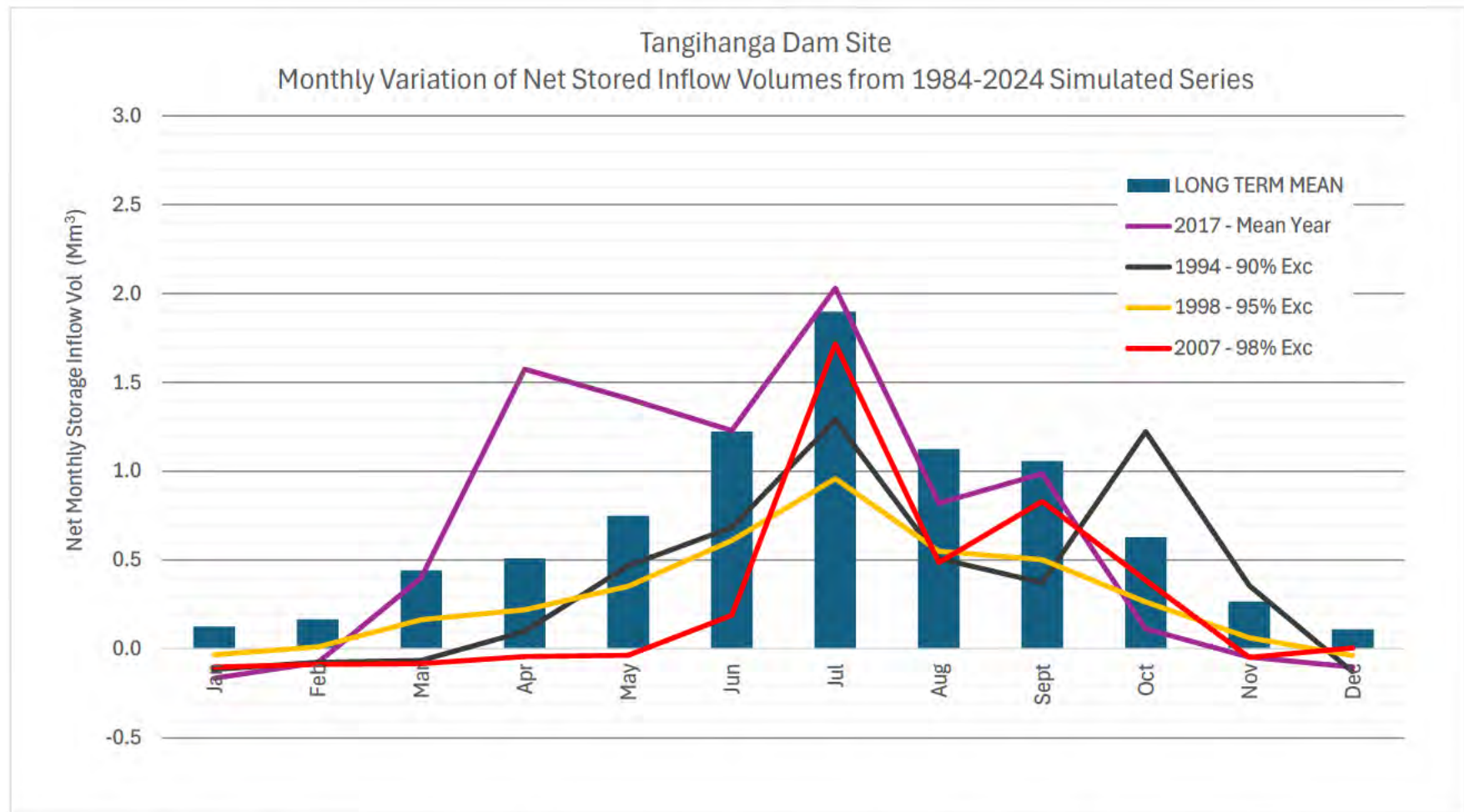


Figure 19: Variation of monthly stored inflows for the long-term mean, mean year (2017), 90% (1994), 95% (1998) and 98% (2007) exceeded years from 1984-2024 synthetic series

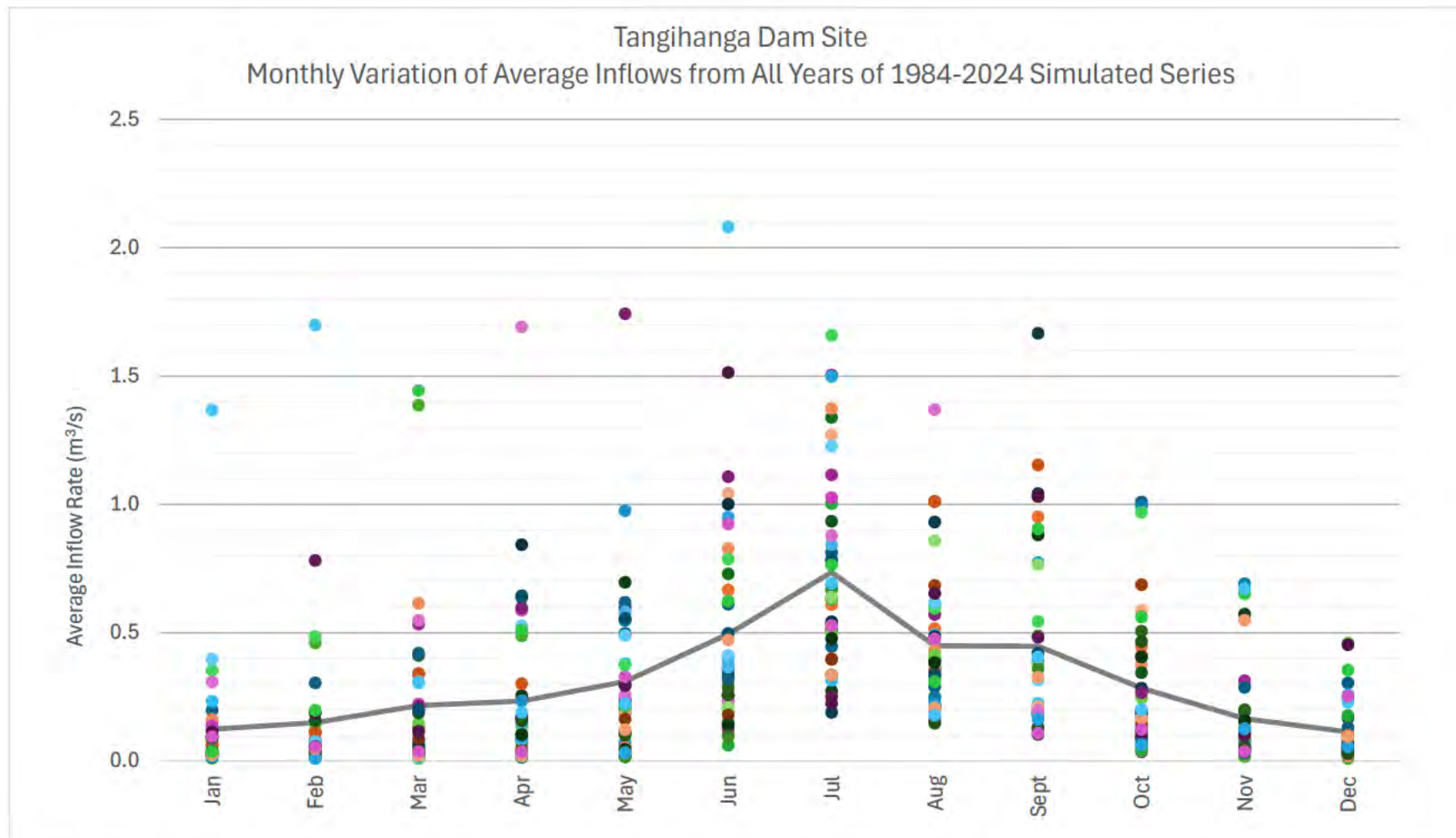


Figure 20: Monthly variation of average inflows (in m³/s) plotted for all years from 1984 to 2024

The following general patterns emerge from the above results:

- > The wettest months in winter (typically July) are on average more than 6 times wetter than the driest months (Dec - Feb).
- > Summer inflows in dry years can see very low inflows extending from November through to May.
- > Evaporation losses from the reservoir surface are typically higher than mean natural catchment inflows in December and January and are generally higher than summer inflows in all summer months. This can be seen in **Figure 19** with negative values occurring in dry summers in the three dry years shown.
- > As can be seen in **Figure 20**, the monthly variations are not at all regular or predictable, with very wet months sometimes occurring in the middle of summer. For example, the blue dot in February 2023 accounts for Cyclone Gabrielle showing that month was wetter than most winter months in the last 40 years.

3.5.8 Reservoir Sedimentation

Reservoir sedimentation was not addressed in any of the mid-1980's reports and has not been included as part of this initial level of study. This is because the reservoir has a large footprint with relatively small natural inflows, and the outcomes are not expected to drive overall scheme feasibility.

High river sediment transport rates and contributing land erosion issues are, however, a recognised feature of the Tairāwhiti Region. This aspect will accordingly need to be evaluated in future stages so that planning and design can establish the long-term impacts on live storage and any corresponding requirements and costs of facilities and upper catchment restoration planting to help deal with sediment.

GDC retains a comprehensive database relating to sedimentation, along with a range of other regional and nationwide studies that will provide suitable data for future assessment.

3.5.9 Summary Comments on Hydrological Aspects

The focus of the hydrological assessment has been to develop an understanding of the amount of water available for storage, and its long-term and seasonal variability. The results are applied (in later parts of this report) to modelling and analysis of reservoir size, storage dynamics, and availability to meet various water demands.

The 1980's work by KRTA and MWD provided coarse estimates of long-term inflows to the dam site, expressed as an annual mean inflow, ranging from 9 to 10 Mm³ of water but conservatively as low as 7 Mm³. Those statements were based on very limited rainfall data

with generalised catchment runoff coefficients assumed. No stream gaugings were reported, but were strongly recommended.

This 2025 review has utilised some 40 years of flow and a wider range of rainfall records now available from adjacent catchments to estimate runoff characteristics in the Pouarua Stream catchment. This has enabled the derivation of a synthetic long-term monthly inflow series sufficient to provide an estimate and initial characterisation of inflows available to be stored and released at the proposed dam site. The updated annual inflow availability data are tabulated as follows:

Table 7: Annual Inflow Availability Data

	Mean	90% Exc.	95% Exc.	98% Exc.
Annual stored volume in Mm ³	8.30	4.62	3.63	3.22
Year in which value most closely occurs	2017	1994	1998	2007

The following general patterns emerge from the analysis results, which should be accounted for in planning reservoir storage (and thus dam height) requirements:

- > There is a high degree of annual variability from year to year, with the wettest year (2023) in the last 40 years yielding almost 6 times more potential inflow to the dam site than the driest year.
- > On average, there is a large difference between winter and summer inflows, with July typically about 6 times wetter than Jan-Feb.
- > There is also a high degree of variability of average monthly inflows from year to year, with the variable occurrence of extreme drought and cyclonic weather patterns leading to unpredictable and irregular inflow patterns. For example, Feb 2023 (Gabrielle) would have provided close to the highest monthly inflow over the last 40 years at the dam site.

The above analysis is to be considered initial and must be treated with caution, as there is no data available for Pouarua Stream flow, and the catchment characteristics of most of the available flow records are markedly different from the dam site catchment. Accordingly, the recommendations made in the original 1980's studies to establish flow gauging's and recording for the dam site are strongly supported and considered essential for future detailed planning of the Scheme

3.6 GEO HAZARD ENVIRONMENT

3.6.1 Seismic Hazard

3.6.1.1 Previous studies

KRTA (1984) identified the presence of a potentially active fault running through the reservoir area, approximately 350 m upstream of the proposed dam site. At the time, little was known about the fault characteristics and associated seismic hazard at this time. However, two recent studies have significantly improved the understanding the seismic setting and hazard of the Pouarua dam site and the broader Tairāwhiti Gisborne region. Details of both studies are summarised below.

1. **Berryman et al, 2009.** *Holocene rupture of the Repongaere fault, Gisborne: Implications for Raukumara Peninsula deformation and impact on the Waipaoa Sedimentary System.*
 - > Mapping of the ~4.5 km active surface Repongaere fault trace across the Tangihanga station to within 350 m of the proposed dam site.
 - > Two paleoseismic trenches (logged by GNS geologist) across the fault (approximately 1 km west and 2 km east of the dam site).
 - > Results of the study were used to assess the seismic hazard posed by the Repongaere fault.
2. **Litchfield et al, 2022.** *Active fault mapping in Tairāwhiti Gisborne District using LiDAR data. Lower Hutt (NZ): GNS Science.*
 - > Commissioned by GDC to provide updated GIS-based active fault location data, Fault Avoidance Zones (“**FAZs**”) and Fault Awareness Areas (“**FAAs**”) within the district.
 - > Included desktop fault-trace mapping using new mapping methods and recently (2018 – 2020) obtained high resolution LiDAR data across the region.
 - > Whilst the study identified a number of new surface traces along previously mapped faults and some new faults across the region, the Repongaere fault remains the closest fault to the proposed dam site.
 - > With respect to the Repongaere fault, the updated mapping was found to be broadly similar to that of Berryman et al (2009). The proposed dam location lies outside of the assigned Fault Avoidance Zones.
 - > Results of the study did not change any fault characteristics reported by Berryman et al (2009) that impact the associated seismic hazard.

3.6.1.2 Seismic Setting

The seismic setting of the Tairāwhiti region and the proposed Pouarua dam site has been adapted below from Lichfield et al (2022) with minor modifications:

New Zealand lies within the deforming boundary zone between the Australia and Pacific tectonic plates (**Figure 21**). The plate boundary zone is made up of three major components – The Hikurangi Subduction Zone, the Alpine Fault and the Puysegur Subduction Zone. The Tairāwhiti Gisborne region lies within the northern part of the Hikurangi Subduction Zone, where the Pacific Plate is being forced (subducted) beneath the Australian Plate at the Hikurangi Trough, which lies 70 – 120 km offshore of the east coast. The rate of movement between the Australian and Pacific is high in this area (50 – 60 mm/yr) and Tairāwhiti has experienced a significant number of magnitude 5 and 6 earthquakes since 1940.

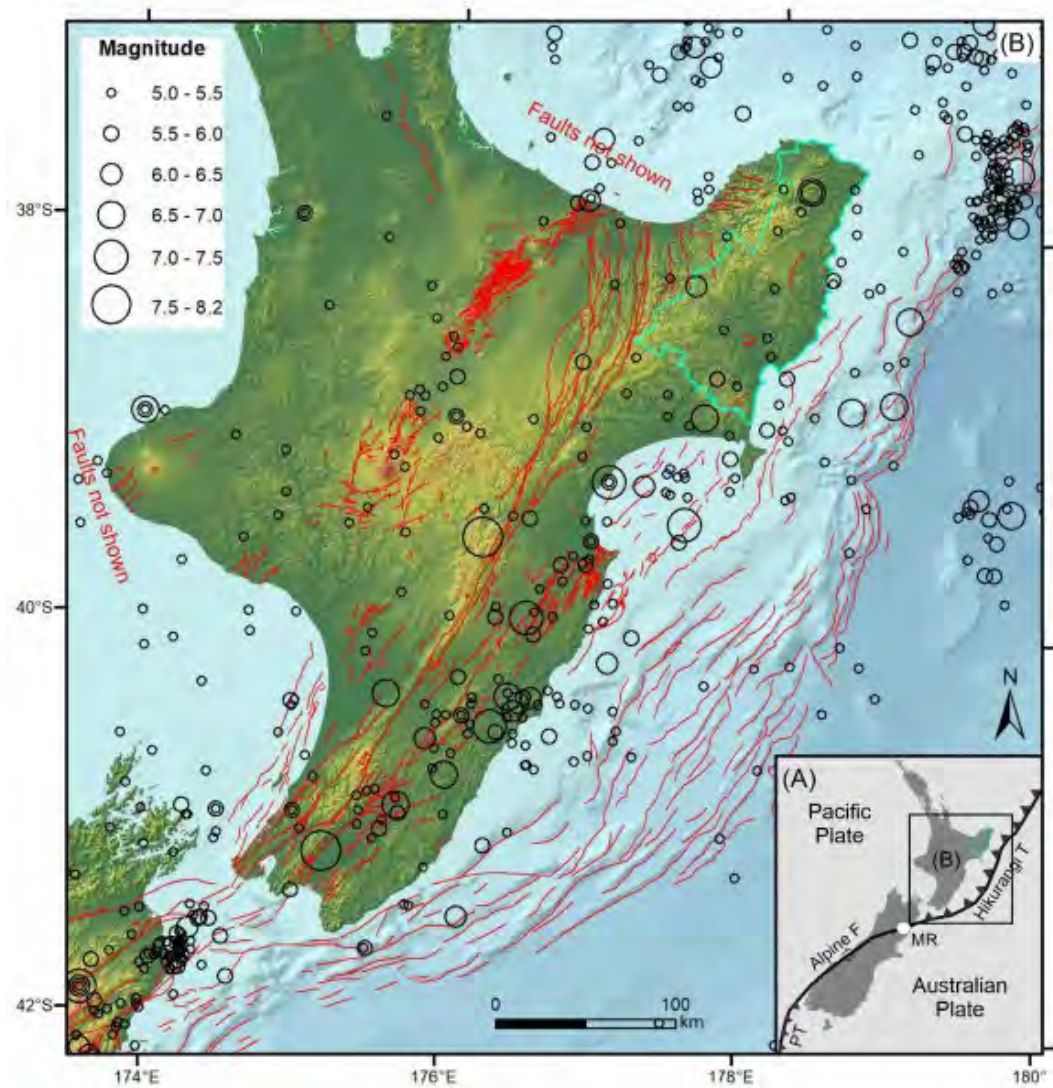


Figure 21: Tectonic setting of Tairāwhiti (outlined in green). Map shows active faults (red lines) and historical earthquakes (circles scaled to magnitude) (Litchfield et al, 2009).

Prior to the Litchfield et al (2022) study, only a few active faults had been mapped in Tairāwhiti and no systematic regional fault mapping had been undertaken since the publication of the 1:250,000 scale geological map in 2000 (Mazengarb and Speden 2000). The Repongaere fault which runs through the proposed reservoir, within ~350 m of the proposed dam, was one of the active faults previously mapped. The sparse, short, previously mapped active faults have often been considered minor, shallow, secondary faults rupturing in response to rapid uplift of the Raukumara Peninsula, driven by movement of the Hikurangi Subduction Zone. However, Tairāwhiti is subject to high rates of fluvial and landslide erosion which has made identification of active faults challenging and it has long been suspected that there are more active faults than previously mapped.

Repongaere fault has been well studied in recent years and is the only fault in the Tairāwhiti region to have been investigated through paleoseismic trenching (Berryman et al, 2009). A fault trace was identified in two of the three excavated trenches, consequently, for most of its trace through the scheme site, the fault has been classified as ‘well-defined’. Fault Avoidance Zones recommended were assigned by Litchfield et al (2022) along the length of the Repongaere fault. FAZs are buffer zones around an active fault and have been adopted by the GDC as risk-based tools to mitigate surface-rupture hazard for land-use planning purposes. The width of the FAZ is determined by how well constrained the fault trace is. The left abutment of the proposed dam site is within approximately 100 m of the Repongaere FAZ as shown in **Figure 23** below.

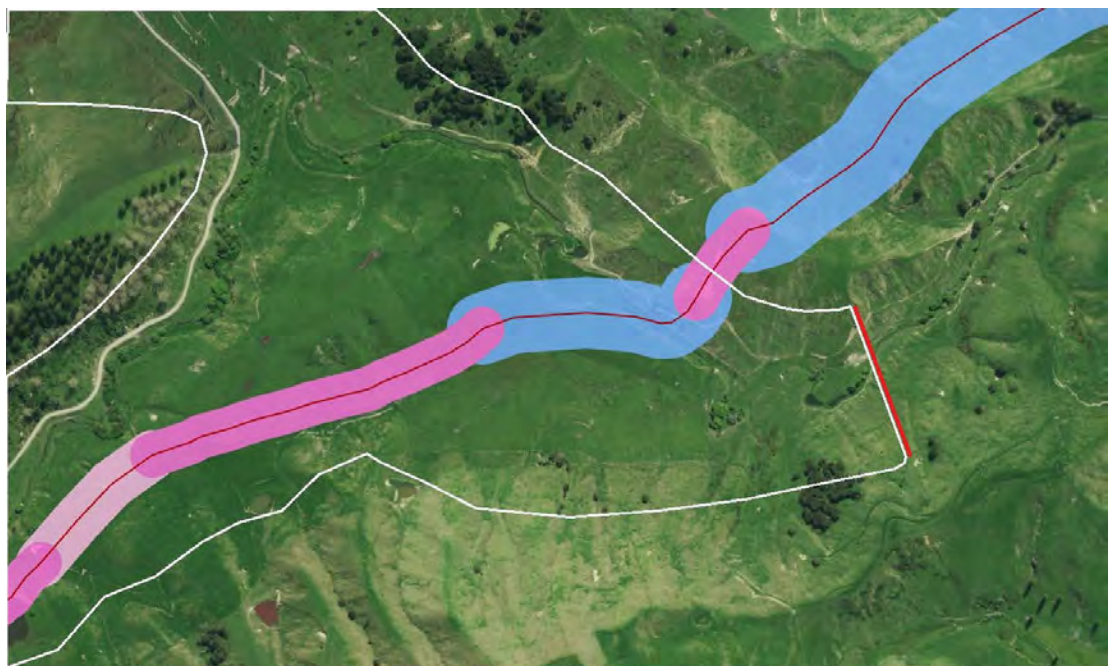


Figure 23: Repongaere Fault with well-defined and uncertain Fault Avoidance Zones (pink & blue, respectively). Approximate dam centreline (red) and reservoir outline (white). Taken from the GNS Active Fault Database (Oct 2, 2025)

Berryman et al (2009) characterised the Repongaere fault as follows:

- > **Last event:** c. 3,400 years before present
- > **Recurrence interval:** c <4,490-6,900 years (Recurrence Interval Class III (>3,500 to 5,000 years))
- > **Fault type:** Normal
- > **Net slip rate:** c. 0.1-0.21 mm/yr
- > **Net single event displacement:** c 0.4-1.1 m

- > **Estimated earthquake magnitude associated with surface rupture:** M_w 6.3 – 6.7
- > **Mapped surface fault trace:** ~4.5 km
- > **Estimated total fault length:** 9 to 20 km

The proximity of the proposed dam to the active Repongaere fault has significant implications for dam type selection and design. Design seismic loads are discussed in Section 5.2.3.

3.6.2 Landslides

The Tairāwhiti region is characterised by widespread landslide activity, primarily driven by its geological makeup. The area consists of weak, interbedded mudstone and sandstone of the Miocene-aged Tolaga Bay Formation, overlain by loose and highly variable Quaternary sediments. These materials, combined with the region's steep hill country and active tectonic setting, contribute to landslides of varying scales—from shallow slips and flows within the surficial Quaternary deposits to deeper, larger, more significant, failures within the underlying weak bedrock. Rainfall is the predominant trigger, particularly when slopes are already saturated from prior storms. Antecedent moisture significantly reduces the threshold for failure, with water infiltration elevating pore water pressures and reducing shear strength in soils. The region has a documented history of intense rainfall events causing extensive landsliding, notably during Cyclone Bola (1988) and Cyclone Gabrielle (2023).

These geological conditions are present at the Pouarua dam site and within the surrounding reservoir area, as outlined in Section 3.4.2. Consequently, landsliding is prevalent across the scheme area's slopes, including on the northern (true left) side of the proposed dam site, as shown on **Figure 24**. A review of publicly available aerial photography and satellite imagery, along with observations from the August 5 site visit, indicates that most landslides occur within the surficial Quaternary sediments. No evidence of deep-seated landsliding was observed within the scheme area. A comparison of imagery before and after the 2023 Cyclone Gabrielle indicates a significant increase in the amount of landslide activity since Cyclone Gabrielle. Additionally, seismic activity associated with the Repongaere fault is also expected to influence slope stability within the scheme area.



Figure 24: 2025 Google Earth image showing extent of slope instability/landsliding on norther valley slopes. A selection of both historic and recent landslide scarps shown in red.

While these relatively shallow failures (typically a few metres or less) are widespread, they are not expected to pose a risk to the long-term operational safety of the dam. The primary considerations of surficial landslides on dam development and operation are:

- > **Construction** – selection of final dam alignment to avoid areas of instability, removal of failed material within the dam footprint, and removal or stabilisation of failed/unstable material adjacent to the dam
- > **Operation** – ongoing surficial failures should be expected throughout the life of the dam, with an increased frequency during and after reservoir filling. Such failures may impact water turbidity, reservoir sedimentation and infrastructure such as access roads

Although no evidence of deep-seated landslides within the Tolaga Bay Formation bedrock has been observed within the scheme area, regionally there are documented large-scale landslides within this formation, including the Mangapoike landslide (McGovern et al., 2021) and the Russell Street landslide (Pola et al., 2025). Landslides within the Tolaga Bay Formation are generally controlled by and occur along structural defects in the rock mass that are oriented unfavourably with respect to the slopes (i.e., low-strength defects, particularly bedding planes, that daylight/dip out of the valley slopes). If found to be present in the study area, such landslides may have dam safety implications during operations.

Future project phases should investigate the presence and associated hazard of such landslides further. Central to this will be understanding the nature and orientations of defects within the Tolaga Bay Formation bedrock.

3.6.3 Volcanic Activity

Whilst there are no active volcanoes in Tairāwhiti, volcanic ash fall originating from the adjacent Taupo Volcanic Zone has fallen over the region in the past and will continue to do so in the future. Ash fall does not pose a risk to development of the proposed Pouarua dam.

3.6.4 Tsunami

There is no Tsunami risk at the proposed dam site. The site is approximately 15 km from the Pacific coast at Poverty Bay and approximately 30 m above sea level.

3.7 CULTURAL ENVIRONMENT

There are a number of iwi/hapu which may have a particular interest in a water storage project in this area. These are outlined in the subsections below, with a map of their rohe. Engagement with mana whenua is important and has commenced.

Based on public records, the Pouarua Dam Site is not known to have any identified Waahi Tapu or areas of identified cultural significance.

The Pouarua Dam Site is not located within an identified statutory acknowledgement area. However statutory acknowledgement areas are located downstream of the site, along the Waipaoa River.

3.7.1 Te Aitanga ā Māhaki

This rohe map in **Figure 25** represents the area over which Te Aitanga ā Māhaki exercises kaitiakitanga for the purposes of the Resource Management Act 1991. The Chair of the Te Aitanga a Mahaki Trust is Pehimana Brown.

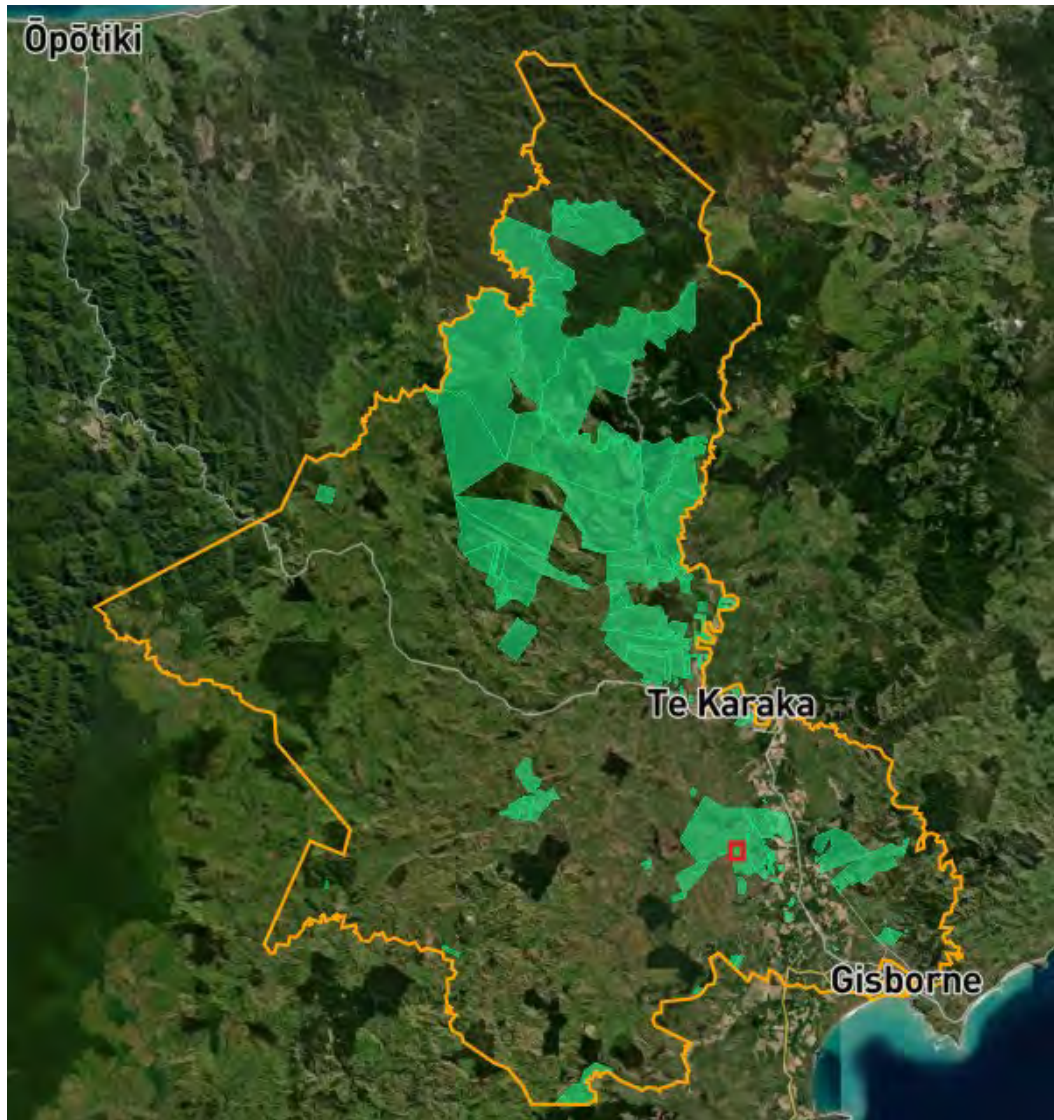


Figure 25: Te Rohe o Te Aitanga-a-Māhaki (orange line) with Maori Land (green) and Pouarua Dam site (red square) (Source: Te Whata Website)

3.7.2 Ngā Ariki Kaipūtahi

Ngā Ariki Kaipūtahi hold Mana Whenua rights primarily in the original number one Mangatu Block region but also in the neighboring Manukawhitikitiki, Whatatutu, Mangataikapua, and Rangatira blocks as they near the confluence of the Waipaoa and Mangatu Rivers.

Ngā Ariki Kaipūtahi tribal boundaries overlap with those of Te Aitanga-a-Mahaki, particularly with the hapu Ngai Tamatea and Te Whanau a Taupara. Alan Haronga (of WPT) is chair and Pehimana Brown is deputy chair of Mangatu Blocks.

3.7.3 Te Whānau a Kai

The rohe of Te Whānau a Kai overlaps with the rohe asserted by a number of other hapū and iwi, including Rongowhakaata and Te Aitanga a Māhaki⁵. The Chair of Te Whānau Trust a Kai is Dave Hawea.

3.7.4 Rongowhakaata

This rohe map in **Figure 26** represents the area over which Rongowhakaata exercises kaitiakitanga for the purposes of the Resource Management Act 1991. The interests of Rongowhakaata also overlap with Te Aitanga ā Māhaki at Patutahi. The Chair of Rongowhakaata Settlement Trust is Connie Maynard.

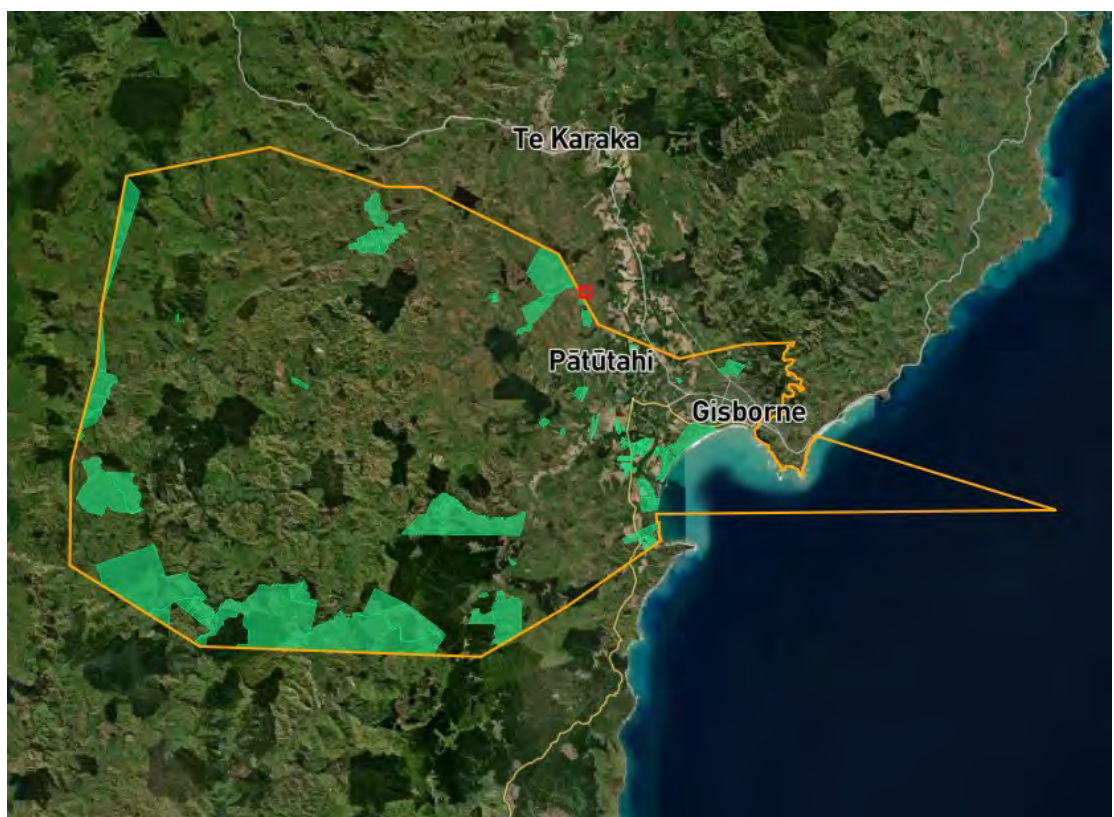


Figure 26: Te Rohe o Rongowhakaata (orange) with Maori land (green) and Pouarua Dam site (red square) (Source: Te Wakata Website)

⁵ Environment Court Decision No. [2021] NZEnvC 115

3.7.5 Ngāi Tāmanuhiri

This rohe map in **Figure 27** represents the area over which Ngāi Tāmanuhiri exercises kaitiakitanga for the purposes of the Resource Management Act 1991. The Chair of the Tāmanuhiri Tūtū Poroporo Trust is Pauline Hill, with Doug Jones as Chief Executive.

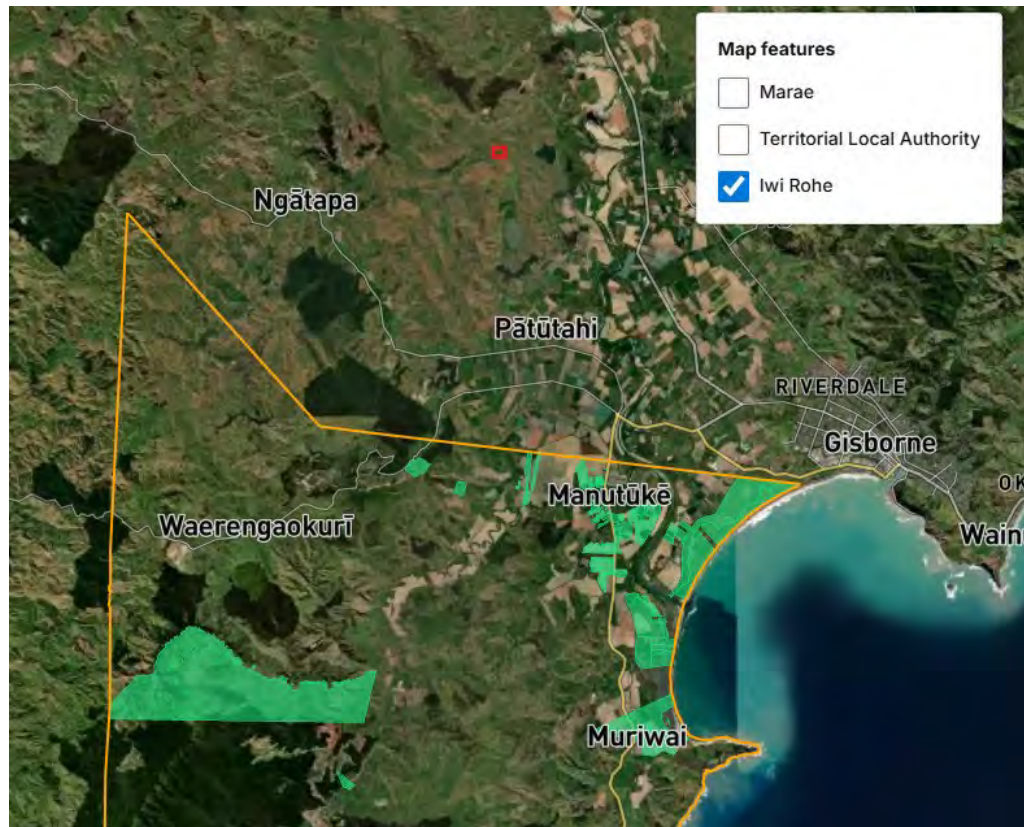


Figure 27: Te Rohe o Ngāi Tāmanuhiri (orange line) with Maori Land (green) and Pouarua Dam site to the north (red square) (Source: Te Whata Website)

3.7.6 Statutory Acknowledgements

A Statutory Acknowledgement is a formal recognition by the Crown of the mana of tangata whenua over a specified area. It recognises the particular cultural, spiritual, historical and traditional association of an iwi with the site. Statements of statutory acknowledgements are set out in Treaty of Waitangi settlement legislation.

The Pouarua Dam site is not within an identified statutory acknowledgement area. However, there are notable statutory acknowledgements located downstream in the lower Waipaoa River, including the following:

Rongowhakaata Statutory Acknowledgement:

- > Waipaoa River (including Karaua Stream) within Rongowhakaata area of interest OTS-005-036.

Ngai Tamanuhiri Statutory Acknowledgement:

- > Part Waipaoa River (including Karaua Stream) OTS-005-006.
- > Ngai Tāmanuhiri Coastal Marine Area OTS-005-005.

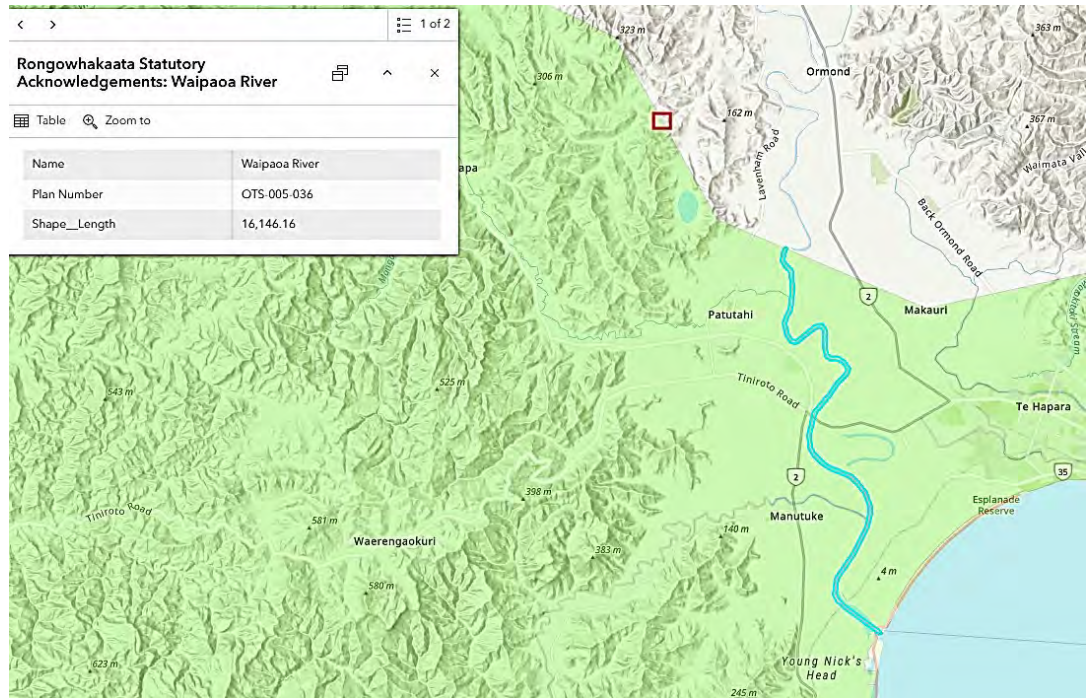


Figure 28: General location of Pouarua Dam site (red box) and Rongowhakaata Area of Interest (green) and Statutory Acknowledgement Area on the lower Waipaoa River (blue)

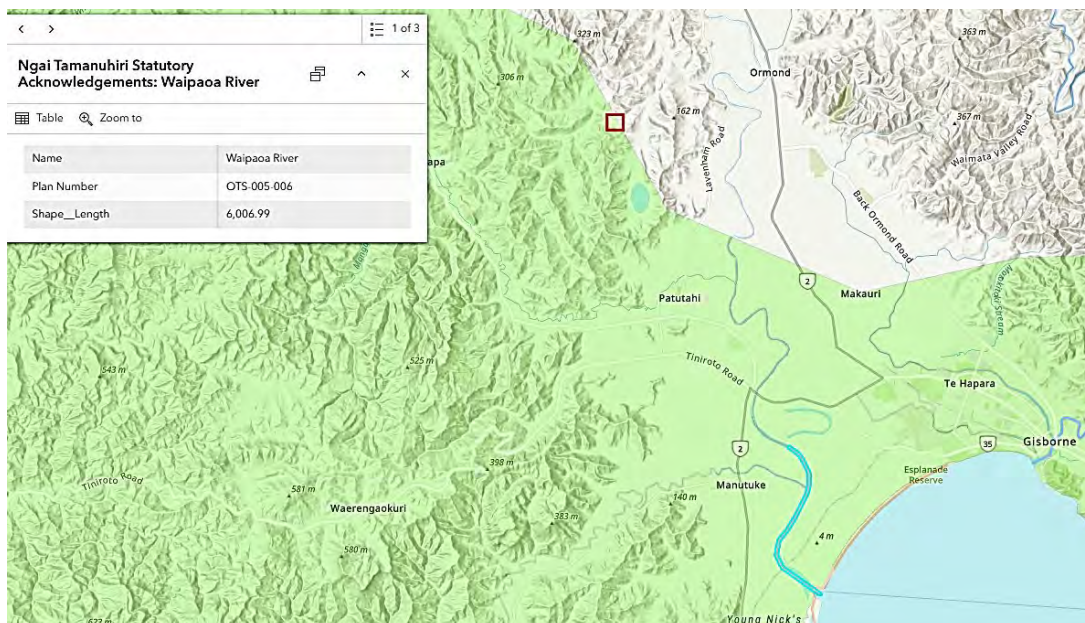


Figure 29: General location of Pouarua Dam site (red box) and Ngai Tamanuhiri Statutory Acknowledgement on the lower Waipaoa River (blue)

3.7.7 Treaty Settlements and Redress

3.7.7.1 Rongowhakaata Claims Settlement Act 2012

The Rongowhakaata Claims Settlement Act 2012 is a New Zealand Act that provides for the final settlement of the historical Treaty of Waitangi claims of the iwi (Māori tribe) Rongowhakaata.

Key aspects of the Act include a formal Crown apology and acknowledgement of past wrongs, the provision of cultural and financial redress, the vesting of 9 cultural redress properties, and the establishment of a Right of First Refusal (“**RFR**”) for Rongowhakaata in relation to certain Crown land. It also sets out protocols related to Conservation, Crown Minerals, and Fisheries, as well as a protocol for Taonga Tuturu (cultural taonga).

Through consultation the scheme is expected to remain consistent with the Rongowhakaata Claims Settlement Act 2012 and associated statutory acknowledgement area (refer to Section 3.7.6) in relation to the Waipaoa River.

3.7.7.2 Ngāi Tāmanuhiri Claims Settlement Act 2012

Key aspects of the Act include a formal Crown apology (including an agreed historical account and crown acknowledgements), cultural redress and financial and commercial redress.

Through consultation, the scheme is expected to remain consistent with the Rongowhakaata Claims Settlement Act 2012 and associated statutory acknowledgement area (refer to Section 3.7.6) in relation to the Waipaoa River.

3.7.7.3 Other Treaty Settlement Negotiations

Te Aitanga ā Māhaki does not currently have a completed treaty settlement, though a significant Waitangi Tribunal report on the Mangatū forest in 2013 recommended the return of land and compensation for the prejudice suffered by the iwi and its associated shareholders. The iwi was awarded negotiation mandate in 2014 and has been actively engaged in the settlement process, including negotiations and potentially other remedies through the Waitangi Tribunal.

There is no specific, recently completed or actively negotiated treaty settlement explicitly named for Ngā Ariki Kaipūtahi; however, they are claimants within the broader Turanganui-a-Kiwa inquiry, which aims to settle claims for various iwi and hapū in the region, including the Mangatū Incorporation and Te Aitanga ā Māhaki. Ngā Ariki Kaipūtahi have filed historical claims with the Waitangi Tribunal, focusing on issues such as the Crown's purchase of Mangatū forest land.

4. CONCEPT STAGE: PLANNING CONTEXT

4.1 ZONING AND OVERLAYS

The activities associated with the Scheme are entirely located in within the GDC jurisdiction. GDC is a unitary authority which combines the roles of both territorial (city or district) and regional councils into one entity.

The TRMP covers all of Gisborne's resource management plans, including the regional policy statement, regional coastal plan, regional plan and district plan.

Under the TRMP, the site is zoned Rural General as shown in **Figure 30**.

To the east of the site is the Lower Waipaoa River which is a scheduled river under the TRMP (Schedule G15B) as illustrated in **Figure 31**. Schedule G15B contains the additional key habitats for Long Finned Eel – a nationally threatened native species which the Gisborne region is recognised as providing a national stronghold for populations.

Approximately 1.8km to the south of the Pouarua Dam Site is Lake Repongaere (which includes the Littoral Wetland) identified as Schedule G18 under the TRMP as Outstanding Waterbodies. This is the largest natural lake in the region with a range of ecological and cultural values. Part of this area is also covered by the Protection Management Areas ("PMAs") overlay.

Lake Repongaere is also identified as Schedule G15C under the TRMP which recognises this site as having Habitats of Threatened Indigenous Flora and Fauna for Bittern and the New Zealand Dabchick.

To the east of Lake Repongaere is a site Dod Pond identified as Schedule G15C under the TRMP which recognises this site as having Habitats of Threatened Indigenous Flora and Fauna of Bittern, the New Zealand Dabchick and the New Zealand Shoveler.

The eastern side of the site is subject to flood hazard overlays. Part of the WPT land is shown as a High Hazard Area (F2) and part of the site is shown as Area Liable to Flooding (F4), as illustrated in **Figure 32**. However, these hazards are not considered to impact on the location of the dam wall or reservoir.

Parts of the site have low to moderate liquefaction and active faults present, as further discussed in Section 3.6.1 of this report. These are illustrated in **Figure 33** below.

Parts of the wider site have aquifers present as shown in **Figure 34**. The shallow Waipaoa Gravel Aquifer and the deep Makauri Gravel Aquifer are present, with Potential Groundwater areas shown in grey on **Figure 34**.

There are no known Waahi Tapu site overlays identified on the GDC planning maps. There are no known archaeological sites within the site of the Pouarua Dam wall, however there are sites to the south and east as shown in **Figure 35** which could be impacted by the proposal.

The Pouarua Dam site would fall within Land Overlay 2. Land Overlays 2 (shown in blue), 3 (shown in dark orange) and 3A (shown in light orange) in **Figure 36** are susceptible to soil erosion.

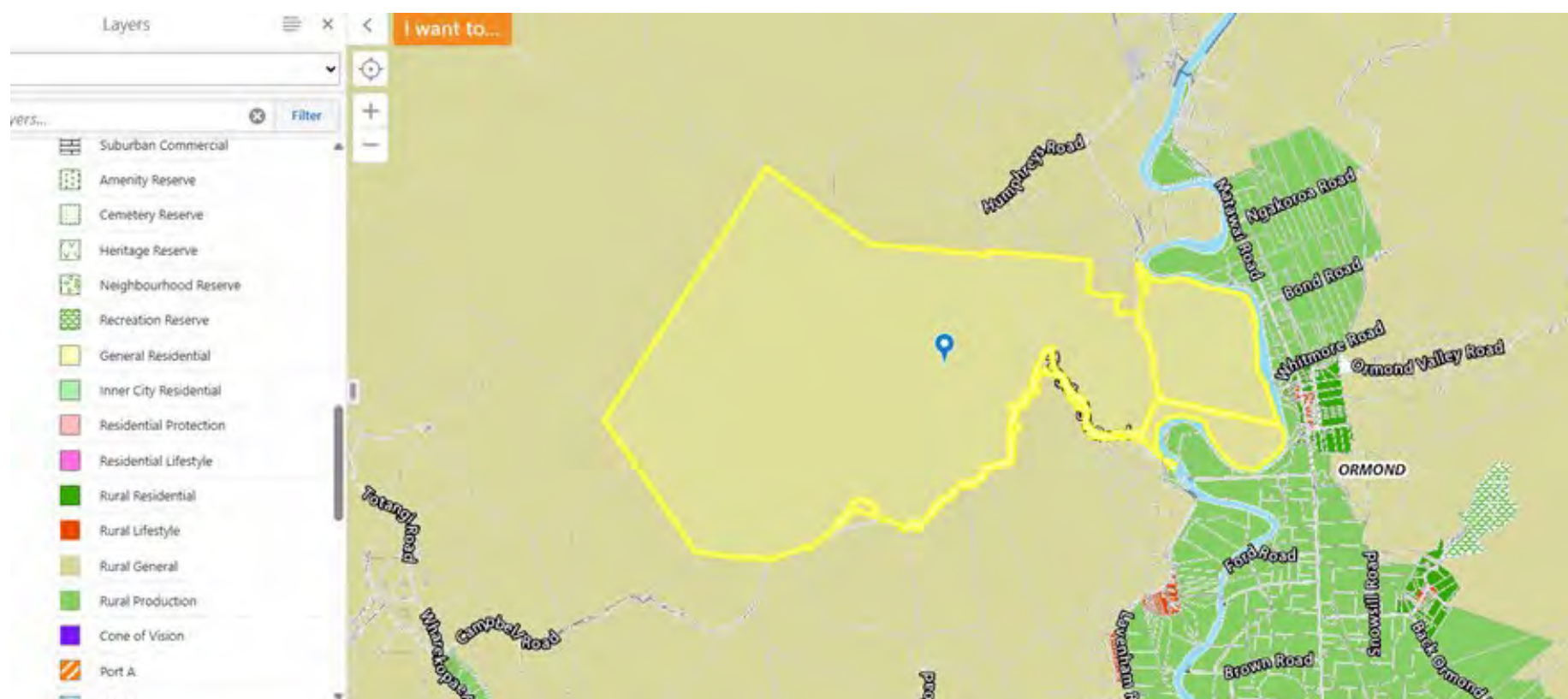


Figure 30: Zoning of the site



Figure 31: Scheduled Waterbodies (location of Pouarua Dam site shown in red box)

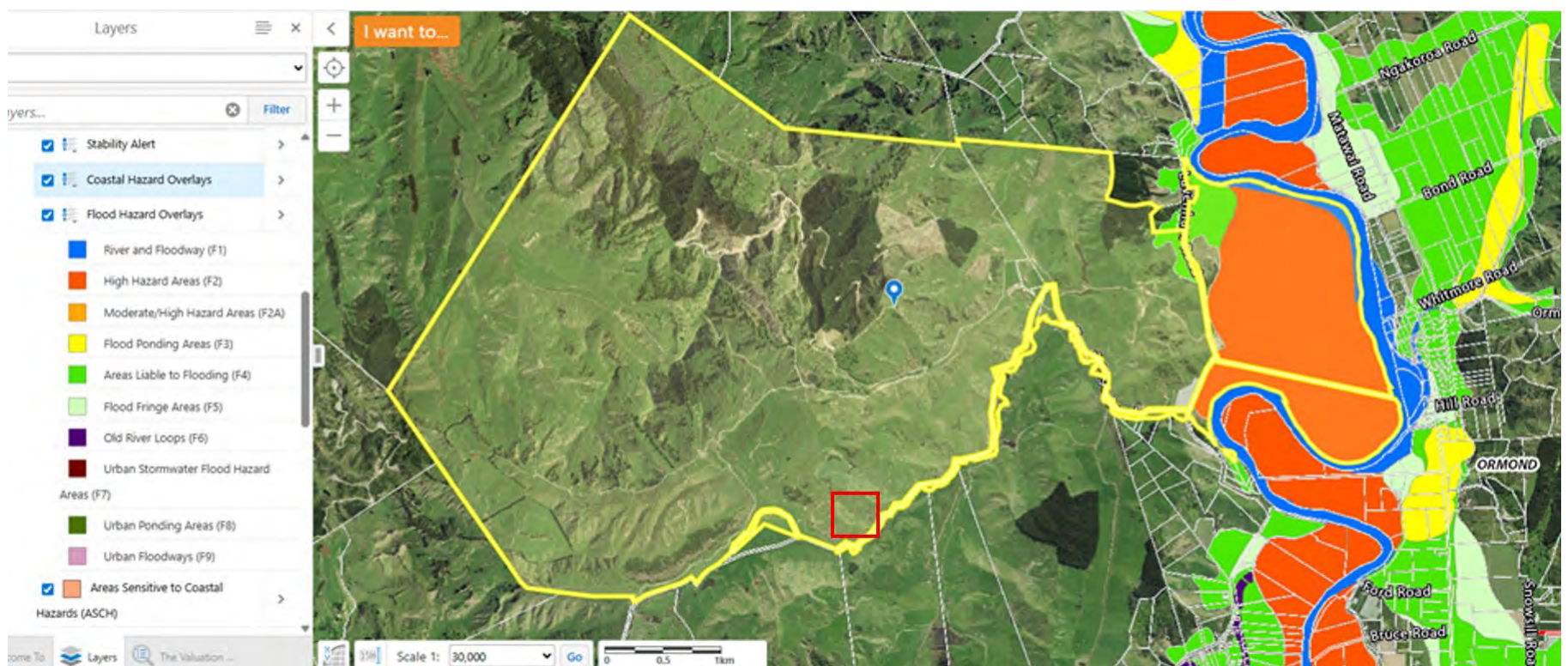


Figure 32: Flood Hazard Overlays

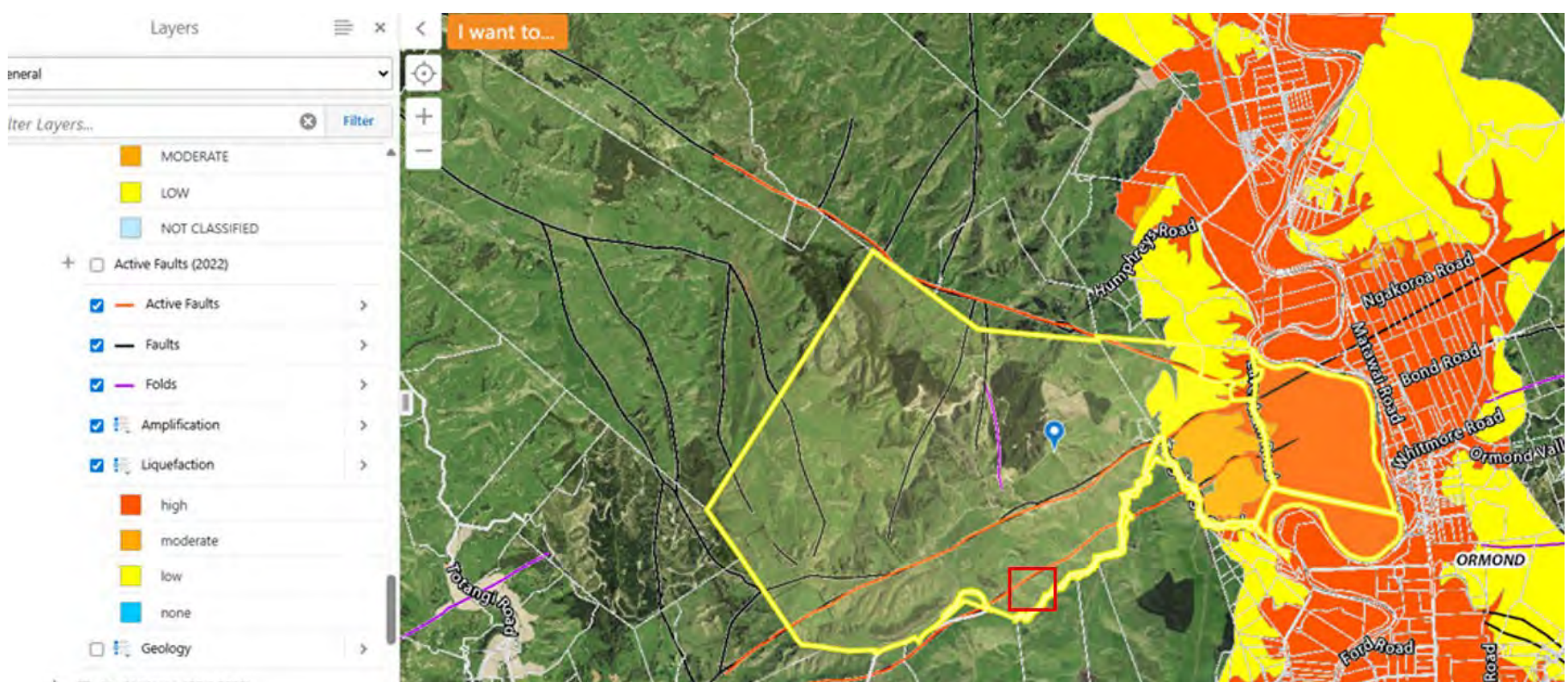


Figure 33: Liquefaction and Active Faults

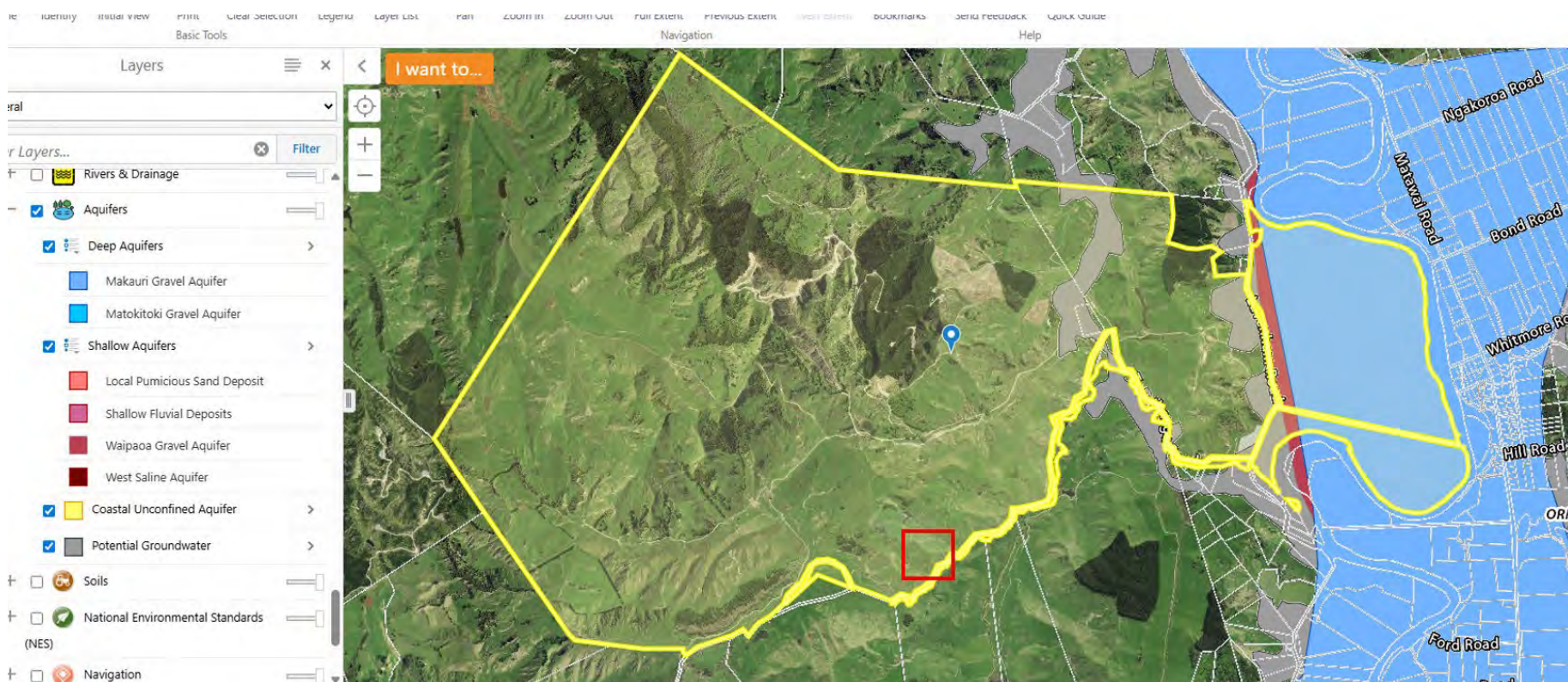


Figure 34: Aquifers

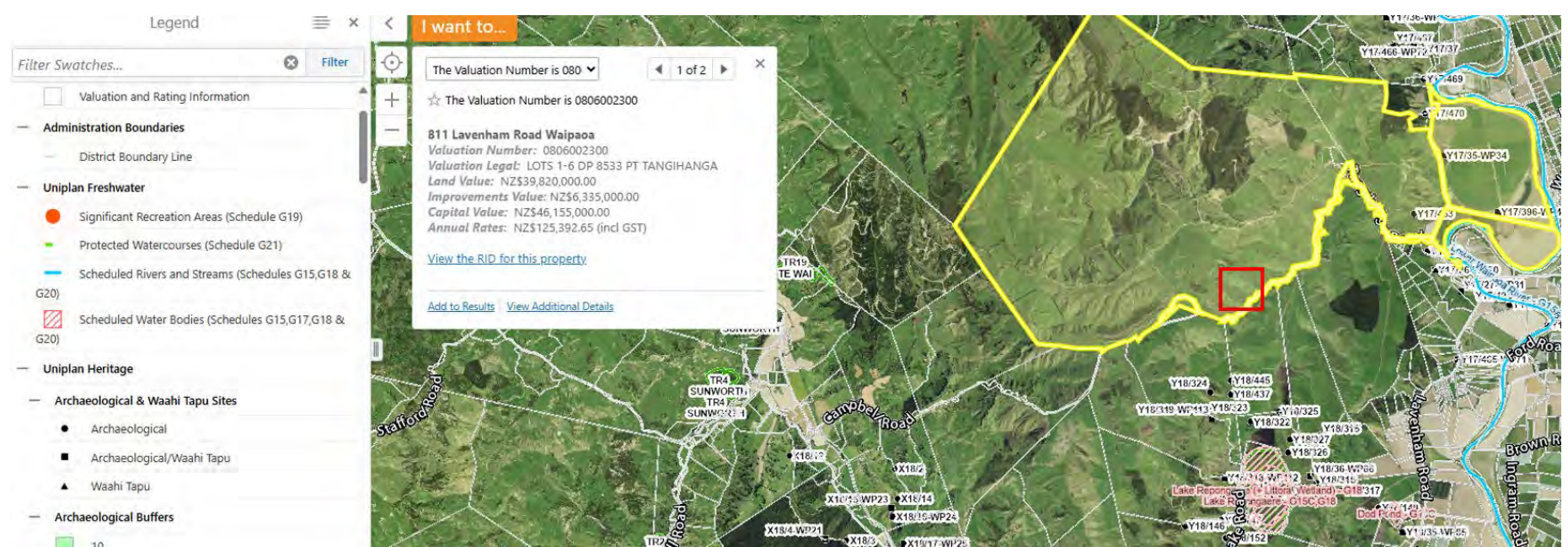


Figure 35: Archaeological Sites in the surrounding area (black dots) and Lake Repongaere and Littoral Wetland (red hash) with the Pouarua Dam site shown (red square)

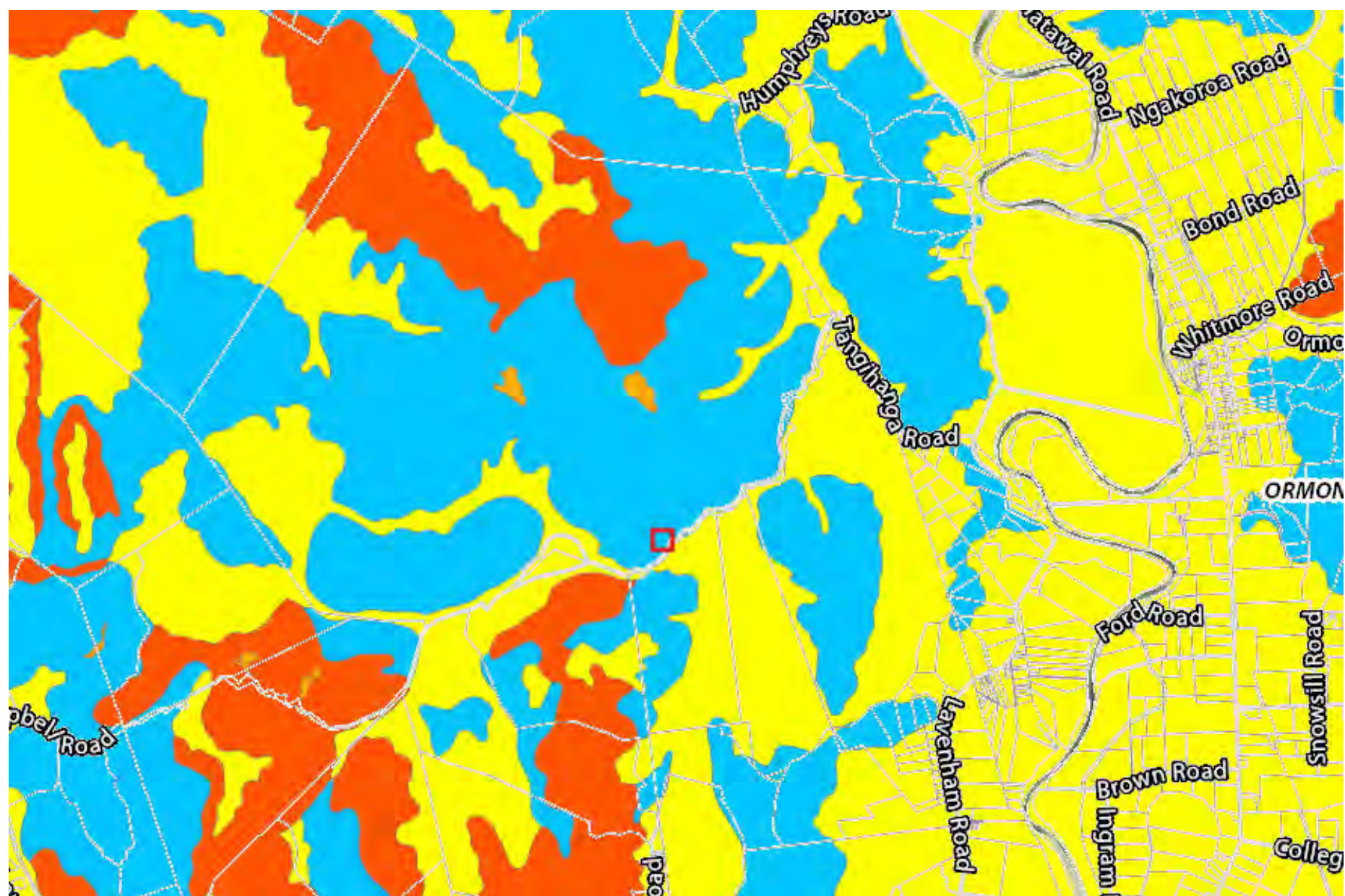


Figure 36: Land Overlay Categories with Pouarua Dam site shown (red square)

4.2 OVERVIEW OF ENGAGEMENT UNDERTAKEN

A number of parties were invited to meet with WPT, Mitchell Daysh, Aqualinc and Damwatch representatives to discuss water storage in Gisborne. The purpose of this early engagement was to explore the need for water storage, water utilisation options and potential partnerships. It was imperative to understand whether integration with existing irrigation schemes was possible and whether additional water storage could readily contribute to GDCs potable water supply and resilience. The outcome of early discussions was that those involved were generally supportive and understanding of the pressing need for additional water supply in Gisborne. Findings within this report will be presented back to those involved and ongoing discussions will occur should any consent process be pursued.

Table 8: People engaged in early discussions on water storage and supply

Groups/Iwi/Hapu	People who were engaged in early discussions
MP for the East Coast	Dana Kirkpatrick
GDC	Mayor Rehette Stoltz Jocelyne Allen (Director of Sustainable Futures) Sarah Thompson (Principal Policy Planner) Bridget Bosworth (Hydrologist) Tim Barry (Director Community Lifelines)
Managed Aquifer Recharge (MAR) Group	Tim Tietjen
Te Aitanga a Māhaki	Pene Brown (Chair)
Trust Tairāwhiti	Doug Jones (CE) Joe Williams (Business Growth and Innovation Manager)
Te Whanau a Kai	Dave Hawea (Chair)
Rongowhakaata Iwi Trust	Samuel Lewis (Elected Trustee)
Ngāi Tāmanuhiri	Beth Tupara-Katene
Federated Farmers	Charlie Reynolds
Horticulture NZ	Leanne Roberts
Adjoining Landowners	Bridget Telfer Warick Bruce Guy and Nick Humpherys Stuart Hickling

4.3 STATUTORY CONSIDERATIONS

This section provides a high-level review of the key regulatory documents which may affect the consenting of the Pouarua Dam. At the end of each section, observations are made around the extent to which the scheme could be consistent with the outcomes sought by the relevant statutory documents. It is noted that the consistency cannot be confirmed until such time as technical reports which inform any environmental effects are provided.

The following documents are considered potentially relevant as they may influence the implementation of the scheme for various reasons:

- > Building Act 2004;
- > Dam Safety Regulations 2022;
- > Resource Management Act 1991 (including national directions and regulations, policy statements, unitary plan and iwi management plans); and
- > Fast Track Approvals Act 2024.

Other relevant strategic documents have also been assessed in relation to the scheme.

4.3.1 Building Act 2004

Large dams (over 20,000m³ in volume or 4 meters in height) may also require a building consent in addition to any resource consent requirements.

Dams are classed as buildings for the purposes of the Building Act 2004 (“BA”). The BA has a stated purpose to ensure that people who use buildings can do so safely and without endangering their health. The BA also contains requirements for dam owners relating to post-construction dam safety.

The BA introduced legislation for managing the safety of existing and new dams in New Zealand. Under this Act, regional councils must have a policy on how they will deal with dangerous dams, earthquake-prone dams and flood-prone dams in their region, and how the policy will apply to heritage dams.

Section 135(2) of the BA requires the dam owner to submit a PIC to the regional authority up to three months after the dam is commissioned.

4.3.2 Dam Safety Regulations 2022

The Dam Safety Regulations 2022 (“**DSR**”) pull together post-construction regulatory requirements into a single, consistent nationwide framework. The owners of dams are responsible for ensuring that their dams are being managed appropriately, proportionate to the potential impacts they pose.

If a dam is four or more metres in height and stores 20,000 or more cubic metres volume of water, or other fluid, it is a classifiable dam and is impacted by the regulations. Small dams are excluded from the regulations. This includes small 'turkey nest' dams, irrigation races, stock drinking ponds and weirs. If a dam is not classifiable, this means it is not impacted by the DSR, and no further action is required by dam owners.

Dams that are classifiable but are assessed as having a low PIC require no further action other than to review the PIC every five years. Dams with a medium or high PIC are required to have a dam safety assurance programme (“**DSAP**”).

A process diagram has been prepared by the Ministry of Business and Innovation which sets out how to navigate the regulations and when a recognised engineer must be involved (i.e. the boxes outlined purple).

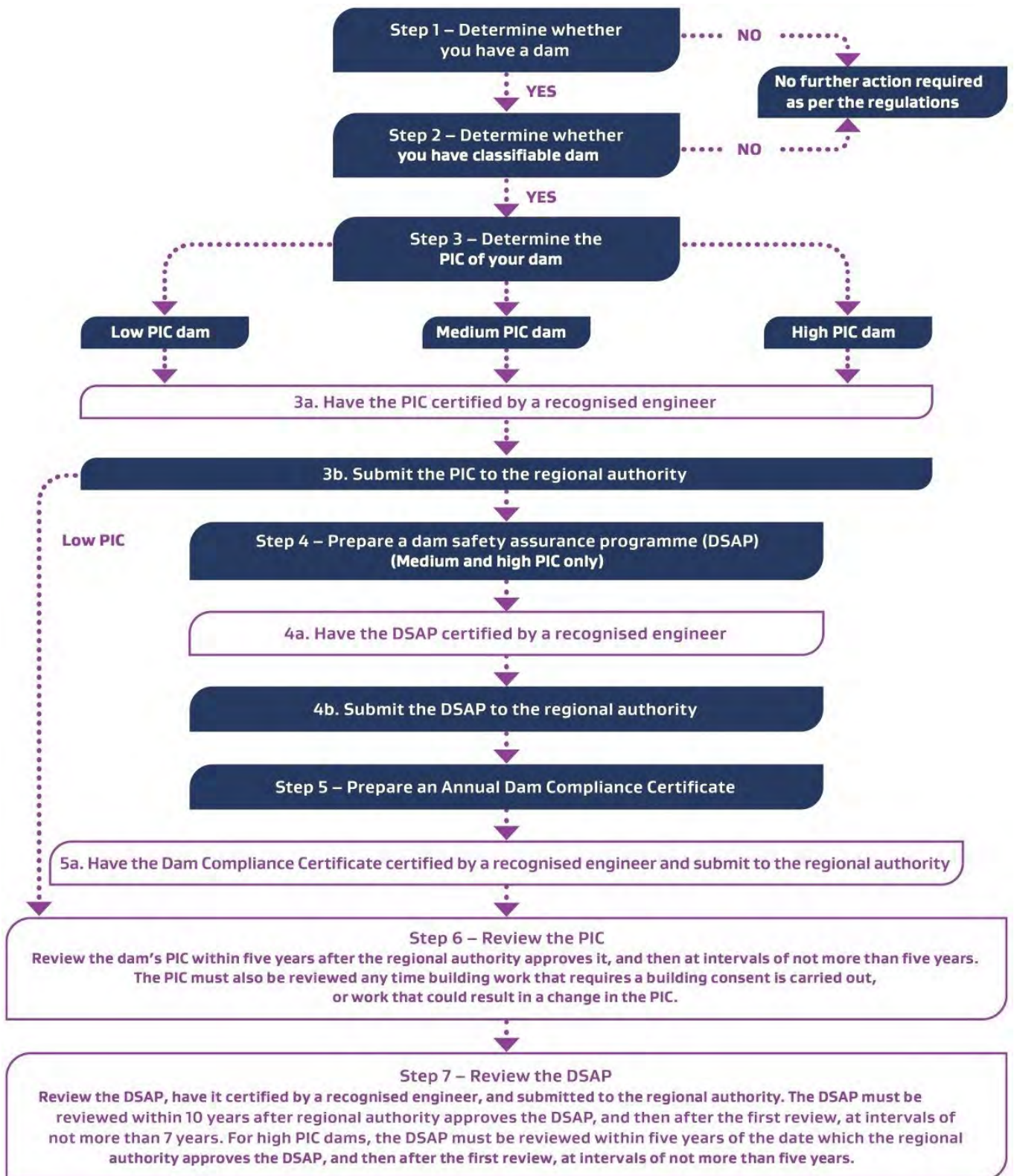


Figure 37: Process Diagram of How to Navigate the Regulations (Source: Guide to complying with the Dam Safety Regulations July 2025 (MBIE))

4.3.3 Resource Management Act 1991

The Resource Management Act 1991⁶ (“**RMA**”) is the legislative document for managing the use, development and protection of natural and physical resources in a way that achieves the sustainable management principle.

Appendix 3 provides a statutory assessment of the Pouarua Dam Site concept against the RMA (Sections 5 to 8), relevant national policy statements, national environmental standards and regulations and the Tairāwhiti Resource Management Plan (“**TRMP**”).

While the concept appears to generally align with these documents, technical reports are required to confirm this at time of consent preparation.

Key policy issues that require further technical consideration in relation to this project at the time of consent preparation, would include:

- > The presence of and potential effects on any identified natural inland wetlands in or around the site to ensure consistency with the NPS-FM and confirm whether approvals are required under the NES-F;
- > Earthworks for future dam construction, erosion control and land rehabilitation will be a key consideration to ensure consistency with Policy C7.1 of the RPS; and
- > Water quality within the Waipaoa should be considered further in relation to achieving consistency with Water Quality Objective DF1.4.2.2 of the TRMP.

4.3.4 Relevant Rules of the TRMP

The rules of the TRMP which may be relevant to the consenting of this project include those set out in Table 9.

The potentially applicable rules and activity status will be re-evaluated at the consenting stage, once a project description is confirmed and technical reports completed. However, on the basis of Table 9 and with the bundling principle⁷ applied, the dam construction, operation and maintenance have the potential to require resource consent as a Non-Complying Activity⁸ under the TRMP.

⁶ It is noted that the RMA is in the process of reform.

⁷ The "bundling principle" in the Resource Management Act (RMA) refers to the practice of assessing multiple resource consent activities together as a single proposal.

⁸ For a non-complying activity to be granted consent under Section 104D of the RMA, the applicant must prove that the activity will have only minor adverse environmental effects, or that it will not be contrary to the objectives and policies of the plan.

Table 9: RMA Activity Status of Potential Activities Associated with Dam Construction, Operation and Maintenance

Activity	Potentially Relevant Rule/s	Likely Activity Status
Damming of water	6.3.13(4)	Discretionary
Water intake structures	6.3.2(18)	Discretionary
Water outfall structures	6.3.2(18)	Discretionary
Discharges of potable water into fresh water or to land from a water storage reservoir or water supply pipeline, where this is from a Council municipal water supply	6.2.3(6)	Permitted <i>NB: Any discharge from a water storage reservoir or water supply pipeline where this is not from a Council municipal water supply defaults to 6.2.3 (14).</i>
The point source discharge of liquids to land or waterbodies and their margins where the discharge is to a waterbody or to land in a way that directly enters water above a community drinking water supply intake point.	6.2.3(14)	Non-Complying
Underground pipe networks for the conveyance of water, and any ancillary equipment (including pump stations).	6.3.2(8)	Permitted <i>NB: The use, erection, reconstruction, placement, alteration and extension of structures, including bridges, cables, lines, pipelines and suspended fences, which are suspended over the bed of a lake or river which do not have any contact with the bed of the river where structures are suspended at least 500mm above the 2% AEP flood level (50 year flood) at the lowest point of the structure.</i>

Activity	Potentially Relevant Rule/s	Likely Activity Status
Take and use of surface water during high flows (water harvesting) for community water supplies.	6.1.2(8)	Restricted Discretionary
The take and use of surface water or groundwater not lawfully established before the date of notification of this Plan.	6.1.2(6)	Restricted Discretionary
The erection or placement of a dam or other barrier structure in, on, under or over the bed of a river.	6.3.2(18)	Discretionary
Excavation of the bed of a lake, river or stream.	6.3.2(19)	Discretionary
Deposition of any substance in on or under the bed of a lake, river or stream.	6.3.2(20)	Discretionary
Activities that do not comply with the permitted activity standards or any other solid or fertiliser discharges not provided for in another rule in this plan.	6.2.12(7)	Discretionary
Land Overlay 1 & 2 - Land disturbance and vegetation clearance activities which do not comply with the General Standards and are not provided for as Controlled or Restricted Discretionary activities	7.1.6(9) and 7.1.6(20)	Discretionary
Activities which are not provided for as Restricted Discretionary or Prohibited activities	4.6.1A (22)	Discretionary
Water Quantity Limits – Permitted take is 4000l/s Minimum Flow B Block and 2000l/s Allocation Cap B Block	DF1.2.2.2	Discretionary (if limits are to be exceeded)

4.3.4.1 High Flow Water Take Consent

The development of the scheme would be reliant on a high flow water take from the Waipaoa River B Block to supplement water storage.

The Poverty Bay Flats⁹ is generally considered by GDC to be fully allocated to overallocated. Therefore, no new permits for the Waipaoa River and its tributaries during the low-flow peak summer season (Oct-April) will be granted and there is a waitlist for consent applicants. The exception to this is the Waipaoa B Block, which is currently around two thirds allocated (with 1,254.92L/s available as quoted by GDC on 5 September 2025) with no waiting list.

This high flow take required for this project would be from Waipaoa B Block. Under the operative TRMP, the Waipaoa B Block has an allocation cap of 2000 l/s and a minimum flow of 4000 l/s.

As addressed under Section 5.9, there is enough water available from the B Block allocation to fully augment the natural catchment inflows for most of the reservoir sizes considered, to achieve annual reservoir refill at an acceptable level of dry season resilience.

WPT should apply for a water take to GDC to facilitate the opportunity that the Tangihanga project affords. While Waipaoa B Block still has available allocation there is a risk of that allocation being assigned to other consent holders in the interim.

4.3.5 Iwi Management Plans

Iwi management plans provide a mechanism for tangata whenua interests to be considered in resource consent decision making processes. In the Gisborne region, there are two iwi planning documents recognised by an iwi authority and lodged with the GDC. These are the:

- > Te Aitanga a Mahaki Iwi Environmental Inventory; and
- > Nga Ariki Kaiputahi Hapu/Iwi Management Plan.

The key provisions of these plans are set out in the subsections below.

4.3.5.1 Te Aitanga a Mahaki Iwi Environmental Inventory

The overall objective is to ratify an Environmental Inventory that provides a framework that will allow Te Aitanga a Mahaki iwi along with local and central governments to evaluate and enhance local rivers and waterways whilst educating and empowering its people. It provides

⁹ The Poverty Bay Flats is an area of 18,000 hectares and is the single largest area of highly fertile soil in the country. It's among the most productive horticultural areas thanks to a combination of high sunshine, fertile soils and mild temperatures (Source: GDC website).

a framework to build upon with future initiatives that will establish and implement strategies for environmental restoration thus fulfilling the aspirations of the iwi as kaitiaki of the area. This is another step towards realising the vision of "restoring the mauri (life essence) of the Waipaoa River".

Table 10: Consistency with the Te Aitanga a Mahaki Iwi Environmental Inventory

Key considerations from the Environmental Inventory	How to achieve consistency
Te Aitanga a Mahaki has always had an affinity and an obligation to the land, rivers and sea.	Consultation has commenced with iwi and is ongoing in regard to their role as Kaitiaki.
There is a series of maps to identify a number of Te Aitanga a Mahaki's environmental resources by providing spatial and pictorial examples of environmental detail that are significant to Te Aitanga a Mahaki.	There does not appear to be any features identified within these maps that are within the Pouarua Dam site.
Significant Regional Water Issues for Iwi include: 1. Kaitiakitanga - limited input into plans and implementation 2. Cultural landscapes - restoring mauri, protecting wahi tapu	Consultation has commenced with iwi and is ongoing in regard to their role as Kaitiaki. The mauri of waterbodies is relevant to this project. There are no identified waahi tapu identified within the Pouarua Dam site.
The East Coast region represents 7 percent of the land area of the North Island, but it contributes 50 percent of the worst soil erosion. The Waipaoa River enters the sea at the southern end of Turanganui a Kiwa. It is a high sediment-yielding river, annually depositing 15 million tonnes of sediment into Poverty Bay.	Soil erosion is noted as a key issue and any earthworks required to facilitate this project will have to consider this.
It experiences low summer flows which can result in elevated temperatures above 30 degrees.	The scheme would only take supplementary water for the dam in high flow conditions and will assist with water supply in low flows and drought conditions.
The region has very few wetlands and only a few minor lakes. Historically around 90% were drained when the land was converted to	An ecological assessment will be required to identify any potential for effects on wetlands, having regard to the National Environmental

Key considerations from the Environmental Inventory	How to achieve consistency
pasture. Those that remain comprise small farm ponds and dams, however collectively these are significant. Repongaere Lakes is a significant wetland and habitat for waterbirds.	Standard for Freshwater and the National Policy Statement on Freshwater Management.
Further work into freshwater ecology is required for waters draining into Poverty Bay. A range of species of significance to iwi (Koura (freshwater crayfish), Inanga (Whitebait), Morehana (cockabully), Moruru, and Korokoro (Lamprey) in the rivers. Tuna (eels)) were by far the most important river species to Te Aitanga a Mahaki. Lake Repongaere was famous for providing plentiful amounts of eels and always having kai for the people. Lake Repongaere provided an important eel fishery that still exists today.	An ecological assessment will be required to identify any potential for effects on ecology.
Pa and Marae sites surrounding Lake Repongaere.	It is noted that Lake Repongaere is a site of cultural significance and is 1.8km to the south of the Pouarua Dam site. Unlikely to be affected but requires verification.

4.3.5.2 Nga Ariki Kaiputahi Hapu/Iwi Management Plan.

This Iwi Management Plan is a legal document that recognises records and authenticates the legal right of Nga Ariki Kaiputahi as tangata/mana whenua to exercise their vision for the descendants of Nga Ariki Kaiputahi. It is relevant to the Pouarua Dam Site within the Tangihanga Station.

As Kaitiaki,¹⁰ the health and wellbeing of the natural environment is paramount to Nga Ariki Kaiputahi. The Piwakawaka bird and Kowhai tree are important kaitiaki of Nga Ariki Kaiputahi.

¹⁰ The term 'kaitiakitanga' is defined in the RMA as meaning the exercise or guardianship by the tangata whenua of an area in accordance with Tikanga Maori in relation to natural and physical resources.

Nga Ariki Kaiputahi yearns to restore the Mangatu ngahere back to its pre-colonised condition to be preserved for mokopuna and the future of native wildlife that are endemic to the natural habitats of this ecosystem.

Table 11: Consistency with the Nga Ariki Kaiputahi Hapu/Iwi Management Plan

Key considerations from the Management Plan	How to achieve consistency
It is best practice for resource consent applicants to consult with Nga Ariki Kaiputahi where proposals might affect matters as set out in sections 2(b), 6(e), 6(f), 7(a), 7(e) and 8 of the RMA.	Ongoing engagement will be required in the preparation of any future consent process.
Cumulative effects and disturbances, removal or indirect removal of habitat and the impact on wildlife are to be monitored on a regular basis. Sustainable best management practices are to be upheld and documented in disturbed areas.	An ecological report will be required for the consenting process that considers all effects on wildlife, including cumulative effects.
The prevention of exploitation in native flora and fauna use requires a reduction in access so that ground cover is disturbed as little as possible.	An ecological report will be required for the consenting process that considers all effects on native flora and fauna, avoiding where practicable to do so.
Monitoring mechanisms must be in place to avoid and limit the introduction of non-native species into the area.	An ecological report will be required for the consenting process that considers the potential for introduction of non-native species to the area.
Nga Ariki Kaiputahi encourages natural re-vegetation by indigenous flora and fauna and avoids the removal of vegetation, topsoil and seed source unless it is for Te Ao Maori and Te Ao Wairua purposes.	Any need for indigenous vegetation removal will be considered in the ecological assessment.
Erosion of the hillsides is some of the worst in the country. To counteract this effect, it is the expectation of the Hapu/Iwi that native trees such as Totara and Manuka be planted on these slopes by any users of the land old and new.	To be considered in any rehabilitation plan that may be considered necessary as a result of earthworks.
It is essential that water quality control is kept at a high standard and water levels do not fall below the accepted level that our native freshwater	High flow takes to supplement the reservoir will be required. Taking at high flow can limit the ecological impacts on habitats within and around

Key considerations from the Management Plan	How to achieve consistency
species require to survive such as the Tuna and Inanga. Nga Ariki Kaiputahi objects to the polluting of their sacred rivers and streams. Nga Ariki Kaiputahi also objects to the disposal and release of contaminated waters within their tribal boundaries.	watercourses. However, an ecological assessment will consider any potential adverse effects associated with any take.
The Hapu/Iwi objects to permits issued by local bodies where adequate safety measures are not in place such as emergency Iwi plans to protect areas outlined as customary land and culturally significant sites by the Hapu/Iwi of Nga Ariki Kaiputahi. Permits to extract water from the Mangatu, Waipaoa and Waingaromia Rivers must be done so in close consultation with consideration to the Iwi/Hapu's cultural concerns which are recognised as paramount.	Ongoing consultation with mana whenua is paramount through the consenting process to ensure any cultural concerns are recognised.
All Waahi tapu and heritage sites are to remain untouched. These sites are sacred to Nga Ariki Kaiputahi	There are no known or identified Waahi tapu or heritage sites within the site of the dam. Accidental discovery protocols can be employed to ensure that any unexpected discovery can be managed in an acceptable way.

4.3.5.3 Other Relevant Strategies

4.3.5.4 GDCs Te Rautaki Hanganga Infrastructure Strategy (2024-2027)

An Infrastructure Strategy is prepared every three years by GDC to inform the Long-Term Plan ("LTP").

The key points of relevance from the Infrastructure Strategy (2024-2027) are as follows:

- > Gisborne has limited water storage, and if impacted by an event, this could have significant consequences.
- > Council plan to renew critical assets with a short remaining useful life over the next 10 years and undertake condition assessments on critical assets with a longer estimated remaining life. Renewal programmes can be brought forward (or pushed out) depending on the result of the condition assessments.

- > Water service activities (including water supply, wastewater and stormwater) could be provided by a larger water provider outside of Council. This depends on the outcome of the next steps in the Government's Three Waters reform programme. This creates an added level of complexity for Council, where the future of this asset is uncertain.
- > A water supply resilience review has been included in the LTP Operational Expenditure. Water supply research and modelling will inform where future investment should be, taking into account security of water from adverse weather events but also understanding any climate change impacts of lower rainfall areas.

4.3.5.5 Future Development Strategy (2024 – 2054) and Implementation Plan

GDC's Future Development Strategy ("FDS") is a 30-year vision planning tool that outlines areas of the region where there's potential for future housing growth. It identifies areas capable of supporting more homes in the future and shows the key infrastructures required to support this growth. Page 8 of the FDS Implementation Plan identifies that new water reservoirs to increase resilience will be needed in the long term.

4.3.5.6 Tairāwhiti 2050: Shaping the Future of Our Region

This document is known as the GDC Spatial Plan and sets the vision for the region for the next 30 years.

Outcome 2 of this Spatial Plan relates to resilience. It sets out that there is a need for increased resilience in infrastructure, economies and the community. One of the opportunities is to secure and protect long-term water availability for all communities, including the use of surface water storage.

Outcome 5 of this Spatial Plan relates to sustainability. It outlines that there is a need to explore more efficient commercial and domestic water use, transitioning to more dry cropping and surface water storage opportunities.

4.3.5.7 Tairāwhiti Future Development Strategy 2024-2054

Changes to Gisborne's urban growth plans are managed by the GDC through its FDS, which identifies potential areas for future housing growth and the required infrastructure over a 30-year period. The FDS outlines the need to identify sustainable freshwater supply to meet growing residential population needs – i.e., individual dwelling rainwater collection and building capacity in wastewater and water supply infrastructure.

4.3.5.8 Trust Tairāwhiti: He Huarahi Whai Oranga - Tairāwhiti Economic Plan

Trust Tairāwhiti is the regional wellbeing trust, with a strategic focus on community initiatives, economic development and providing for future generations in Tairāwhiti.

The Tairāwhiti Economic Strategy Steering Group is a collective of regional leaders made up of the Chief Executives from Rongowhakaata Iwi Trust, Te Aitanga a Mahaki, Te Rūnanganui o Ngāti Porou, Tāmanuhiri Tūtū Poroporo Trust, GDC, and Trust Tairāwhiti.

The Tairāwhiti Economic Plan prepared by Trust Tairāwhiti outlines the need to adopt a *water for the economy* approach by investing in water infrastructure systems to provide access to commercial water unlocking the productivity potential of whenua.

4.3.6 Fast Track Approvals Act 2024

The single purpose of the Fast-track Approvals Act 2024 (“**FTAA**”) is to provide a fast-track decision-making process to:

“Facilitate the delivery of infrastructure and development projects with significant regional or national benefits.”

When making decisions to approve or decline a substantive application, and when setting conditions, Panels are required to give greatest weight to the purpose of the Act, essentially the regional or national benefits of the scheme.

The FTAA has been described as a ‘one-stop shop’ and provides an opportunity for the scheme to obtain different types of approvals (i.e. any approvals required under the Wildlife Act; Heritage New Zealand Pouhere Taonga Act 2014; or Freshwater Fisheries Regulations 1983 which may be applicable) through a single application.

Panels do not have to apply the tests under the originating legislation, such as the RMA for resource consent applications; rather these tests must be considered and weighed against the purpose of the Act. This potentially makes projects that could be considered contrary to a national direction, regional policy statement or plan easier to consent.

The FTAA does not follow the notification and submission process in the RMA. Instead, the Panel will invite “written comments” from certain groups and people including relevant local authorities, iwi authorities, and the owners and occupiers of the land adjacent to the application site. There is a limited timeframe for these entities to provide comments. Appeals are typically restricted to questions of law and have fewer parties able to appeal.

Projects must meet specific criteria to be eligible to pursue the fast-track process, which is set out in Section 5 of the FTAA. Of particular relevance to this project will be an agreement in writing by owners of identified Maori Land on which the activity will occur (Clause 5, 1(a)(ii) FTAA).

4.4 CONSENTING OPTIONS, COSTS AND TIMEFRAMES

This section of the report provides a high-level overview of consenting options available and a breakdown of likely timeframes and budgets associated with the process.

4.4.1 Consenting Options

A number of potential consenting options are available for the scheme. The three best options can be summarised as follows:

Option 1: Fast Track Approvals Act Approach

This option is a one stop shop to gain approvals. It involves making a Referral Application to MFE followed by a Substantive Application to the EPA. Appeals are typically restricted to questions of law. This FTAA has the sole purpose to *facilitate the delivery of infrastructure and development projects with significant regional or national benefits* (refer to Section 4.3.6 for further information on the FTAA).

Option 2: Traditional Resource Consenting Approach.

This option involves making consent applications to GDC under the provisions of the RMA. The decision on the application would be open to appeal to the Environment Court by any party.

Option 3: Direct Referral to Environment Court at Applicant's request, with GDCs consent.

This option allows GDC (if there is reasonable probability that any first instance hearing decision will be appealed by one or more parties) to undertake a direct referral to the Environment Court. Any appeal against that Environment Court decision goes to the High Court on points of law only.

It is also noted that RMA reforms are underway. It is too early to understand the final implications of the RMA Reform legislation and any additional opportunity to apply in future under another pathway.

4.4.2 Recommended Option

It is recommended that Option 2 is pursued in relation to the High Flow Water Take consent for the reasons discussed in Section 4.3.4.1. This consent is a necessary component to make the TWSS viable.

For the broader infrastructure project, all options have merits, and it is proposed that once any decision is made to proceed to consenting the scheme, WPT discusses the most suitable pathway with GDC and other stakeholders.

In general terms, there are pros and cons for each option, with indicative timeframes and budgets (based on Mitchell Daysh experience with similar projects) of:

- > **Option 1:** 12 months and budget of \$2-2.4 million;
- > **Option 2** (including a potential Environment Court hearing process): 3 years and \$2-3 million; and
- > **Option 3:** 18 months and \$1-1.5 million.

4.5 SUMMARY OF FINDINGS

With the information at hand in this early scoping phase, the scheme is considered likely to achieve general consistency with relevant statutory documents, including the RMA, national policy statements, national environmental standards and regulations and the objectives and policies within the TRMP. Consistency will be reviewed again once the range of technical expertise is provided for the resource consenting phase.

Iwi management plans have been reviewed, and with ongoing engagement with mana whenua, the scheme would remain consistent with their values.

Initial consultation has indicated a clear need for a project of this nature in this region, with a range of strategies which support this, including those prepared by GDC and Trust Tairāwhiti.

There are three potential consenting pathways available to this project, each with pros and cons. It is recommended that the consenting options available are discussed further with GDC before deciding on a pathway.

It is recommended that as soon as possible, an application for a high flow water take consent from the Waipaoa River is made to GDC under the traditional resource consenting pathway for water harvesting. While B Block is not overallocated currently, water take permits are on a first in first serve basis and an early application will reduce risk of decline.

5. CONCEPT STAGE: ENGINEERING

5.1 GENERAL ARRANGEMENTS OF DAM AND RESERVOIR WATER SUPPLIES

The components discussed under this Section comprise the key elements of the water ‘supply’ side of the scheme, that is – the dam and its appurtenances, the reservoir and all water sources into the reservoir. Distribution components relating to water demand are covered separately under Section 6.

The preferred dam and reservoir scheme layout is shown on the plan included in Appendix 1. Whereas the KRTA (1984) report appears to have promoted a single dam height (30m high) as the preferred option, the MWD (1985) summary report presents a range of dam heights from 25 – 35m with NTWL from RL 55 – 65 masl. The present study follows the MWD (1985) approach considering the main parameters as a range within which an optimum is expected to be found once a more detailed investigation can be undertaken.

The main elements of the preferred option range have been evaluated to an initial technical and economic level. The details are reported later in this report, which has resulted in the following summary of the general arrangement:

- > A zoned earth embankment dam with a height of 29 m to 37 m, crest length of 170 m-210 m (respectively), associated spillway and outlet works at the same dam site as identified in KRTA (1984) and MWD (1985) at the head of a narrowed valley section draining the Pouarua Stream.
- > Reservoir storage of 14.5 Mm³ to 38 Mm³ over the preferred range of dam heights, with a NTWL of RL 55 masl to RL 65 masl respectively. Compared to most regional water supply storage schemes in New Zealand, the reservoir is relatively large for the dam height and scale with a surface area of 190 to 260 ha ¹¹ (at NTWL) respectively extending up to 4.5km upstream from the dam at its furthest point.
- > Water harvesting infrastructure to pump and deliver additional water from the Waipaoa River to the reservoir over a distance of some 3.5km, with capacity of between 500 L/s and 1,255 L/s ¹² depending on the finally selected reservoir storage. The lower and upper ends of the range correspond with the lower and upper range of dam heights and reservoir storages noted above. This is because a smaller reservoir will require less water augmentation than the larger reservoir sizes for a given level of reliability (or annual recharge).

¹¹ 1 ha = 10,000 m² or 100 ha = 1 km².

¹² 1,000 L/s = 1.0 m³/s (or cumec).

The selected range of dam heights and storages is based on basic economic comparisons (i.e. simple Net Present Value or “NPV”), whereby all options in between the upper and lower bounds of the range are expected to have similar or better economic metrics.

All dam options are expected to require supplementary water to be harvested to maximise cost efficiency of the dam infrastructure. This is largely because water volumes available from the natural catchment only are insufficient to reliably refill the reservoir on an annual basis. Further details on the option comparisons and reasons for the above preferred selection are reported in Sections 5.6 and 5.9.

Where the geometrical parameters in the above descriptions differ slightly from the parameters given in the 1980’s reporting for a given dam height, this is generally due to use of updated and more accurate data and geospatial tools now available. Any significant changes from the earlier scheme that have been made are identified as such in this report. Section 5.3.3 provides a comparison between the MWD (1985) and present study parameters.

5.2 DESIGN REQUIREMENTS AND SAFETY CRITERIA

5.2.1 Introduction

The concepts and outline design for the dam and its appurtenances must meet the statutory and normal industry standards for the safe construction and operation of a conventional water storage scheme. In New Zealand the principal relevant safety standards are incorporated within the Building Act 2004 (Ministry of Business, Innovation, and Employment, 2004), the New Zealand Building (Dam Safety) Regulations 2022 (New Zealand Government, 2022), and the New Zealand Dam Safety Guidelines 2024 (“NZDSG”) (NZSOLD, 2024). These regulations and guidelines are similar to those used in other countries for water retaining infrastructure and reflect best international as well as New Zealand practice. The requisite standards are dependent on the size/scale of the Scheme and the nature of land use and potential dam safety risks downstream of the Scheme.

5.2.2 Potential Impact Classification (PIC) Assessment

The 2022 Dam Safety Regulations state that a ‘Classifiable Dam’ is “*a dam that has a height of 4 or more metres and stores 20,000 or more cubic metres volume of water or other fluid*”. Any Pouarua Dam option would be a Classifiable Dam, and as such would require PIC assessment which would have it categorised as either ‘Low’, ‘Medium’ or ‘High’ PIC depending on the hazard it presents in terms of failure consequences.

The PIC is used (among other things) to determine the design criteria for seismic and flood events in accordance with the NZDSG, as further described in the following sub-sections.

For this level of study an initial basic-level PIC assessment was undertaken. This starts with a high-level dam break assessment (parametric – not modelled), which is a hypothetical assessment of the extent and degree of inundation that might occur downstream if the dam was to fail catastrophically, releasing its stored contents. It does not consider the probability that such an event might actually occur.

Noting that there are a range of dam height and stored volumes under consideration, the initial assessment was carried out for a dam option at the smaller end of the scale. If the outcome was High PIC, then this would apply also to any larger dam sizes. The dam assessed on that basis was a 24m high earth embankment with a stored volume of 7 Mm³ (equivalent to NTWL of RL 50 masl) (refer to Section 5.3.3 for detailed parameters).

The high-level review indicated that dam break flows would travel down-valley through agricultural land (largely owned by WPT) to the Waipaoa River some 3.5km to the east, crossing at least two public roads. There are four residential buildings within the inundation zone. The dam therefore falls into the major damage level category defined in the NZDSG and 2022 Regulations.

Based on the above methodology, the total Population at Risk (“**PAR**”) was initially assessed at 17, which falls within the range of 11 to 100 given in Table 3.2 of the Regulations. Accordingly, the PIC of Pouarua Dam is expected to be assessed as High (regardless of the criterion for Potential Lives Lost or “**PLL**”). As noted above, any larger dam option would also likely be classified as High PIC.

5.2.3 Seismic Criteria

The NZDSG 2024 consider two primary seismic loads and associated criteria in dam design:

- > **Operating Basis Earthquake (“OBE”)** - A moderate earthquake that the dam should be able to withstand while continuing normal operations. The dam structure should remain essentially undamaged and fully operational after an OBE event.
- > **Safety Evaluation Earthquake (“SEE”)** - The maximum design earthquake representing the most severe seismic event reasonably expected at the site. The dam must survive an SEE without catastrophic failure, though some structural damage may be acceptable provided the dam maintains its primary safety functions and reservoir retention capability.

The selection of appropriate earthquake magnitudes and return periods for both OBE and SEE depends on the dam's PIC classification, with higher consequence dams requiring more conservative design earthquake parameters.

As discussed in Section 5.2.2, a preliminary assessment indicates the Pouarua Dam will be classified as a High PIC dam. Based on this High PIC classification and associated design return period events, initial screening of peak ground acceleration (PGA) estimates have been completed for the proposed dam site. PGA values have been derived from the New Zealand National Seismic Hazard Model 2022 (NSHM22, GNS Science, 2022) using an average shear wave velocity (Vs30) of 750 m/s, which Perrin et al. (2015) indicate as representative of 'Papa' formation bedrock. It should be noted that the 2024 NZDSG requires High PIC dams to have detailed site-specific studies to determine design seismic loads, including site investigations to determine appropriate Vs30 values. The recommended OBE and SEE design return periods and preliminary PGA estimates from NSHM22 are provided in Table 12.

Table 12: Recommended OBE and SEE design return periods and preliminary PGA estimates from NSHM22

PIC Classification	OBE Return Period (years)	SEE Return Period (years)	Preliminary Site PGA Estimate - OBE/SEE (g)
High	150	10,000	0.3 (OBE) / 2.4 (SEE)

The preliminary SEE of 2.4g is considered very high and as such will have a significant influence on the design of the dam and appurtenant structures (e.g., spillways, diversion culverts, intake towers). Given the close proximity of the dam site to the active Repongaere fault, future site-specific seismic assessments should also consider the risk of secondary fault displacement across the dam footprint.

5.2.4 Flood Criteria

Under the 2024 NZDSG, the permanent flood protection measures for a Classifiable Dam are to be designed for the Inflow Design Flood (“IDF”) corresponding to the PIC of the dam. For Pouarua Dam, expected to be High PIC, the spillway should be sized between the 1 in 10,000 AEP flood and the Probable Maximum Flood (“PMF”). A PMF is the largest flood that could physically occur in a specific catchment, resulting from the most severe combination of weather/rain conditions that are reasonably possible. A PMF is therefore not assigned a probability of occurrence – it is the hypothetical maximum probable event that could occur.

The NZDSG provide for a range between these flood sizes depending on the PAR and the PLL from the PIC assessment.

The 1980's reporting did not include flood size estimation. While the required design flood size for Tangihanga is at the most extreme level for any dam, the catchment size is relatively small which means the capacity (and therefore cost) of the spillway is not anticipated to be a determining factor in scheme feasibility. Further discussion on spillway types, including review of the generic type proposed by the 1980's studies, is included in Section 5.5.1.

Different (lower) flood criteria apply during construction, which is discussed in Section 5.5.3.

5.2.5 Emergency Drawdown Criteria

In line with modern dam safety practice, a High PIC dam in a seismically active area would be anticipated by the NZDSG to require emergency dewatering facilities in case of damage. The dam will therefore need to include appurtenant facilities and equipment suitable for drawing reservoir levels down within a reasonable period. The capacity needs to be sufficient to overcome normal inflows.

Guidance on capacity and timing requirements for dewatering the dam may be taken from industry practice guidelines such as USBR TM3 Criteria and Guidelines for Evacuating Storage Reservoirs and Sizing Low-Level Outlet Works (1990). According to USBR (1990), for a dam in the high hazard/significant risk category, the reservoir should be able to be drawn down to 50% of its height in 40-50 days, and 25% in 70-90 days (amongst other criteria). The timing reduces further if the dam is categorised as high hazard/high risk.

For Pouarua Dam, over 90% of the reservoir volume will be impounded by the top half of the dam. However, the small catchment size will yield relatively low mean winter inflows compared to most large dams (likely between 0.4 and 0.7 m³/s). This helps to offset the large size of the reservoir in terms of the required capacity of emergency dewatering facilities.

Nevertheless, to achieve the required drawdown rate is estimated to require an emergency discharge capacity in the order of 10 times the capacity of normal dam inflows. The corresponding requirements should therefore be planned for and design concepts developed in the next stage of study.

This issue links into design capacity requirement for the dam outlet works, which is further described in Section 5.5.2. In summary, the emergency dewatering capacity of the permanent outlet works is expected to influence if not dictate the physical dimensions of the outlet pipework, maintenance access, and temporary diversion works.

5.3 DAM LOCATION, HEIGHT AND RESERVOIR STORAGE OPTIONS

5.3.1 Site Options

As noted in Section 5.1, the proposed dam centreline location investigated by KRTA (1984) and MWD (1985) was retained for this current study. Review of the 1980's reporting indicated no over-riding reasons to prefer alternative locations, and no other sites were reported as having been considered or discounted. The reported geotechnical investigations focussed on the site selected at the time which provides a useful reference framework for the geotechnical review reported herein. The selected dam location is at the head of a valley that widens out upstream, which is a typical criterion for searching suitable dam sites.

The valley continues downstream with similar geometry for a further 1.2km (approx.) before the Pouarua Stream confluences with the slightly larger Repongaere Stream draining Lake Repongaere. This confluence is taken as the downstream limit of any Pouarua Dam option as impoundment of the Lake Repongaere catchment (which has been briefly investigated in the past) would now be considered unsustainable from a land-use and ecological perspective.

Several other potential dam sites have, however, been identified at desk-top level within this valley reach. These, and their location with respect to the selected site, are shown in **Figure 38**.

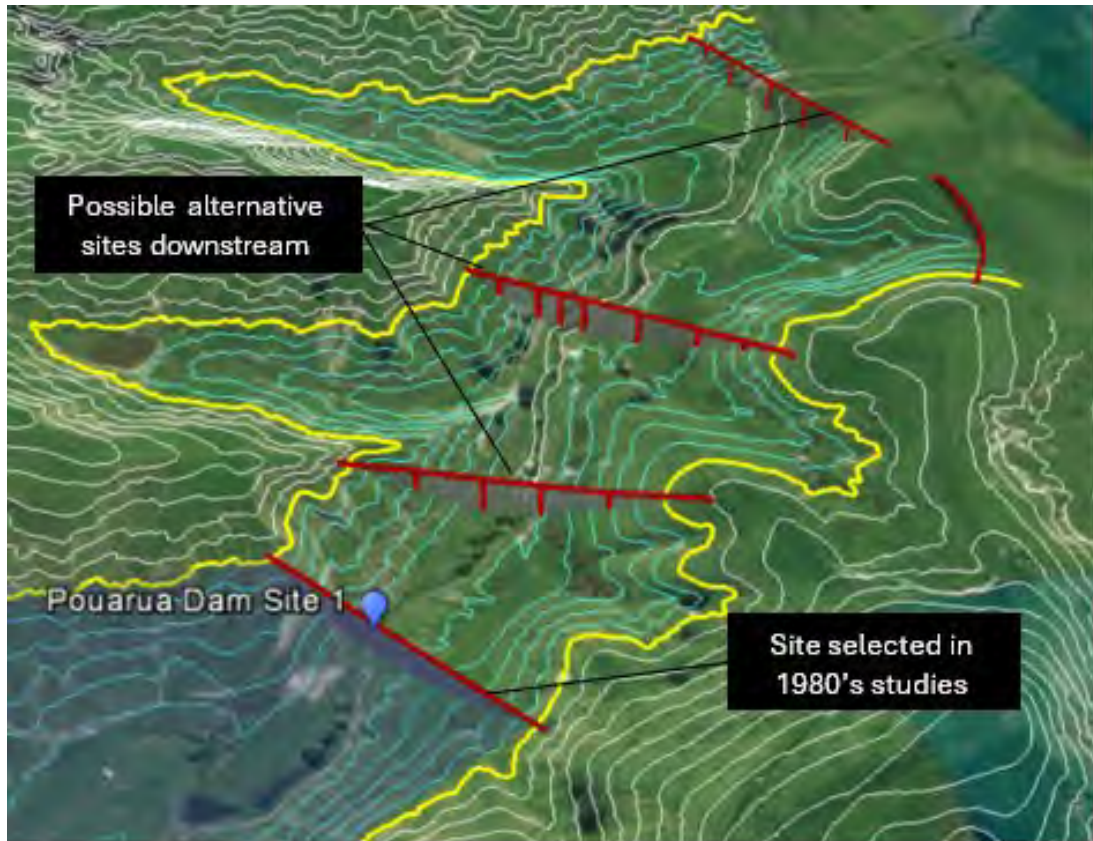


Figure 38: Possible alternative dam site locations downstream of currently selected location (source: Google Earth)

As these other options all occur within a relatively narrow section of the valley downstream of the selected location, the incremental storage benefit each would bring is relatively small compared to the overall reservoir volume. There is no option with a shorter crest length than the selected option, all would have the same PIC and general risk profile in terms of downstream hazard, and all are within the same land ownership parcels. Therefore, to become preferred, they would need to offer a significant cost benefit or risk in one or more of the following areas:

- > Geotechnical aspects such as abutment stability, landslide potential, reduced overburden depth or closer proximity to suitable earth construction materials.
- > Reduced cost of other related elements such as spillway, construction diversion works, or access roads.
- > Reduced cost of downstream works (distribution and/or water harvesting infrastructure).

The most downstream option shown on **Figure 38** (some 0.7 km downstream of the selected site) was suggested by the WPT representative on site as a potentially desirable dam location. Further review of this site against survey data however, revealed that for any dam option less than about 20m height an additional saddle dam (as shown on **Figure 38**) would be required to close off a lower-lying saddle to the south.

The summary finding from the above discussion is that the selected site location remains preferred with no obvious over-riding benefits of other downstream sites identified at this level of study and is recommended for consenting. An envelope of potential site locations is indicated on the plan in Appendix 1 to retain flexibility to optimise if required, and account for the outcome of anticipated further geotechnical investigations.

5.3.2 Constant Parameters Selected for Dam Height and Storage Relationships

The following parameters were used as constants in evaluating the relationship between dam height and NTWL. The reasons for their selection, and why in some cases they vary from those adopted by MWD (1985), are also given:

- > **Dam height definition:** under modern practice, dam height is generally stated as the vertical difference in height between the dam crest and the lowest ground level at the toe of the dam after construction.
- > **Lowest final ground level** at the toe of the dam was taken as **RL 30 masl**, based on the latest LiDAR survey data available from the LINZ website. Figure 3 of the MWD (1985) report shows a 35 m high dam with a corresponding crest level of RL 67 m given in Table 1 of that report, implying the level at the toe of the dam was taken by MWD to be RL 32 masl. Dam heights in the present study will therefore have 2 m added for this difference for any given NTWL.
- > **Freeboard** allowance between NTWL and the crest of the dam was taken as **4.0m**. The corresponding value adopted by MWD (1985) was 2.0m, hence dam heights in the present study will have a further 2 m added for any given NTWL. The higher freeboard now adopted is generally consistent with modern practice for moderate-height ungated earth dams, with the increase from past practice largely relating to the PIC and corresponding flood size the modern dams are expected to be designed for. The selected freeboard is an interim value only for purposes of dam height comparison, with no rigorous assessment carried out for current purposes, and is quite likely to change in future design stages.
- > The **overall dam height increase** combining the above effects is therefore 4 m from the 1980's dam heights to the present study dam heights, for any given NTWL.

- > **Minimum operating water level (“MOWL”)** above the lowest dam level is assumed to be 8.0m for this study, which equates to **RL 38.0 masl**. This value is arbitrary based on experience and has not been subject to rigorous assessment. The reservoir ‘**live storage**’ is then defined by the difference between this minimum value and NTWL for all dam options. Water below that is ‘dead storage’ and not able to be accessed. While it is desirable to maximise the operating range from a water use perspective, practical hydraulic limits apply to ensure the lowest water intake has sufficient submergence to avoid hydraulic and debris issues. Sediment incursion into low-lying areas of the reservoir is also a factor. The assumed minimum operating level was not given (or found) in the previous reporting.

5.3.3 Height and Storage Options Investigated

As noted earlier, the MWD (1985) summary report presented a range of dam heights with NTWL ranging from RL 55 to 65 masl. The corresponding range of reservoir capacities was 13.7 to 37.1 Mm³. This is a very wide range (~3x difference).

As the smallest of these reservoirs has about 3 times more capacity than the (currently estimated) 90% exceeded annual inflow from the natural catchment, the range was extended down slightly for the purposes of the present study. The reason for this was to include a dam height at which the available storage could refill annually for most of the time – without augmentation from external harvested water sources. None of the dam heights considered by KRTA (1984) or MWD (1985) meet this parameter.

The full range of dam and storage parameters considered for the present study is given in Table 13. For convenience of comparison, the corresponding value for the range of three NTWL values reported in MWD (1985) is given in *(italics)*.

Table 13: Range of dam and storage parameters evaluated in the present study

NTWL (RL, masl)	Dam Height (m)	Crest Level (m)	Reservoir Area at NTWL (km ²)	Live Storage (Mm ³)
45	19	49	0.57	2.19
50	24	54	1.23	6.70
55	29 (25)	59 (57)	1.86	14.43 (13.7)
60	34 (30)	64 (62)	2.41	25.09 (24.2)
65	39 (35)	69 (67)	3.00	38.60 (37.1)

The smallest dam in the above table has a very small volume amounting to only about a quarter of the available natural catchment inflows and clearly presents an inefficient use of the available natural water resource. As the unit cost per m³ of stored water typically increases markedly as dam size decreases this small dam option was removed from further consideration. The sizes highlighted in green in the above table were retained for further comparison.

5.4 DAM TYPE ASSESSMENT

5.4.1 Foundations Assessment

Foundation geological and geotechnical conditions play a fundamental role in dam type selection. Key properties of the foundation material include strength, deformation, permeability, stability and durability characteristics.

Previous investigations indicate the geological profile across the proposed dam site (described in Section 3.4.2.2) comprises weak, fractured and permeable mudstone and sandstone bedrock. This bedrock is overlain by quaternary sediments of varying thickness: up to 10 - 15 m of alluvial sediments in the valley bottom, several metres of colluvial material on lower valley slopes, and up to a few metres of volcanic tephra and recent soils on undisturbed upper slopes.

The **quaternary sediments** are expected to be highly variable in both composition and lateral extent, with generally poor engineering properties, including low strength, high compressibility, with layers of high permeability. Such materials may be susceptible to differential settlement, liquefaction, and slope instability. Consequently, these sediments are unlikely to be suitable as foundation material regardless of dam type and are likely to require removal. Partial removal of material may be possible if further investigations encounter deposits with more favourable engineering properties within the dam footprint.

Previous site investigations identified **Tolaga Bay Group bedrock** comprising predominately mudstone on the true-left valley side and sandstone on the true-right side. Site investigations described the bedrock as soft/weak, weathered, fractured and permeable, though quantitative laboratory and permeability data were not provided in the associated reports. Regional geological studies indicate rock strength varies from moderately soft to hard.

Foundation properties of the mudstone and sandstone are expected to be variable but generally poor. Rock strength is expected to be typically weak to extremely weak, with weathering profiles, likely related to depth, directly influencing rock strength.

Areas of high permeability may result from large discrete rock mass defects, zones of heavily fractured rock, and/or permeability contrasts between sandstone and mudstone units. Investigation will be required to determine the spatial extent and thickness of these lithological units and to characterize the variability of rock mass properties throughout the foundation zone. Given the foundation conditions described above, key foundation considerations for the Tolaga Bay Group bedrock are summarised below.

> **Bearing Capacity Considerations**

- > Foundation strength considered adequate for embankment dam loading but insufficient for concrete dam structures
- > Extensive zones of weathered and fractured rock with soil properties will require removal or treatment to achieve an appropriate foundation

> **Seepage Management**

- > High permeability anticipated along rock mass defects, with sandstone units expected to be less permeable than mudstone
- > Comprehensive grouting programs and subsurface drainage anticipated for seepage control

> **Abutment Stability**

- > As discussed in Section 3.6.2, landsliding in Tolaga Bay Group Formation is commonly controlled by rock mass defects orientated unfavourably relative to the valley slopes. Foundation design will require detailed mapping of discontinuity orientations and properties, particularly bedding plane contacts between lithologic units.

5.4.2 Materials Assessment

The engineering properties, quantities and proximity of potential construction materials directly influence the dam type selection, zoning design, construction methodology, project economics and overall project feasibility. Geologic materials identified both at and nearby the dam site are evaluated for their suitability as construction material below.

5.4.2.1 Quaternary Sediments

Quaternary sediments at the dam site are inferred to comprise a mix of alluvial gravels, sands, silts and clays, volcanic tephra, and colluvial sediments deposited by slope processes (landslides and erosion). Localised pockets of organic material may also be present.

Although certain fractions of these deposits (e.g., sand and gravel) could potentially be suitable for construction, the individual layers are expected to have limited lateral continuity. As a result, securing adequate volumes of material with consistent engineering properties is unlikely, and selective excavation of suitable zones would be logistically challenging.

Earlier studies (MWD, 1985) proposed that embankment shoulders could be constructed from recompacted surface soils. However, this updated assessment concludes that the Quaternary sediments are unlikely to provide suitable material for embankment construction and have therefore not been considered further. Confirming their suitability would require extensive field investigation and laboratory testing.

Remnant terrace deposits, comprising primarily sands and gravels, may represent a potentially more reliable source of construction material. However, their distribution, composition, and available volumes are currently poorly understood. These deposits are expected to yield materials similar to those of the Matatoki Gravel. Given current knowledge, the Matatoki Gravel is considered the more reliable source in terms of both composition and volume.

5.4.2.2 Tolaga Bay Group Bedrock

Tolaga Bay Group mudstone and sandstone bedrock (commonly called ‘Papa’ as noted earlier) is present at the dam site. The rock is weak and would not be suitable for use as either rock fill or drainage material. However, consistent with the previous KRTA (1984) and MWD (1985) studies, the mudstone component may have potential as a low permeability core material for an embankment dam. In the Hawke’s Bay similar Papa material has been considered as a clay core material for at least two proposed large dams Damwatch is aware of the proposed Ruataniwha Dam on the Makaroro River and the Whanawhana Dam on the Otamauri River.

The ability of an embankment core to accommodate foundation movement is critical in a high seismic environment and the material must therefore be cohesive and well-graded. Materials with higher plasticity (typically $PI > \sim 12$) are preferred for their superior resistance to cracking and internal erosion, while uniform non-cohesive materials such as silt are highly susceptible to erosion and unsuitable.

Evaluation of core material requires laboratory testing to assess grain size distribution, fines content, and plasticity characteristics. No such testing was undertaken in previous studies. While this material is still considered a viable source at this stage, additional investigations will be necessary to confirm its suitability.

Investigations should include:

- > Map the distribution of mudstone and sandstone beds to identify the location (s) of an appropriate mudstone borrow area
- > Confirm relevant mudstone material properties including grain size distribution, fines content, and plasticity through laboratory testing
- > Confirm available volume of reliable material

5.4.2.3 Matokitoki Gravel

The Matokitoki Member (Matokitoki Gravel) of the Mangatuna Formation overlies Tolaga Bay Group bedrock in outcrops on Tangihanga Farm, approximately 3 km northwest (downstream) of the dam site. The Matokitoki Gravel has been widely used on the farm for roading aggregate, and Wi Pere have established a quarry (Lavenham Road Quarry) which is connected by existing farm roads. In addition, Wi Pere commissioned a geological investigation of the Matokitoki Gravel deposit, including test pits, to assess its volume, quality, and potential material applications (Francis, 2011). The quarry was also visited by Damwatch during the site visit on 5 August (Section 3.2), at which time the quarry face and an existing stockpile were inspected. A photo of the quarry face is provided in **Figure 39**.



Figure 39: Lavenham Road Red Metal/Matokitoki Gravel Quarry Face on Tangihanga Farm

Key characteristics of the Matokitoki Gravel are summarised below:

- > **Regional description:** (Mazengarb and Speden, 2000) describes the material as “*iron-stained, cross-bedded, polymict gravel and intercalated sands with non-marine fossils*”.
- > **Material composition:** Francis (2011) recorded 60–80% well-rounded gravel and cobbles and 20–40% very coarse sand. Distinct beds of sand (up to 500 mm thick),

occasional clay beds (<200 mm thick), and coarser horizons with a high proportion of cobbles were noted. The gravel and cobbles are of mixed lithology, with most particles being hard to very hard. No softer Papa rock was observed in the 10 test pits at Lavenham Road Quarry, although Papa was identified at the nearby Tangihanga Road Quarry.

- > **Deposit thickness and volume:** The gravel deposit is at least 22 m thick (and likely thicker), with estimated minimum volumes between 500,000 and 625,000 m³. Overburden is minimal.

Damwatch observations: Field observations were generally consistent with Francis (2011). The gravel was rounded, of mixed lithologies and typically strong, however some weaker Papa materials was observed. Sand and fine-grained (possibly clay) beds were visible in the quarry face. The stockpiled material displayed some cohesiveness (indicating fines content) and appeared to be more well-graded (fine to coarse sand) than previously described.

Based on the description above, the Matokitoki Gravel appears suitable for use as bulk embankment fill material (i.e., earthfill shoulders), with minimal processing or selective excavation expected. Processing may also produce material suitable for use in filter and drainage zones as well as a concrete aggregate. The available material volumes reported by Francis (2011) exceed the total volume required for the proposed embankment. To confirm its suitability as a construction material, further investigation is required to better understand:

- > Material grading and fines content;
- > The proportion of weaker papa material;
- > The strength and durability of the gravel and cobble fraction; and
- > Material variability within the deposit.

In addition, the potential to consistently produce material of acceptable quality through processing, screening, and selective excavation will need to be confirmed.

5.4.2.4 Patutahi Limestone

The Patutahi Limestone is a member of the Tolaga Bay Group and outcrops on the Tangihanga farm approximately 2 km north of the proposed dam site and reservoir. Regionally, the Patutahi Limestone has been used widely as a roading aggregate and as rip-rap for river and foreshore (Mazengarb and Speden, 2000). A major regional quarry (Patutahi Quarry) is located approximately 20 km south of the site.

This material is currently used as roading aggregate across the farm, and a quarry connected to the dam site by existing farm roads has been established on the Tangihanga farm. Wi Pere commissioned geological investigations (Francis 2011 and 2012) consisting of drilling, test pitting, and laboratory testing to assess the volume, quality, and potential applications of the limestone, including evaluation of overburden ratios and economic quarrying viability.

While Damwatch did not visit the Tangihanga limestone quarry during the August 5 site visit, a processed limestone stockpile that had been transported from the quarry to an area near the Matokitoki quarry was inspected.

Key details of the Patutahi Limestone from the Francis (2011 and 2012) Tangihanga investigation are summarized below:

- > **Material Descriptions** - range from *"Yellow brown, soft to mod hard, sandy, coarse with some beds of yellow-grey or pink grey hard to very hard, crystalline, shelly, fractured"*. Additionally, the limestone is noted to be *"somewhat porous in weathered exposures, dense and very hard when unweathered and contains some fossils"*.
- > **Material Variability and Weathering** - the limestone is interbedded with sandstone and exhibits a deep weathering profile. The hard unweathered portion is typically only intersected at depth (>30 m) by investigative boreholes. Within the unweathered portion, layers of weathered limestone were observed, indicating a variable weathering profile.
- > **Aggregate Testing Results** - Aggregate testing (impact value and linear shrinkage tests) indicated *"aggregate quality varies throughout the limestone in a somewhat unpredictable way"* and the material was generally *"softer than material from the regional Waerengaokari or Patutahi quarry but would probably make a good forestry metal"*.

Damwatch inspected a material stockpile that had been crushed/processed to approximately 50–100 mm and transported to a site near the Matokitoki Gravel quarry. A photo of the stockpiled material is shown on **Figure 40**.

Key observations of the stockpile included:

- > Material was yellowish brown, moderately strong, coarse grained with a somewhat porous appearance. Although the material was moderately hard, it did not appear overly durable.
- > Stockpile contained a large quantity of sand-sized material which may indicate breakdown during processing and transportation.



Figure 40: Processed Patutahi Limestone stockpile on Tangihanga Farm

Based on the information above, the following assessment is provided regarding potential use of the Patutahi Limestone as a dam construction material:

- > The unweathered, strong portion of the Patutahi Limestone has potential for use as an embankment rockfill material and/or as riprap for armouring/protection of the upstream face or other areas.
- > The weathered limestone lacks the strength and durability for use as a construction material.
- > There appears to be considerable variability in both aggregate quality and the distribution of unweathered limestone within the Tangihanga quarry. Extensive investigations and laboratory testing would be required to prove the quality and volume of suitable material to make this a viable source of construction material. Additionally, the ability to achieve a suitable, consistent material through processing would need to be evaluated.
- > The large thickness of overburden above the unweathered limestone at Tangihanga will have significant cost impacts in establishing this quarry as a viable source. It is understood that the current Tangihanga quarrying operations are on as needed basis to support farm operations in which the quality of material is not of critical importance. As such current operations haven't been established to target the deeper unweathered limestone which would be required for dam construction.

- > Francis (2012) indicates that limestone quality at regional quarries are generally better than at Tangihanga and as such may represent a more reliable source for dam construction. The quality and available volumes from these sources will need to be understood. If suitable material exists at regional quarries, the economics of purchasing and transporting the material to site may will need to be evaluated.

5.4.2.5 Alternative Sources

Alluvial material from the nearby Waipaoa River was considered at a high level as a potential source of sand and gravel for dam construction. Such material is typically required for embankment filter and drainage zones.

This option was discussed with Tim Rhodes (Tangihanga farm manager), who indicated that Waipaoa alluvials have been used occasionally on the Tangihanga farm. His experience is that the Waipaoa alluvial gravels are much weaker than those from the Matokitoki gravels and break down readily when used on farm roads. This poor durability is attributed to the weak Papa bedrock geology in the upper catchment, which is the primary source of the Waipaoa alluvials.

No further evaluation of this material was completed. Additional investigation would be required to determine whether this source has any potential as a construction material for the proposed dam.

5.4.3 Dam Type Screening

5.4.3.1 Previous Studies

A zoned earthfill dam was proposed by previous studies (KRTA 1984 and MWD 1985) on the basis of:

- > Exclusion of rockfill and concrete gravity dams because of site conditions and the non-availability of construction materials.
- > The likely availability of suitable earth fill dam materials within and adjacent to the site.

The studies provide the following details of proposed construction materials but notes that future investigations should include extensive laboratory testing of the dam construction materials and further investigation and testing of the dam foundations:

- > Impervious core constructed of recompacted Papa (but notes difficulties with use of soft 'Papa' rock as construction materials.
- > Embankment shoulders constructed of recompacted 'surface soils'.

- > Graded filter material may need to be imported.
- > Discusses a downstream chimney drain and dumped rip rap on the upstream face but no details of construction material are provided.

5.4.3.2 Updated Dam Type Screening

An updated scoping-level screening of viable dam types for the proposed Pouarua dam site was conducted based on desktop studies (including review of previous studies) and site reconnaissance. This initial assessment of suitable dam types was primarily influenced by foundation conditions, potentially available construction materials, seismic loads, and additional factors such as valley topography. This scoping-level assessment was based primarily on the professional experience of the study team, considered within the geological and materials availability context of the proposed site.

Elimination of Concrete Dam Types

Concrete dam types (gravity, arch, RCC, and buttress dams) were not considered in the available 1980's reporting. The current study team concurs, and concrete or other rigid dam types have not been considered in detail due to inadequate foundation bearing capacity of the weak Papa rock. These dam types typically require minimum foundation bearing capacities of 5 MPa, which would require extensive and costly foundation improvement works.

Although not considered in earlier studies, a hardfill dam may also be a viable option for this site. Hardfill refers to a dam type constructed using lightly cemented aggregates, forming a trapezoidal embankment with conventional concrete, extruded, or grout-enriched hardfill faces. The Matokitoki gravels could provide a potential source of construction material for such an option.

Hardfill dams offer good resilience to seismic deformation and have foundation requirements similar to conventional rock-fill dams. However, the lack of precedent and limited contractor experience with this dam type in New Zealand represent significant drawbacks. Despite these limitations, the hardfill option should be reconsidered in future studies if embankment dams are determined to be unviable.

Embankment Dam Screening

On that basis a high-level screening of embankment dam types was conducted. Embankment dam types (as discussed by NZSOLD 2024) include: homogenous earthfill dams, zoned earthfill and rockfill dams with low permeability core, faced (comprising concrete, asphalt or geomembrane) rockfill dams and rockfill dams with central impervious core (comprising earth, asphalt or concrete.)

Rockfill is distinguished from earthfill by characteristics that it is free draining with high strength material. Whilst typically quarried rockfill may comprise natural coarse gravels meeting the same characteristics.

As a general principle, if a particular embankment dam type is viable, then variants of that type should also be technically feasible. The use of non-natural impermeable barriers (geomembranes, concrete, or asphalt) introduces additional and/or different design, construction, and maintenance requirements. Typically for smaller dams this could result in higher project costs compared to dams utilizing locally available natural materials. The high-level screening discussion provided in Table 14 considers the dam types in the context of various screening criteria.

Table 14: Initial screening discussion of primary dam type for consideration

Criteria	Discussion
Foundation	Most embankment dam types tolerable of weaker foundations. However, where low strength influences the shoulder stability advantages of high strength fills may not be realised. Dams with concrete plinths (faced rockfill and asphalt core) have higher demand on foundations compared to zoned dams with low permeability earth cores. Foundation cutoff treatment will apply in all cases, though the length of treatment will be slightly longer for faced dams which have a concrete plinth along the perimeter of the upstream footprint.
Material Availability	The site exhibits potential suitable core material in its vicinity subject to further verification. This is potentially favourable for a zoned dam type. Local gravels anticipated to be available in suitable quantities for embankment shoulder fill. These would be suitable for zoned dam types and potentially faced dams and/or asphalt core dam types. Processing or import of materials for specific filter or drainage zones is anticipated to varying degrees for all embankment dam types. Local limestone rock is anticipated to be one option for upstream rock armouring if/where required for non-faced dam types.
Seismic Performance	Generally, all embankment dam types can be designed to provide good seismic performance for the range of dam heights being considered. Zoned dam types with wide impervious cores provide resilience to offset fault displacements provided they are designed with adequate filter and drainage capacity.

Criteria	Discussion
	Concrete faced dams can be designed to accommodate displacements. With high quality construction they can withstand significant seismic shaking, but face repairs are likely to be required to some extent (repairs can include geomembrane patches). Asphalt and particularly geomembrane faced dams provide greater flexibility to deform as a result of seismic shaking. Asphalt core dams can also tolerate deformations under seismic shaking, but if ruptured, require extensive repair.
Constructability	Zoned dams focus on earthwork construction without needing to consider additional construction element introduced by faced rockfill or asphalt core dams. Construction plant is however already required for other appurtenant structures, e.g., spillway. Asphalt plant would be additional and specific to impervious element. Geomembranes are significantly quicker to install compared to concrete, and to a lesser extent, asphalt facing solutions.
Technical Risk	Local civil contracting environment familiarity with earthworks projects potentially favours zoned dam types. Impervious core material is marginal / subject to verification. There are recent precedents in New Zealand for concrete faced dam type (i.e., Waimea Community Dam) and geomembrane facing (i.e., Tekapo canal relining) at a scale commensurate with the dam heights being considered.

Preferred Option

The updated screening assessment discussion, presented in Table 14, confirms previous findings that a zoned earth-fill dam with an impervious clay core remains the most viable option for advancement to subsequent project phases. The key factors supporting selection of a zoned earth-fill embankment are:

- > **Foundation compatibility** – most tolerant of weak Papa foundations.
- > **Material economics** – potential utilization of locally available core, filter, and shoulder materials.
- > **Seismic suitability** – superior earthquake resistance in a high seismic environment.
- > **Constructability/technical risk** – most common dam type with relatively simple, well-established construction methods and performance history.

While the overall assessment aligns with earlier studies, the proposed material zoning and design details differ to reflect advances in dam design since those studies were completed. Additionally, this updated assessment concludes that recompacted surface soils are not suitable for use in the dam shoulders, as proposed in earlier studies. Instead, Matokitoki gravels are proposed as the preferred shoulder material. Consistent with previous studies, all proposed construction materials will require investigations and lab testing to confirm their suitability. Further details of the proposed zoning are provided in Section 5.4.4.

Considerations and Alternatives

A zoned earth-fill embankment with an impermeable clay core relies heavily on the local availability of suitable construction materials. While potentially suitable materials at and near the site have been identified, the quality and reliability of these materials must be verified in future project phases, particularly the mudstone component of the Papa bedrock as a clay core material. If the Papa is found to be unsuitable, a geomembrane faced dam is considered a favourable option based on seismic performance and constructability. It would require a full consideration and understanding of the maintenance requirements under normal long-term operation.

While the strong, unweathered portion of Patutahi limestone represents a potential source of suitable rock-fill, extensive further investigations would be required to prove a viable local source, and import costs would likely be substantial (see Section 5.4.2). There is some local precedent for where the limestone has been used as rip-rap and this may be suitable for armouring if such zoning is detailed on the dam.

Should alternative rock-fill become viable through identification of suitable local sources, future studies would need to evaluate how this might influence the selection of dam type, e.g., would it represent a more free-draining and durable fill compared to the available gravels.

5.4.4 Arrangement, Geometry & structure

For a dam concept comprising a zoned central core earthfill dam with vertical and horizontal drainage the dam zoning would comprise:

- > Embankment Fill – Predominantly sourced from the Matokitoki Gravel.
- > Central Core – Selectively sourced from the mudstone units of the Tolaga Bay Group Bedrock, reworked and recompacted to form a central low permeability core.
- > Filter zones – Anticipated to comprise processed sand dominant grades which may require importing to site.

- > Drainage zones – Anticipated to comprise processed gravel grades which may require importing to site.
- > Upstream Wave Protection – Potentially comprising limestone rock “rip rap”.

To address any potential cracking, settlements and displacements the dam may experience as a result of seismic loading, defensive design measures to be applied in the detailed design would include:

- > Foundation stripping of weak and/or potentially liquefiable materials to found the dam on the Papa rock foundation.
- > Modern designed and well-constructed filters on the downstream side of the central core and extending up to crest level. This is to prevent erosion of material from the core.
- > Sufficient capacity within the drainage zones to capture and convey leakage through potential cracks in the core (this assumes the downstream fill cannot be relied upon to be free draining).
- > Provision of an upstream filter to the central core which can also function as a crack stopper. The latter works with the filter material washed into cracks as a result of an earthquake, reducing flow and potential for enlargement.
- > Conservative side slopes. Side slopes should remain consistent to the crest without any localised steepening.
- > Ample freeboard to allow for settlement, slumping or fault movements.
- > Flaring the embankment crest and core at the abutment contacts, where cracking can typically occur, to length seepage paths.
- > Profiling the abutment contacts to minimise step changes.

For a zoned earthfill dam, the construction (excluding spillway) would be earthworks focused. This simplifies construction and recognises wider earthwork construction capability in NZ.

5.5 AUXILIARY STRUCTURES AND WORKS

5.5.1 Spillway

A spillway is required to accommodate inflows that exceed the storage capacity of the reservoir and discharge them safely downstream of the dam. The required capacity of the spillway is governed by the size of the IDF, which for this dam will be between the 1 in 10,000 AEP flood and the PMF as noted in Section 5.2.4.

MWD (1985) proposed a spillway type known as a bellmouth intake, which is a vertical shaft in the reservoir with a bellmouth-shaped inlet at NTWL, the shaft turning into a horizontal culvert through the base or foundation of the dam to discharge near the dam downstream toe. The MWD concept had the spillway also operating as the temporary diversion culvert during construction, which presented a cost saving. This kind of spillway is now rarely employed in modern dam design for several reasons, key among them being:

- > The tower section is vulnerable to earthquake damage with the potential for uncontrolled reservoir release in case of issues.
- > The culvert section is built through or near the base of the dam and presents a dam safety risk in case of leakage.
- > The capacity is generally insufficient for the larger flood sizes that tend to be applicable nowadays to Mid-High PIC dams.
- > Safety risks to reservoir users.

While the natural hazards creating these risks have not changed significantly in the last 40 years, the knowledge around extreme events, design technologies and societal willingness to accept dam safety risks have all changed markedly. It would therefore not be appropriate to retain the 1985 spillway design concept.

The spillway type most suited to the updated dam concept is expected to be a conventional chute-type spillway, ungated, with an ogee (hydraulically curved) crest at NTWL and a concrete chute structure leading to an energy dissipating form of outlet or terminal structure well downstream of the dam toe. For an embankment dam, this type of spillway is always located away from the dam in good quality original materials, through one or other abutment or into an adjacent valley if the topography suits. Often it is possible to utilise excavated material in dam construction, which will be investigated as a cost-saving opportunity in the next phases of study.

While the spillway will have to be designed for at least the 1 in 10,000 AEP flood, the relatively small size of the catchment that will define the design flood size means that the dimensions and cost will still be smaller/lower compared to most other dams and reservoirs of this scale.

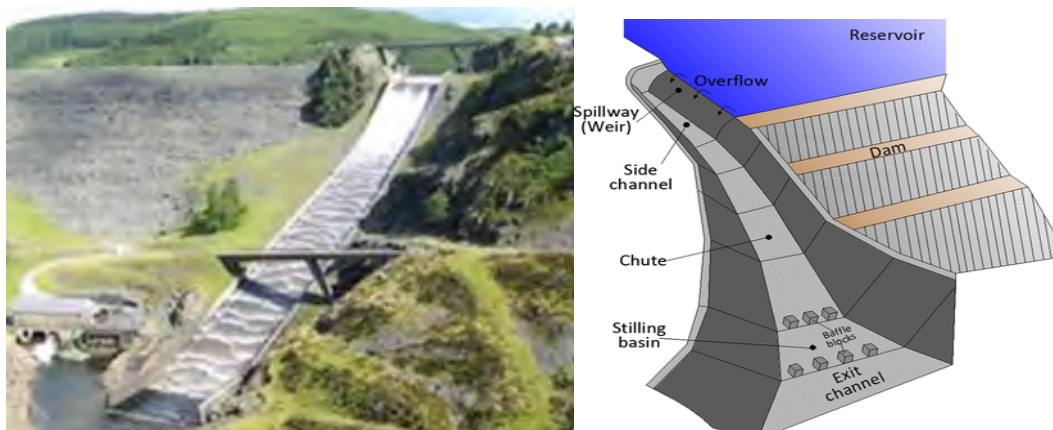


Figure 41: Examples of Chute Spillways

5.5.2 Outlet Works

The outlet works are the facilities that deliver flow from the reservoir to downstream of the dam, with the key functions in modern dam design generally being as follows:

- > To deliver the required flows for subsequent distribution and use at any operating reservoir level.
- > For emergency reservoir dewatering.
- > For release of residual flow requirements downstream.

These works were not addressed in any of the available 1980's reporting, with MWD (1985) simply noting that the dam costs presented did "*not include the cost of water intakes or a water distribution system*". It is important to consider the outlet facilities in any water storage dam as they not only form a significant part of the cost, but their design often needs to link in, both functionally and physically, with other key elements such as the spillway, emergency dewatering facilities, and construction diversion facilities.

The main components of a typical outlet facility generally comprise the following:

- > An intake structure with intake ports open to the reservoir.
- > A pressurised conduit or pipe connecting the intake to the downstream side of the dam.
- > An outlet system that either discharges water directly to the stream (for subsequent re-collection downstream) or connects directly to a piped distribution system.

5.5.2.1 Intake Requirements

The intake facilities will need to be able to draw water off at multiple levels to help manage water quality as the reservoir level changes during the irrigation season. The lowest port will need to be set low enough to take the required design flow at minimum reservoir operating level without drawing in sediment or causing hydraulic issues such as vortex formation. The number of ports will be the subject of specific assessment in future design stages. Water quality may also require additional facilities in the reservoir or attached to the intake to assist water mixing and avoid stratification issues.

The intake ports will require screening to avoid debris entrainment, with the screens set up to be removeable and maintainable, ideally without having to cease water releases. A system of valves or gates will be required to safely manage releases. They are also expected to have dam safety functions such as opening for emergency dewatering or closing to isolate the reservoir and prevent uncontrolled water release.

Several different types of intake arrangement are possible. Each has merits and disadvantages that will need to be considered. A vertical free-standing intake tower is a common form, as it can conveniently be connected to outlet pipework running through a culvert that can be used for maintenance access. Often it is possible to use the same culvert for construction diversion. Such a structure would be subject to high seismic demand at this site however, which would make a cost-effective design challenging.

Another common alternative is an intake shaft founded on or in natural ground on the dam abutment. This can be inclined to suit the natural ground surface or a vertical in-ground shaft with lateral ports extending out to the reservoir. The main advantages of this type are that seismic load conditions are less onerous, and maintenance is possible from land. The disadvantage is that a tunnel is usually required to convey the outlet works downstream of the dam, which can present as a significant cost.

The preferred arrangement will be the subject of future design studies. The high-level cost estimates reported in this study can be assumed to apply to any practical intake type.

5.5.2.2 Outlet Conduit and Water Release Requirements

The outlet pipework for operational releases is designed to operate under pressurised conditions and must be composed of materials that ensure stability, strength and long-term durability. For any intake type, the conduits will need to be installed free-standing within a larger culvert or tunnel. Apart from maintenance considerations, this is a dam safety measure, to ensure that the dam body is not exposed directly to pressurised flows in case of damage to or failure of the conduit.

The required hydraulic capacity for operational releases is further discussed in Section 6. However, the capacity requirement is expected to be driven by the emergency dewatering capacity requirement in this case, which as noted in Section 5.2.5, may be in the order of 10 times normal operational release flows.

As for the intake, the outlet works will also have a system of valves to carry out various operational, maintenance and dam safety functions. The outlet culvert or tunnel in which the pipework is installed must therefore be sized to enable access for inspection, testing and maintenance as may be required.

5.5.3 Construction Diversion Works

Construction diversion works need to be designed to safely discharge a flood size to a standard in keeping with modern international practice and appropriate minimisation of overtopping risk. The required construction flood size is smaller than required of the permanent spillway as the duration of exposure to flood risk (the construction period) is shorter than the overall life of the dam. The construction flood standard can also potentially vary during the construction period, as the consequences of a potential failure increase as the dam height (and potential flood impoundment) increases. Selection of the design construction flood standard will be undertaken in a future design stage, as it would not significantly impact high-level cost estimates for current purposes.

A conventional construction diversion arrangement for construction of an earth dam would include the following elements:

- > An upstream cofferdam, being an earth embankment construction of several metres height sufficient to protect the permanent works taking place downstream.
- > A temporary diversion conduit, comprising either a culvert (or culverts) excavated or built onto in-situ dam foundation materials, or a tunnel excavated through an abutment to the side of the main dam construction. The culvert needs suitable intake and outlet structures to prevent erosion damage and be designed to safely carry the construction flood size.
- > A downstream cofferdam to protect the permanent works against high downstream water levels that may occur during diversion operation (or natural stream flows downstream).

It is important that the construction diversion facilities, and their combination with any permanent outlet works, are planned and designed to allow controlled and staged reservoir filling on completion of the works. This typically requires reservoir inflows to be regulated during the filling process.

Equally important during this phase will be providing for continuous residual flow release downstream during the dam completion and reservoir filling stages, especially when transitioning between temporary and permanent water release systems.

5.6 WATER HARVESTING

5.6.1 Introduction

While the available 1980's reporting identified a preferred reservoir volume some 3 times larger than the natural annual catchment inflows assumed to be available at the time, neither report discussed the opportunity of harvesting water from the Waipaoa River to augment natural inflows to the reservoir (refer to Section 3.1.3 for Waipaoa River catchment information). This may have been partly attributable to the KRTA work considering a range of long-term conjunctive water supplies (as opposed to just the one dam scheme). For example, Section 12.7 of KRTA (1984) noted that "*the relatively large storage capacity [of Pouarua Dam] provides flexibility to overcome extreme drought conditions*".

This rationale is flawed in consideration of an individual dam, as recovery from any 2-3 dry year period could (statistically) take the same length of time to recover from – leaving the following years potentially with less than the desired annual water supply. This means the requirements of water users for high-90's reliability could not be met with such a concept. A long-term water balance view is required to obtain any modern agricultural concept of required reliability.

Section 14.4 of KRTA (1984) does briefly mention the possibility to pump water from the river. However, this is direct to a treatment plant and not to the reservoir. This aspect was therefore not initially considered in the scoping for the current study and was first addressed after the scope, timing and budget parameters of the current study had been established.

Water harvesting to the Pouarua Dam (as considered in this report) is therefore an innovation not previously considered. As is outlined in the following sections, it is an essential ingredient of the Pouarua Dam concept.

5.6.2 Reservoir Water Balance Requirements

This section picks up from the assessment of stored water available from natural catchment inflows only in Section 3.5 to assess harvested water requirements. Table 15 identifies the additional water volumes required for annual reservoir refill at the required dry season coverage levels, for the range of dam heights studied.

As noted in Section 3.5, for current purposes, dry years were assessed based on their probability of exceedance for the 90%, 95% and 98% exceedance levels.

Table 15: Harvested water required for annual storage refill for various dam sizes

			Mean	90%	95%	98%
Natural inflows (Mm ³ /year)			8.30	4.62	3.63	3.22
Dam Height (m)	NTWL (RL, masl)	Live Storage (Mm ³)	Harvested volume required (Mm ³ per year)			
19	45	2.19	-	-	-	-
24	50	6.70	-	2.09	3.07	3.48
29	55	14.43	6.09	9.81	10.80	11.21
34	60	25.09	16.76	20.47	21.46	21.87
39	65	38.60	30.27	33.99	34.98	35.39

The above table illustrates that any dam height above 24 m (NTWL 50m) will require water to be harvested if annual refill is to be reliably achieved with acceptable dry season resilience.

For the smallest dam under evaluation (NTWL 50 m) to be worth considering without water harvesting, it would need to be accepted that the reservoir would have a 20% - 30% chance of not refilling in any one year, or alternatively that only 3-4 Mm³ of water was required annually. This could be considered, for example, if water demand over the initial years was able to be met with the small available storage, and provision made in the design and construction for expanding either or both the dam and the harvesting system in future as demand grows.

For this approach to be valid, it would also require the initial economics of the smaller dam to be acceptable. This aspect is further discussed in Section 5.8.

5.6.3 Harvested Water Availability

5.6.3.1 Water source

The Waipaoa River A allocation block is fully allocated: it is assumed that no water from this block is available for storage refill.¹³ Water is available for harvesting from the Waipaoa River B allocation block, subject to securing resource consent to take this water (refer to Section 4.3.4.1). This allocation block is generally not considered sufficiently reliable to be a run-of-river source for irrigation and therefore there is currently allocation remaining.

¹³ If current A block water users are supplied with stored water from the scheme, their A block water may be available for winter storage refill. This is a potential upside for the scheme's hydrological feasibility.

In the Regional Water Assessment for GDC, Alexander, et al. (2023) found the following in relation to Waipaoa B block water:

- > Over June – October, surface water availability is typically at or close to 100%, although during high flow periods it may not be possible or desirable to take sediment-laden water.¹⁴
- > Availability is typically lowest in January and February. Average supply security for the Waipaoa River (both allocation blocks) over this period is ~70%.
- > Future water availability is likely to decrease for under an RCP6.0 future climate scenario.

Figure 42 shows that lower river flows over summer means average reliability drops to ~70% across the Waipaoa allocation blocks, with some days where takes are fully restricted. June – October supply is close to 100% reliability as flows rarely drop below the cease-take limits.

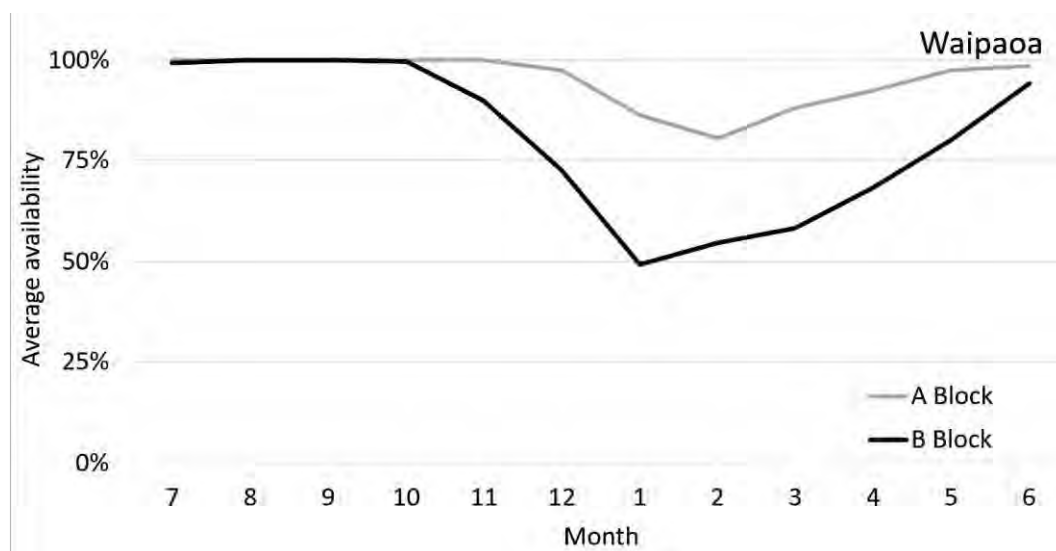


Figure 42: Average monthly availability for Waipaoa A and B allocation blocks (from Alexander, et al., 2023).

5.6.3.2 B Block water

The Waipaoa B block allocation limit is 2,000 L/s. With 745.08 L/s currently allocated (based on email from GDC), up to 1,254.92 L/s is available.

¹⁴ Note that sediment loads have not been considered in the availability assessment. Further more detailed work on storage dynamics may need to consider a high flow cut-off.

To assess the seasonal and long-term variability of a potential supply for water harvesting, we have treated availability of unallocated Waipaoa B block water as a percentage (62.746%) of the total available allocation. This means availability scales proportionally to availability of Waipaoa B block, as in **Figure 43** – i.e. all allocations within the B block are assumed to be subject to equal restrictions; there is no “stacking” within the allocation block. **Figure 43** indicates that on average B block water is 100% available (1,254.92 L/s available for take) 76% of the time across the modelling period, partially available (between 0 L/s and 1,255 L/s available for take) 9% of the time, and unavailable (0 L/s available for take) 15% of the time.

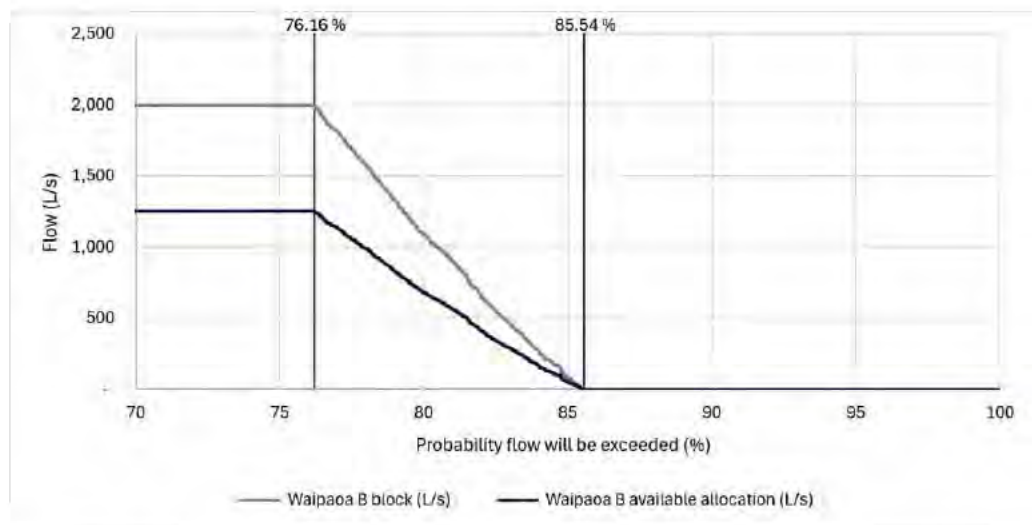


Figure 43: Flow duration curves of available allocation for the whole Waipaoa B block (blue) and for the unallocated portion (orange), with the unallocated portion being equivalent to 62.746% of available allocation. Note all values $\leq 70\%$ are identical.

5.6.3.3 Current allocation rules

Table 16 summarises the Waipaoa River surface water allocation rules. The cease-take flow is the flow at which abstraction from an allocation block must cease. The cease-take flow plus the allocation limit is the flow at which partial restrictions are triggered.

Table 16: Waipaoa River surface water allocation rules (consistent with the TRMP)

Block	Cease-take flow, L/s	Allocation limit, L/s
A block	1,300	2,000
B block	4,000	2,000

5.6.3.4 Potential future allocations accounting for minimum flow changes

GDC have advised that cease take flows are likely to increase in the future; the exact future flows are not known at present. This would mean that takes from the Waipaoa River would need to cease at higher flows (i.e. sooner, and for longer) than they do at present. This does not reduce the size of the allocation block but will reduce the reliability of supply. We have considered the impact of the cease-take flows in **Table 17** on water availability – i.e. a range of scenarios. Our understanding is that both the A and B block will move up by an equal amount, maintaining the gap between the two allocation blocks.

Table 17¹⁵: Waipaoa River allocation block current and potential future cease-take flows. All values are L/s.

Block	Current	Future lower	Future upper
A block	1,300	2,000	2,800
B block	4,000	4,700	5,500

Climate change may also have an impact on future water availability. Under climate change (based on IPCC-5) Collins, et al. (2018) predicted a multi-model median change in MALF of -8% to mid-century (2050) for the Waipaoa River. We have specifically considered the impact of climate change on water availability, but including a conservatively high future minimum flow can be considered a proxy for this.

5.6.3.5 Modelled water availability

We modelled unallocated Waipaoa B block water availability (62.746% total availability) on a daily basis for a 30-year period from the 1992/93 to 2021/22 water year inclusive. Each water year¹⁶ runs from 1st July to 30th June.

Figure 44 shows Waipaoa B block availability per water year under each cease-take flow iteration, relative to how much water could be taken if allocation wasn't restricted by Waipaoa River flows. **Figure 44** shows that increasing the cease-take flow decreases the availability, as expected.

¹⁵ The future lower and upper values in this table reflect the range being assessed by the Freshwater Advisory Group.

¹⁶ Using a water year, or hydrological year, as the basis of analysis and reporting on water supply and demand avoids splitting an irrigation season into two parts, as would be the case if calendar years were used.

Under current cease-take flows, Waipaoa B block has an average availability of 81%. This decreases to 77% with future lower cease-take flows, and to 74% with future upper cease-take flows.

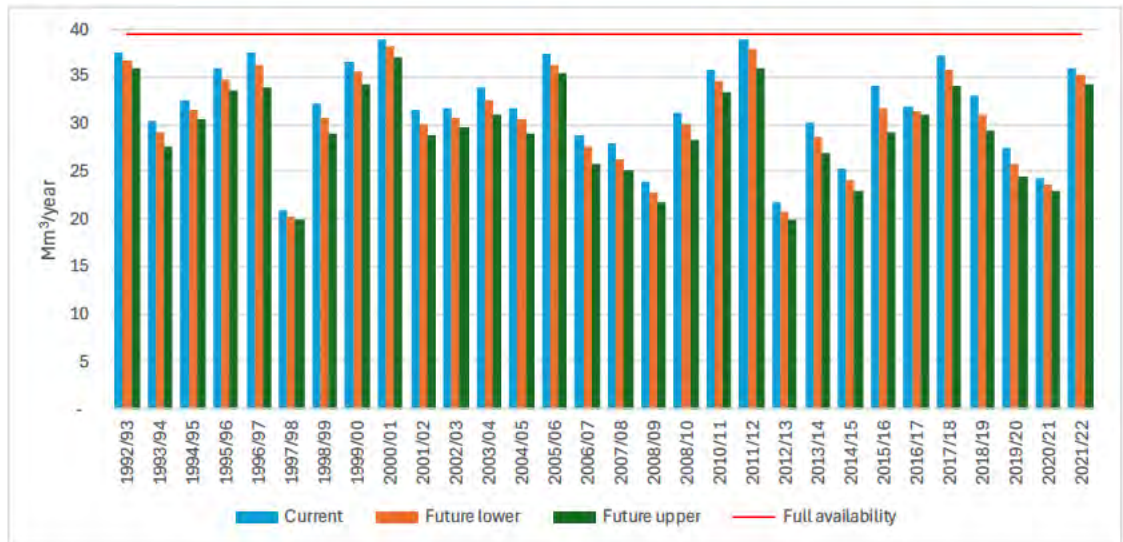


Figure 44: Waipaoa B block annual availability as Mm³/year based on Table 17 cease-take flows. Full availability assumes 100% of unallocated Waipaoa B block water is available. Data is presented relative to water years (1 July to 30 June). Full availability assumes 100% of unallocated Waipaoa B block water is available.

5.6.3.6 Seasonal variation

Figure 45 shows average Waipaoa B block volumetric availability per month under each cease-take flow iteration, relative to how much water could be taken if allocation wasn't restricted by low river flow (note the monthly unrestricted volume fluctuates with the number of days in the month). **Figure 46** shows the same data as a percentage of available allocation. This shows average availability in June exceeds 90%, and in July through October, it is at or approaching 100%. Average monthly availability decreases to a minimum in January. Current average January availability is 49% across the modelling period. The future upper cease-take flow reduces this to 39%.

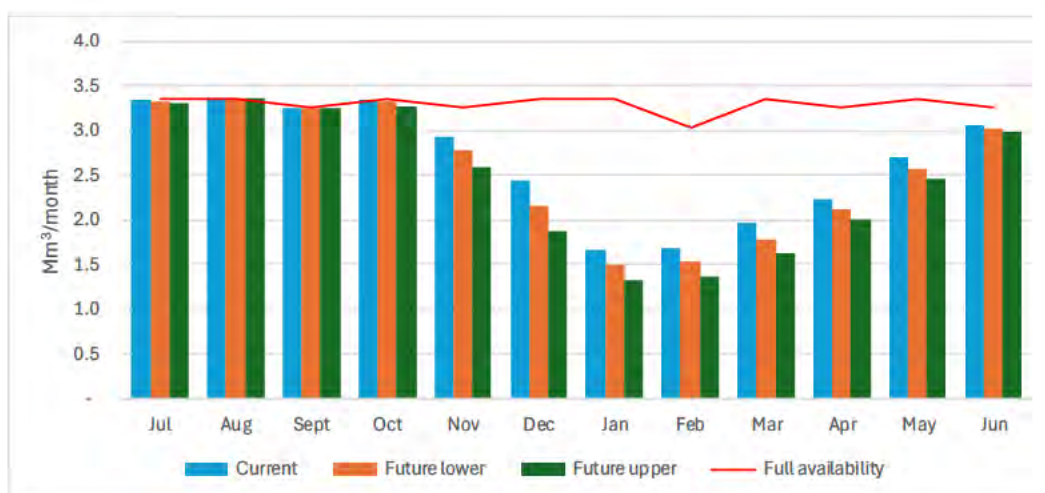


Figure 45: Waipaoa B block average monthly availability as Mm³/month based on Table 17 cease-take flows. Full availability assumes 100% of unallocated Waipaoa B block water is available.

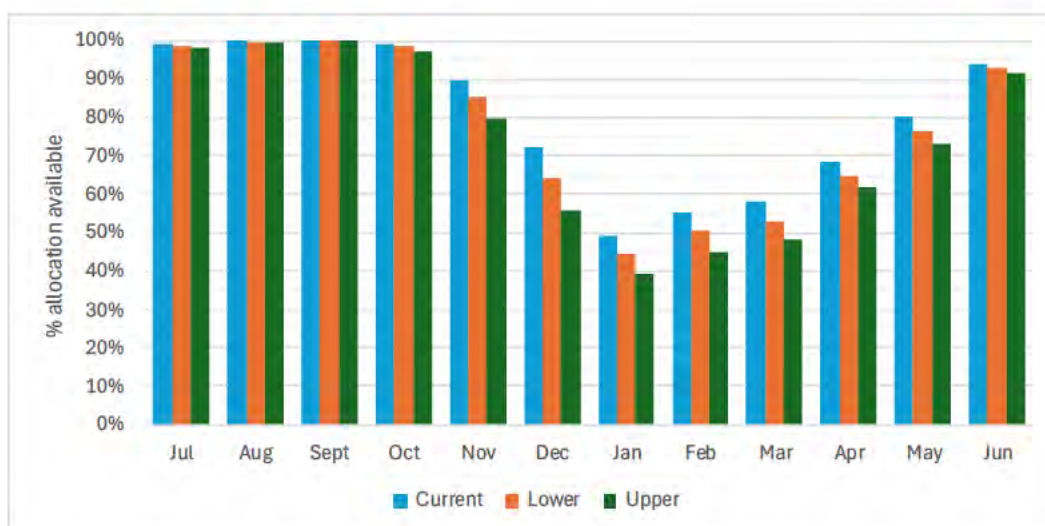


Figure 46: Waipaoa B block average monthly availability as a percentage based on Table 17 cease-take flows. Full availability assumes 100% of unallocated Waipaoa B block water is available.

Table 18 shows the average seasonal water availability. This shows Waipaoa B block availability in summer and autumn is much lower than in winter and spring.

Table 18: Waipaoa B block average seasonal water availability based on Table 17 cease-take flows.

Season	Current		Future lower		Future upper	
	%	Mm ³	%	Mm ³	%	Mm ³
Winter	98%	9.7	97%	9.7	97%	9.6
Spring	96%	9.5	95%	9.3	92%	9.1
Summer	59%	1.0	53%	0.9	47%	0.8
Autumn	69%	1.4	65%	1.3	61%	1.3

5.6.3.7 Long-term variation (mean versus dry years)

Figure 47 shows annual Waipaoa B block availability per water year under each cease-take flow iteration relative to full availability, and average annual availability under each cease-take flow. This shows the following water years have:

- > Below average availability: 1997/98, 2006/07 to 2008/09, 2012/13, 2014/15, 2019/20, and 2020/21.
- > Average availability: 1993/94, 1994/95, 1997/98, 1998/99, 2001/02 to 2004/05, 2009/10, 2013/14, 2015/16, 2016/17, 2018/19.
- > Above average availability: 1992/93, 1995/96, 1996/97, 1999/00, 2000/01, 2005/06, 2010/11, 2011/12, 2017/18, 2021/22.

Over the period modelled, the 1997/98 water year has the lowest Waipaoa B availability under all cease-take flows. With current cease-take flows, 2011/12 has the greatest availability and with future lower and upper cease-take flows 2000/01 has the greatest.

While there is annual variability in the volume of Waipaoa B block water available for harvesting, on average there is sufficient water to refill a dam with NTWL 60 - 65 m using the 1,255 l/s of B block water available for allocation, under both current and assumed future minimum flow rules.

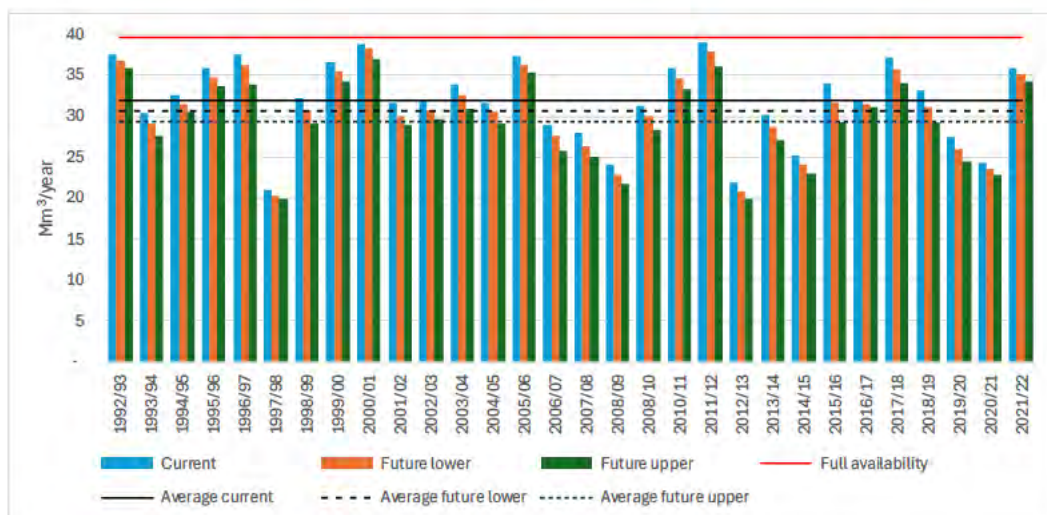


Figure 47: Waipaoa B block annual availability as Mm³/year based on Table 17 cease-take flows. Full availability assumes 100% of unallocated Waipaoa B block water is available. Data is presented relative to water years (1 July to 30 June). Full availability assumes 100% of unallocated Waipaoa B block water is available.

5.6.4 Water Supply Infrastructure Requirements

Water harvesting infrastructure to pump and deliver additional water from the Waipaoa River to the reservoir would require to have a capacity of between 200 L/s and the maximum allowable of 1,255 L/s¹⁷ depending on the finally selected reservoir storage and reliability levels required to meet a given demand. The harvesting system capacities adopted for each dam height evaluated – in terms of its NTWL, are given in Table 19.

Table 19: Water harvesting system estimated capacities for range of dam sizes studied.

NTWL (RL, masl)	50	55	60	65
Assumed rated system capacity (L/s)	200	600	1,200	1,255

¹⁷ 1,000 L/s = 1.0 m³/s (or cumec).

The route for the water harvesting infrastructure has not been accurately defined at this level of study. There are at least two options that should be retained for final design:

1. The shortest feasible route from the Waipaoa River to the site, which would partly be along the natural drainage path (valley floor) of the Pouarua Stream, but would cross a low saddle (requiring a deep excavation), with an overall distance of some 3.5 km to the preferred dam site. This would be similar to the alignment shown on dwg. 12.1a of KRTA (1984), or perhaps slightly shorter as the treatment plant and pumping station shown in the KRTA concept are not included in the present study.
2. A longer route that follows the Pouarua Stream more closely with ground level close to the required pipe grade, thus avoiding the deep cut, but involving some 1km (approx.) of additional pipeline.

Either of these alignments could be extended by a further 1km (approx.) to connect into the existing Tangihanga Farm Pond, if this was found to be a more cost-effective solution in consideration of the wider distribution system. This latter aspect is further discussed in Section 6.6.1.

The main components of a typically envisaged system would be as follows:

- > Pump station at the Waipaoa River with associated pump sets and valves in a pumphouse building, along with associated power supplies and control equipment. A potential option was viewed during the August 2025 site inspection where gallery-type systems have been installed already on the Waipaoa for local irrigation water supplies. Each gallery was understood to be capable of approximately 100 L/s, and such systems could be constructed in a modular setup to expand if/as required.
- > A rising main from the pump station to the dam site, generally buried where possible with either pipe-bridge or inverted siphon sections for stream crossings. The pressure rating would be within the capability of HDPE pipework. However, an assessment accounting for transient conditions will be required in a future stage.
- > A discharge system at the dam that can be safely connected into the reservoir to operate over the full range of reservoir levels. Different types of systems are potentially available, with options including a floating boom system accessible at (or near) dam crest level, or a low-level conduit run in adjacent to the reservoir outlet pipework.

Sizing of the rising main pipework will depend on the capacity selected and should be optimised in future design stages.

Other considerations or options that can be considered in terms of the functionality of the water harvesting system include the following:

- > For a low-level inlet arrangement, if the rising main pipework is separate to the outlet pipework this may require the outlet works culvert or tunnel to be sized slightly larger to accommodate the additional conduit.
- > Alternatively, it may be cost-effective to use a common pipeline for both inlet and outlet functions, either locally at the dam or over the entire length of the rising main. As a common pipeline could only flow in one direction at a time, viability would depend on the timing requirements of both harvesting and distribution systems and the overall volumes of water to be transferred in any given direction.
- > The water harvesting pipework could be arranged with a connection to a piped distribution system such that water could be directed from the Waipaoa pump station to either the dam or the distribution system directly (or both), as well as a gravity outlet from the dam to the distribution system.

As noted above, these aspects are discussed further in Section 6.6.1, and will influence the final preferred arrangements for a water harvesting system.

5.7 PRELIMINARY COST ESTIMATES – DAM AND WATER HARVESTING SUPPLY

5.7.1 Basis of Estimates

This section presents a high-level cost estimate for the dam and water supply infrastructure elements of the Scheme. The purposes of the estimate are mainly as follows:

- > To enable a screening assessment to be made between different dam and storage options to better direct the next stages of study, and
- > To provide information for WPT when progressing a decision on whether to proceed further with the scheme.

For these purposes this Section 5.7 does not include the distribution infrastructure. Cost estimates and economic comparisons for the entire scheme are covered separately in the Executive Summary.

An estimate for the water harvesting system was made separately to the dams and reservoir estimate so that comparisons with or without water harvesting could be made. This approach was also required as the basis for estimating harvesting system cost was less developed than for the dam.

The level of cost estimation is based on guidance provided in AACE Practice Note 69R-12 (Hydropower Industry) (Table 20).¹⁸ This Note is used as it is the most applicable of the series to large dams. The table summarises the characteristics of five estimate classes. The maturity level of a project's definition is the primary characteristic determining the Estimate Class. Although the maturity is roughly related to a percentage of complete definition, it is the maturity that determines the estimate class, not the percentage.

The assessment of cost is for a new structure with minimal design inputs to concept screening level and therefore has an Estimate Class of 5. This methodology for developing of a cost estimate is considered appropriate in meeting the scheme requirements for a cost estimate with an accuracy within the ranges indicated in **Table 20**.

Table 20: Estimate Classes from AACE Practice Note 69R-12

Estimate Class	Maturity Level of Project Definition Deliverables% of complete	End Usage Typical purpose of estimate	Methodology Typical estimating method	Expected Accuracy Range Typical variation in low and high ranges [a]
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Notes: [a] The state of technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope

¹⁸ AACE Recommended Practice 69-R12: Cost Estimate Classification System – As Applied in Engineering, Procurement, And Construction for The Hydropower Industry, Jan 2013

Expected accuracy ranges for each phase can also be visualised with reference to **Figure 48** below, also taken from AACE 69R-12.

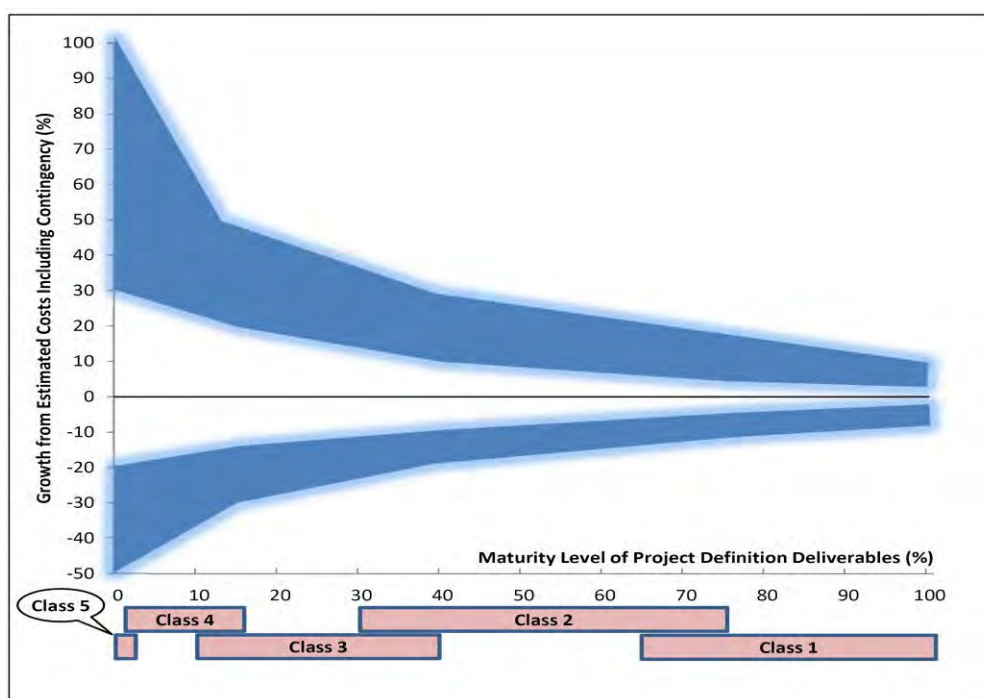


Figure 48: Maturity Level of Project Definition Deliverables

5.7.2 Dam and Reservoir Estimate

As the dam concept was developed based on a specific dam location with an assumed dam type, zoned cross section and material characteristics, broad quantities were able to be derived for bulk work items. The estimate for the dam and reservoir was therefore made on a schedule of quantities basis with quantities multiplied by all-in unit rates for all-in or bulk work items. In this way, the entire project was defined under some 25–30 line-items reflecting the major works components under the following main headings:

- > Main Dam Embankment.
- > Temporary Diversion Works.
- > Outlet Works.
- > Spillway.
- > Reservoir Works (clearance and surface works).
- > Site Access and General Works.
- > Unscheduled Items (i.e. a 'placeholder' for smaller items not captured within the above main components).

Dam quantities were taken off for the four dam heights identified earlier with NTWL of RL50m, 55 m, 60 m and 65 m. Other items not able to be quantified by material were estimated based on database information held by Damwatch for similar recent projects and structures and scaled to the required capacity or size accordingly. These items included the spillway, outlet works, temporary diversion works, reservoir clearance and stabilisation, and site access/general works.

Rates for direct construction costs used for the study were all-in rates, adapted from database information held by Damwatch and adjusted for inflation to the year 2026. The rates are intended to reflect civil infrastructure costs and contracting conditions presently observed in New Zealand, with construction assumed to be executed by a 'Tier 1' contractor.

Preliminary and General (P&G) costs were added at 30% of the direct construction works costs to account for contractor's on- and off-site overheads, margin, site mobilisation, insurances and bonds, and other management activities such as environmental, QA and traffic management.

Project management, planning and engineering costs were added at an overall rate of 18% of the total construction cost. These allow for investigations and engineering, planning and consenting, other project management and implementation costs, and construction monitoring activities.

Contingency has been added at 30% of the total of the above elements. The term 'contingency' should be treated with caution here, as a true contingency should reflect an actual assessment of risks based on the level of project maturity and overall technical, design and construction risk applicable to the scheme. The contingency applied in this case is not based on any such assessment and may be better thought of as an 'assumed provision for uncertainty'.

Costs Excluded:

- > **Land acquisition** costs have not been attempted to be estimated at this stage and are excluded from the estimate.
- > **Distribution system** costs are not included in the estimate.

As noted earlier, cost estimates and economic comparisons for the wider scheme inclusive of the distribution system are outlined in the Executive Summary.

5.7.3 Water Harvesting System Cost Estimate

Unlike the dam, the water harvesting system has had no engineering concept development, and thus a unit rates assessment based on quantities was not possible. Instead, the estimate was based on database information held by Damwatch for similar recent projects, scaled on a parametric basis to the assumed pumping capacity of the system applicable to the range of reservoir volumes being considered, and the assumed length of rising main.

The direct construction costs so derived were increased for P&G, planning and engineering at the same percentages of 25%, 15% and 25% respectively, recognising that the level of uncertainty and risk that may lead to increased cost is expected to be slightly less for conventional underground pipe systems than for a large dam. Pump operating (power supply) and maintenance costs have not been incorporated for purposes of the dam/reservoir costs in this Section but have been accounted for in the scheme-wide estimate allowing for the distribution system (refer to the Executive Summary).

The harvesting system capacities adopted for that purpose are those given in Table 19 (Section 5.6.4), ranging from 200 L/s to 1,255 L/s, the latter figure being the maximum allowable capacity for B-Block water take.

5.7.4 Preliminary Cost Estimate Results

The estimated costs for the dam and reservoir works and for the harvesting system are summarised in Table 21 and Table 22, for each dam size in terms of its NTWL. Pursuant to the Class 5 estimate parameters given in Table 20 above, the potential confidence limits on the estimate are -30% to +60% on the contingency-inclusive amounts. This range is between the two sets of limits in Table 20 for Class 5 and reflects that a degree of concept-level design has been undertaken.

Individual cost values are given in M NZD at assumed 2026 costs. The results are used as a basis for simplified economic comparisons in Section 5.8.

Table 21: Preliminary Cost Estimate Breakdown for Dam and Reservoir Works

Item	NTWL 50m	NTWL 55m	NTWL 60m	NTWL 65m
Construction Works	-	-	-	-
Main Dam Embankment	\$18.3	\$22.5	\$31.7	\$38.3
Temporary Diversion Works	\$3.2	\$3.2	\$3.4	\$3.2
Outlet Works	\$7.7	\$8.9	\$10.3	\$11.3

Item	NTWL 50m	NTWL 55m	NTWL 60m	NTWL 65m
Spillway	\$7.2	\$7.8	\$8.2	\$8.6
Reservoir (clearance & surface works)	\$0.8	\$0.9	\$1.0	\$1.1
Site Access and General Works	\$2.3	\$2.3	\$2.3	\$2.4
Unscheduled Items	\$3.9	\$4.6	\$5.7	\$6.5
Sub-total Direct Works	\$43.4	\$50.2	\$62.5	\$71.3
Preliminary and General Items	\$13.0	\$15.1	\$18.7	\$21.4
Total Construction Contract Works	\$56.5	\$65.3	\$81.2	\$92.7
Planning, Engineering and PM	\$10.2	\$11.8	\$14.6	\$16.7
TOTAL EXCL. CONTINGENCY	\$66.6	\$77.1	\$95.8	\$109.4
Contingency	\$20.0	\$23.1	\$28.8	\$32.8
TOTAL INCL. CONTINGENCY	\$86.6	\$100.2	\$124.6	\$142.2

Table 22: Preliminary Cost Estimate Breakdown for Water Harvesting System

Item	NTWL 50m	NTWL 55m	NTWL 60m	NTWL 65m
<i>System capacity in L/s</i>	<i>200</i>	<i>600</i>	<i>1,200</i>	<i>1,255</i>
Estimated overall cost - direct	\$1.8	\$3.9	\$7.0	\$7.3
Preliminary and General Items	\$0.4	\$1.0	\$1.8	\$1.8
Total Construction Contract Works	\$2.2	\$4.8	\$8.8	\$9.1
Planning, Engineering and PM	\$0.3	\$0.7	\$1.3	\$1.4
TOTAL EXCL. CONTINGENCY	\$2.5	\$5.5	\$10.1	\$10.4
Contingency	\$0.6	\$1.4	\$2.5	\$2.6
TOTAL INCL. CONTINGENCY	\$3.1	\$6.9	\$12.6	\$13.0

5.8 DAM HEIGHT AND STORAGE ECONOMIC COMPARISONS

5.8.1 Basis of Comparison

The selected range of dam heights and storages were compared on a simple cost per m³ (or unit cost) of water sold for each of the four dam sizes (or NTWLs) considered. The comparison was made for both with and without water harvesting scenarios. A similar approach was applied in the MWD (1985) comparison. This provides an indication of the scheme configuration within the range studied likely to provide the most cost-effective outcome. However, it does not in itself provide a gauge on economic viability.

To provide an indication of viability, the unit costs were subjected to a basic economic comparison using a simplified NPV approach whereby net future revenue benefits of the scheme over an assumed payback period are brought to a present value. This NPV can also be represented as a unit cost (\$/m³) which is then directly compared against the unit costs for each scheme configuration.

It should be highlighted that this analysis does not represent a rigorous economic assessment of the scheme, noting that the maturity level of the scheme concept and cost estimation are insufficient for this purpose. It is intended mainly as a tool for narrowing down the target options, and support for decisions about proceeding further with the scheme.

Unit Cost Basis

The unit cost used was the total capital cost (contingency included) of any given option as given in Section 5.7.4 above. As noted earlier, this is for the cost of the dam, its appurtenances and water harvesting infrastructure only. It does not include land acquisition or water distribution costs.

Assumptions for Water Revenues and NPV parameters

The following parameters were assumed for purposes of the simplified economic comparison:

- > Discount rate = 7%
- > Payback period = 30 years
- > Average water price = 65¢/m³

The above assumptions were developed with the assistance of WPT's financial advisor, who provided guidance on current water sales for irrigation use as well as the financial metrics, noting that:

- > The assumed water sales rate is intended as an all-in rate accounting for both variable and fixed components.
- > O&M costs are not explicitly accounted for, which for the dam itself should not be large in comparison to water revenues, but will be more significant for harvested water pumping costs and will need to be factored into future studies.
- > A discount rate as low as 5% could potentially be selected (which would improve the economic comparison), based on the expectation of community benefits and possibility of regional or national-level contributions. Other references (e.g. AgriBusiness Group's 2016 report on the cost of providing additional irrigation¹⁹) have used up to 8%.

5.8.2 Results of Comparison

The results of the unit cost comparison are given in **Table 23** for each dam size (or NTWL) considered, for both with and without water harvesting. The volume of water available for harvesting is based on the 'possible future' scenario, with a new more rigorous minimum flow regime in Waipaoa River assumed to be in place.

Table 23: Comparison of cost, storage and unit costs for each dam size with and without water harvesting

Description	Unit	NTWL 50m	NTWL 55m	NTWL 60m	NTWL 65m
TOTAL COSTS					
Dam works only	M\$	86.62	100.19	124.60	142.23
Harvesting works only	M\$	3.14	6.92	12.58	13.05
Total dam + harvesting	M\$	89.77	107.10	137.18	155.28
RESRVOIR STORAGE PARAMETERS					
Live storage available	Mm ³	6.70	14.43	25.09	38.60
Available water without harvesting	Mm ³	6.70	8.33	8.33	8.33
Available water with harvesting	Mm ³	6.70	14.43	25.09	31.43
UNIT COSTS \$ per m³ AVAILABLE WATER					
Unit cost dam only without harvesting	\$/m ³	12.92	12.02	14.95	17.07
Unit Cost dam with harvesting	\$/m ³	13.39	7.42	5.47	4.94

¹⁹ AgriBusiness Group (2016); *Calculation of the Cost of Providing Additional Irrigation Capability Through Damming in Gisborne District*, March 2016.

The unit costs can then be compared with the NPV of net water revenues over the assumed payback period. Based on the above parameters this was calculated to be **\$8.07/m³**, which can also be considered as the capitalised value of 1 m³ of available water. The above unit costs are compared against this capitalised unit value in **Figure 49**.

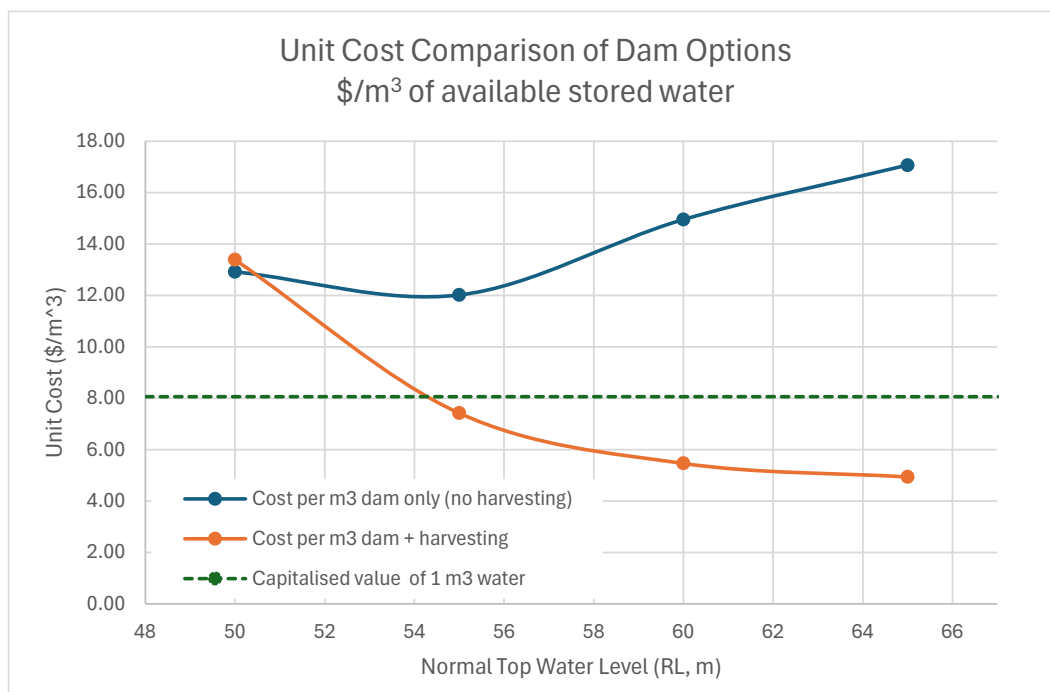


Figure 49: Comparison of unit costs with and without water harvesting against capitalised unit value of water

5.8.3 Key Conclusions of Economic Comparisons

The following key conclusions can be made about the above economic comparisons:

- > Unit dam costs falling below the capitalised unit value (green dashed line) indicate potential economic merit within the relatively coarse economic parameters assumed and confidence limits of the Class 5 estimate. Note however that distribution and land acquisition costs are not included in the above unit costs.
- > Ongoing studies should focus on the larger dam sizes with NTWL 60 m and above, up to about NTWL 65 m. This finding aligns well with the MWD (1985) findings and has been further guided by the water demand assessment in Section 6, which found demand requirements aligned well with the larger storage sizes investigated above. It can be seen from **Table 23** that a limit of B Block water availability will likely be reached at a dam with NTWL 62 m (approx.), however there may be other reasons to consider higher storage capacities other than just the availability of B Block water (e.g. climate change

resilience) that justify retaining flexibility for optimising within a range of dam heights and storages.

- > Water would need to be harvested for **all dam options** to achieve annual refill at any reasonable level of dry season resilience. Dam options without water harvesting are significantly less likely to be economically attractive.
- > Unit costs **with** harvesting included are substantially better than **without** harvesting because of the much larger volume of water available from the Waipaoa River B Block allocation compared to natural catchment inflows, combined with the relatively low incremental cost of delivering this additional water to the reservoir.
- > The question might then be asked – “why not just pump water straight into the distribution system and avoid the dam?” The reason is that the water harvesting benefit would not be able to be realised unless it is coupled with a large reservoir storage. A useful analogy may be to consider solar power generation with or without a large battery. It may of course be worthwhile making provision for direct supply of B Block water into the distribution system. However, pumping to storage will generally tend to provide the most benefit – until such point as the reservoir is full or spilling is anticipated.
- > The idea of scaling the scheme up over time has been considered (i.e. future proofing the design to allow the dam height to be increased in future as additional water harvesting is brought online). The purpose being to stage investment to match a potentially growing demand. Inspection of **Figure 49** suggests staged development is unlikely to be a cost-effective option, as the up-front cost of an initially smaller dam receiving natural catchment inflows only will likely be economically unattractive. Accordingly, staging is not further considered in this report.

5.9 SUMMARY OF FINDINGS

General Arrangement of Dam and Reservoir Water Supplies

The main elements of a preferred dam and reservoir size range have been evaluated to an initial technical and economic level. The option range is consistent with that studied in the 1980's with NTWL between RL 60 m and 65 m. The study outcomes have resulted in the following preferred general arrangement to take forward:

- > A zoned earth embankment dam with a height of 34m to 39m, crest length of 190m-230m (respectively), associated spillway and outlet works at the same dam site as identified in the 1980's.

- > Reservoir storage of 25.1 Mm³ to 38.6 Mm³ over the preferred range of dam heights, with a NTWL of RL 60 masl to RL 65 masl respectively. The reservoir is relatively large for the dam height with a surface area of 240 to 300 ha ²⁰ (at NTWL) extending up to 5.0 km upstream from the dam.
- > Water harvesting infrastructure to pump and deliver additional water from the Waipaoa River B Block allocation to the reservoir over a minimum distance of some 3.5km but potentially up to nearly 6 km, with capacity of between 500 L/s and 1,255 L/s ²¹ depending on the finally selected reservoir storage. The range in pipeline length depends on optimisation of the alignment and selection of most suitable river offtake and pumping locations.

The range of dam and storage parameters considered for the present study is given in the following table. The corresponding value for the range of three NTWL values reported in MWD (1985) is given in *(italics)*.

Table 24: Dam and storage parameters considered for the present study

NTWL (RL, masl)	Dam Height (m)	Crest Level (m)	Reservoir Area at NTWL (km ²)	Live Storage (Mm ³)
50	24	54	1.23	6.70
55	29 (25)	59 (57)	1.86	14.43 (13.7)
60	34 (30)	64 (62)	2.41	25.09 (24.2)
65	39 (35)	69 (67)	3.00	38.60 (37.1)

Dam Type Assessment

This 2025 updated scoping-level screening of viable dam types confirms previous findings that a zoned earth-fill dam with an impervious clay core remains the most viable option for advancement to subsequent project phases.

²⁰ 1 ha = 10,000 m² or 100 ha = 1 km².

²¹ 1,000 L/s = 1.0 m³/s (or cumec).

The key factors supporting selection of a zoned earth-fill embankment are:

- > **Foundation compatibility** – most tolerant of weak Papa foundations
- > **Material economics** – potential utilization of locally available Papa bedrock as clay core and Matokitoki gravels as filter and shoulder materials
- > **Seismic suitability** – superior earthquake resistance in a high seismic environment
- > **Constructability/technical risk** – most common dam type with relatively simple, well-established construction methods and performance history indicated

While the overall assessment aligns with earlier studies the proposed material zoning and design details differ to reflect advances in dam design since those studies, were completed. Consistent with previous studies, all proposed construction materials will require investigations and lab testing to confirm their suitability.

Hydrology and the Natural Catchment

This 2025 review utilised some 40 years of flow records now available from adjacent catchments to estimate runoff characteristics in the Pouarua Stream catchment – which to date remains ungauged. The updated annual inflow availability data are tabulated for different levels of dry season probability as follows:

Table 25: Updated annual inflow availability data for different levels of dry season probability

	Mean	90% Exc.	95% Exc.	98% Exc.
Annual stored volume in Mm ³	8.30	4.62	3.63	3.22
Year in which value most closely occurs	2017	1994	1998	2007

The mean annual volume is relatively consistent with the 1980's studies (7 – 10 Mm³) and amounts to about 1/3rd of the reservoir and dam size promoted by those studies (and the present study). Accordingly, the reservoir would not refill annually from natural catchment inflows in most years for the dam sizes considered.

Water harvesting from the available B Block allocation will therefore be required for any of the investigated dam sizes if annual reservoir refill is to be achieved with a reasonable level of dry season resilience.

Dam Design

An initial PIC assessment indicated that any of the dam heights considered would be classified as High PIC. This would put the Pouarua Dam in the highest hazard category under the NZSOLD Dam Safety Guidelines (2024), meaning it will require the maximum design levels for earthquake and flood protection under current New Zealand (and international) industry practice.

Water Available from Block B Allocation

There is enough water available from the B Block allocation to fully augment the natural catchment inflows for most of the reservoir sizes considered, to achieve annual reservoir refill at an acceptable level of dry season resilience. This applies up to reservoirs with NTWL of about RL 62 m, above which the reservoir would be able to fill from both harvested and natural sources in wetter years. Reservoir storage with NTWL up to RL 65 m would provide additional back-to-back dry year resilience, which may be a preferred outcome.

Preliminary Cost Estimates

Preliminary cost estimates were undertaken for the following main purposes:

- > To enable a screening assessment between different dam and storage options to better direct the next stages of study, and
- > To provide information to assist WPT progressing a decision on whether to proceed further with the scheme.

The accuracy of the cost estimate was consistent with this initial level of project maturity for a new structure with minimal design inputs to concept screening level. This is termed a Class 5 estimate (the most high-level on a scale of 1 to 5) based on the industry-recognised AACE Practice Note 69-R12 (hydropower industry).

The estimate covered the dam, its appurtenances (spillway, outlet works, etc) and water harvesting works, and included the construction contract works, all non-construction activities (planning/engineering/project management) and a contingency for cost uncertainty of 30%. It did not include land acquisition or distribution works costs.

The total estimated costs on this basis (i.e. including contingency) are given in the following table as separate items for the dam/reservoir works and the water harvesting works.

Table 26: Preliminary cost estimate for different sized dams. Estimate includes construction, non-construction (planning, engineering) and contingency costs.

Reservoir NTWL (RL, masl)	50	55	60	65
Water harvesting system capacity (L/s)	200	600	1,200	1,255
Dam and reservoir works cost (M\$)	86.6	100.2	124.6	142.2
Water harvesting works cost (M\$)	3.1	6.9	12.6	13.1

Preliminary Economic Comparisons

The selected range of dam heights and storages were compared on a simple cost per m³ (or unit cost) of water sold for each of the four dam sizes (or NTWLs), with and without water harvesting scenarios.

An indicator of economic viability was gained by using a simplified NPV approach whereby net future revenue benefits of the scheme (assumed at 65¢/m³) over an assumed payback period (30 years) are brought to a present value using an assumed discount rate of 7%.

The key outcomes and conclusions were as follows:

- > The larger dam sizes with NTWL 60 m up to about NTWL 65 m all indicated positively as having potential economic merit, provided water harvesting from the B Block allocation was included.
- > Water would need to be harvested for **all dam options** to achieve annual refill at any reasonable level of dry season resilience. Dam options without water harvesting were found to likely be economically unattractive.
- > Water harvesting would still need to be coupled with a large reservoir storage to make it worthwhile, as B Block water is not available on demand all the time – especially during summer when it is most needed.
- > The idea of scaling the scheme up over time to stage investment alongside growing demand is unlikely to be a cost-effective option, as the up-front cost of an initially smaller dam receiving natural catchment inflows only will likely be economically unattractive.

6. CONCEPT STAGE: WATER DEMAND

A range of options has been considered for supply-demand modelling:

- > Dam with NTWL 50 m, with catchment inflows only.
- > Dam with NTWL 50 m, with up to 200 l/s supplementary inflow harvested from the Waipaoa B Block.
- > Dam with NTWL 60 m, with up to 1255 l/s inflow harvested from the Waipaoa B Block.

Within each of the options, a range of variables have been considered, including the volume of storage reserved for municipal supply, likely changes to the Waipaoa River allocation rules, and the environmental flow release requirements downstream of the dam, and the level of supply reliability for new irrigation.

Based on the key findings of Section 5, the results in this section are focussed on the option of a dam with NTWL 60 m, with up to 1255 l/s inflow harvested from the Waipaoa B Block.

6.1 DEMAND FOR WATER STORAGE VOLUMES

We have considered three sources of demand for stored water:

1. To meet the shortfall between the Waipaoa A block available allocation and irrigation demand - i.e. “top-up” of existing supplies, which is likely to be increasingly necessary with future changes to water allocation rules.
2. To enable irrigation of high-value land-uses on currently unirrigated areas – i.e. land-use change and associated contribution to regional GDP, employment, etc. enabled by access to water.
3. To increase supply security for the GDC reticulated supply.

Consistent with the Regional Water Assessment project for GDC (Alexander, Calder-Steele, & Dark, 2023) we have used 1992/93-2021/22 water years (1 July to 30 June) as our modelling period. Alexander, et al. (2023) calculated 95% supply reliability for Waipaoa A block water and 81% for Waipaoa B block water based on data across the modelling period. We therefore aim to achieve 95% supply reliability as a baseline reliability level for new irrigation areas.

Note that at this stage of investigation we have not considered water demand or distribution at a property scale: this will need to be considered in more detail in future investigations, alongside engagement with potential water users.

6.2 DESCRIPTION OF DEMANDS

6.2.1 Waipaoa A block shortfall

This is the portion of the current Waipaoa A block irrigation demand that is unmet by the Waipaoa A block supply. The Waipaoa A block is generally considered a reliable supply of water; however there have been irrigation seasons such as 1997-98 and 2016-17 with significant supply restrictions. GDC has indicated that the minimum flow / cease-take flow for the A block will likely be raised in the short to medium term to protect instream habitat. However, there is uncertainty at this stage regarding the new flow value. Regardless of where the new cease-take flow is set, any increase will result in reduced supply reliability for existing water users.

We calculated daily Waipaoa A block irrigation demand based on the 2020/21 GDC crop type survey, irrigated area, and soil PAW as classified by Alexander, et al. (2023). We considered this demand against daily Waipaoa A block available allocation (with current cease take flows (**Table 17**)) to identify the demand that is unmet each day across the modelling period.

Figure 49 shows average monthly demand is greatest in January, with no shortfall in supply between April and August inclusive (i.e. supply meets or exceeds demand across this period).

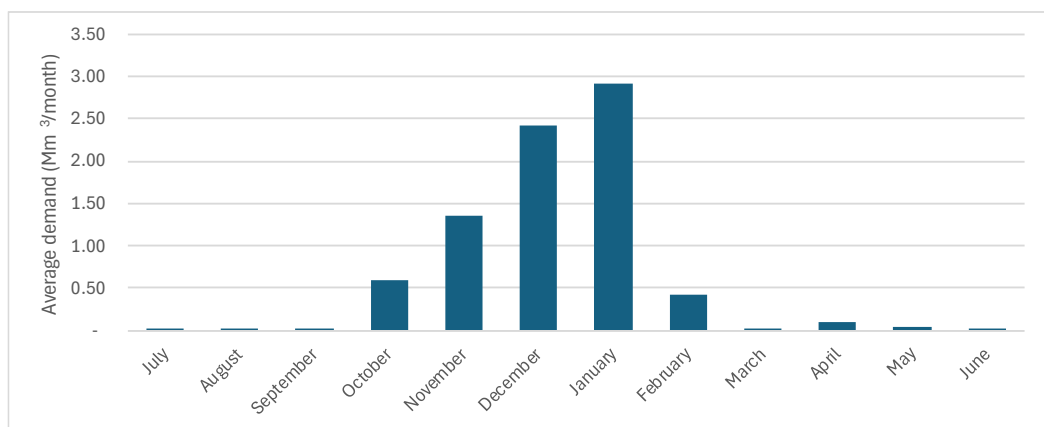


Figure 50: Average monthly Waipaoa A block shortfall irrigation demand

Figure 51 shows Waipaoa A block supply is inadequate to meet Waipaoa A block demand every year. The largest unmet demand is in the 1997/98 water year, which is also the year with the lowest availability (as in Section 5.6.3). The average unmet demand per water year is 7.9 Mm³ (of an average total demand of 8.6 Mm³).

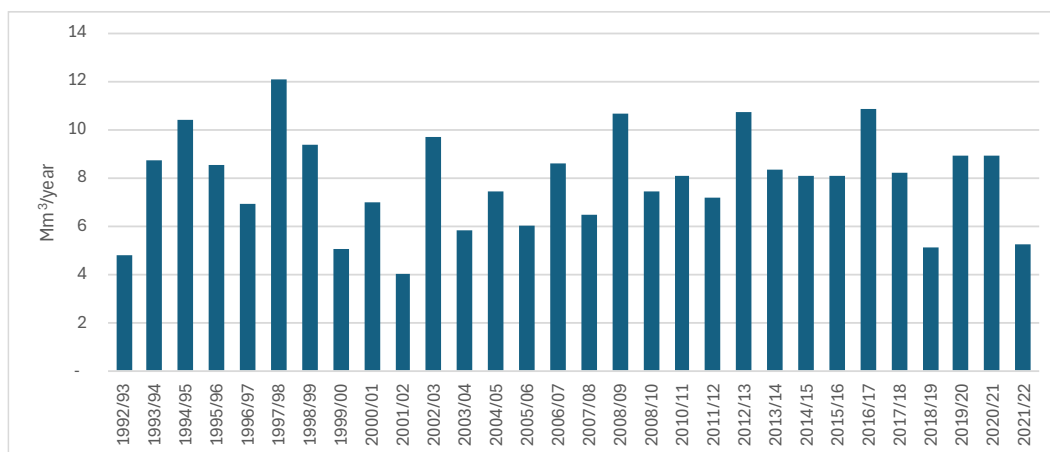


Figure 51: Total annual Waipaoa A block irrigation demand shortfall. Data is presented relative to water years (1 July to 30 June).

6.2.2 New irrigation area

This is the water needed to provide a new irrigation supply at 95% supply reliability to currently unirrigated areas within the potential Pouarua supply area (Appendix 4, maximum command area extent 11,222 ha).²² We calculated daily demand for irrigation over the 30 year period encompassing the 1992/93 -2021/22 water years based on soil PAW as classified by Alexander, et al. (2023) and modelled water requirements for likely crop types. We have assumed that there will be changes in crop type (from the current land uses) as irrigation conversions occur to ensure return on investment.

After trialling different combinations²³ of water demands for kiwifruit, apple, and vegetable production, we found that 100% vegetable had the highest demand, and 100% apple had the lowest. We adopted a baseline crop type combination²⁴ for demand modelling, which also represents the demand closest to the average across the combinations trialled.

The total area irrigated impacts demand, and the amount of demand impacts the supply reliability. To achieve 95% supply reliability the irrigated area will need to be adjusted to reflect changes in water supply.

²² This is the broad area topographically suited to irrigation and not currently irrigated that is able to be supplied from the dam without significant pumping. It may not be economically feasible to distribute water to this full area.

²³ Apple/vegetable/kiwi: 40/20/40, 50/-/50, 25/50/25, 100/-/-, -/100/-, -/-/100.

²⁴ 20% veg, 40% kiwifruit, 40% apples.

6.2.3 Municipal supply resilience

It is possible that the dam could be used to store water to supplement the GDC municipal reticulated supply to increase its resilience. The location of the storage is substantially closer to Gisborne city than GDC's existing impounding dams, which would reduce the risk of future pipeline failures such as occurred in 2023. Options to integrate water from the storage scheme into GDC's network are discussed further in Section 6.6.1.

Annual treated GDC reticulated supply ranges from 5.3 Mm³/year to 5.8 Mm³/year (Tonkin + Taylor, 2025). Tonkin + Taylor (on behalf of GDC) identified potential storage sites within the Waipaoa catchment based on agreed storage requirements of 3Mm³/year and 12 Mm³/year (Tonkin + Taylor, 2025). It is currently unclear what proportion of this volume was assumed to be for municipal supply.

We have investigated scenarios that include up to 12 Mm³ of the stored volume being held in reserve for municipal supply, i.e. approximately two years of storage.

Storing 3-12 Mm³ for reticulated supply buffering will mean less stored water available to meet irrigation demand.

6.3 APPROACH TO SUPPLY-DEMAND MODELLING

To determine the potential demand for stored water we have modelled the supply-demand balance and storage dynamics of the reservoir. This approach provides an estimate of the volume of water that can be reliably supplied from the reservoir, taking into account variation in supply and demand and inter-year effects such as the ability to refill following a dry year when storage is drawn down substantially.

We have considered two sources of supply:

1. **Catchment flows:** Land surface runoff within the Pouarua River catchment above the proposed dam site. This incorporates evaporation from storage and providing for 5.1 L/s environmental flows downstream of the dam (refer to Section 3.5 Catchment and Hydrology).
 - a. We have also considered the impact of providing for 173 L/s environmental flows (based on mean flow estimate for the dam site – i.e. a conservative upper limit to test sensitivity).
2. **Unallocated Waipaoa B block water:** The Waipaoa B block allocation limit is 2,000 L/s. With 745.08 L/s already allocated, up to 1,254.92 L/s is available (refer to Section 5.6 Water Harvesting). We have treated availability of unallocated Waipaoa B block

water as a percentage of the total available allocation (i.e. restrictions are applied to the whole B block equally).

- a. We also consider the impact of raising Waipaoa River cease-take flows by 1,500 L/s, with this resulting in an equal change to the A and B blocks.

We consider three sources of demand:

1. **Waipaoa A block shortfall:** The portion of Waipaoa A block irrigation demand that is unmet by the Waipaoa A block supply.
2. **New irrigation:** The water needed to irrigate unirrigated crops with 95% reliability within the potential Pouarua supply area (as defined in **Appendix 4** (11,222 ha).
3. **Reticulated supply:** Retaining water in the dam to supplement the GDC reticulated supply while enabling take to meet irrigation demand.

Figure 52 shows our approach to supply-demand modelling.

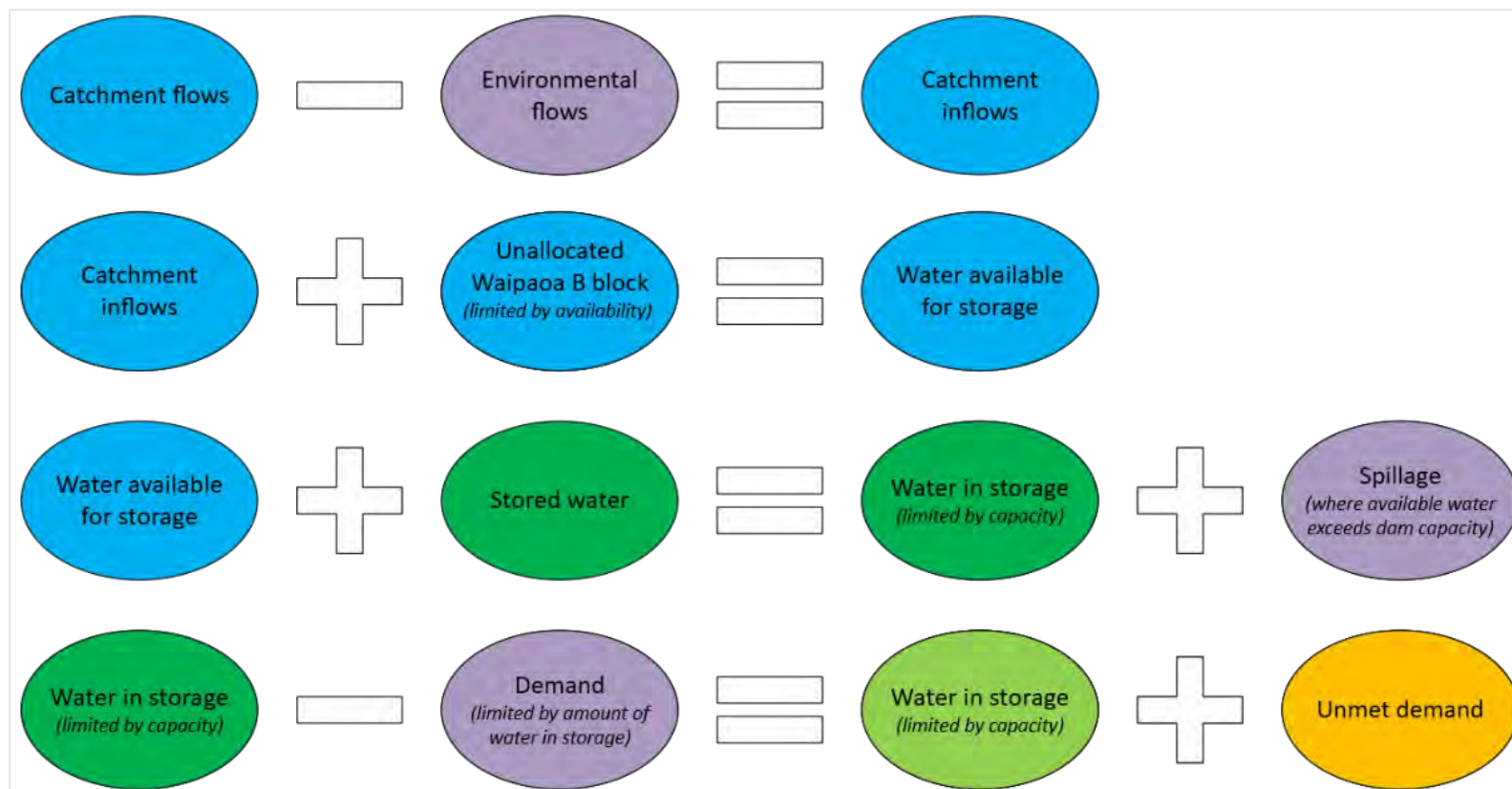


Figure 52: Supply-demand modelling approach. Blue are dam inflows, purple is water leaving the dam, green is water in the dam, and orange is unmet demand.

Consistent with Alexander, et al. (2023) we have used the 1992/93-2021/22 water years (1 July to 30 June) as our modelling period. Alexander, et al. (2023) calculated 95% supply availability for Waipaoa A block water and 81% supply availability for Waipaoa B block water based on data across the modelling period. We therefore aim to achieve at least a 95% supply reliability for new irrigated areas. There is often a non-linear relationship between supply reliability and storage requirements (for a given irrigated area) – i.e. beyond a certain point there is a diminishing return on providing additional storage and an economic feasibility limit is reached. We have investigated the impact of increasing the supply reliability up to 100% over the modelled period.

Baseline modelling parameters are defined in Table 27. We did not vary crop types as the proportions of the crops being considered did not substantially impact the results. Further investigations may need to consider the demand profile in more detail, factoring in indicative crop types for landowners interested in supply from the scheme.

Table 27: Baseline supply-demand modelling parameters.

	Parameter	Value	Unit
New irrigated area	Area cropped in apples	40	%
	Area cropped in kiwifruit	40	
	Area cropped in vegetables	20	
Allocation	Waipaoa A block	2,000	L/s
	Waipaoa B block	2,000	
	Waipaoa B block available allocation	1,255	

Table 28 shows the parameters that were kept fixed in supply-demand modelling, and **Table 29** shows the variable parameters (5.6.3 Water Availability). Along with assumed future changes to the Waipaoa River minimum flows, we have incorporated a higher environmental flow release requirement (based on mean flow at the dam site, rather than MALF) into the future allocation rules scenario.

Table 28: Supply-demand modelling parameters that were held constant.

	Catchment inflows and Waipaoa B block available allocation
Dam size (live storage)	25.1 Mm ³
Waipaoa B available allocation	1,255 L/s
Waipaoa A block allocation limit	2,000 L/s
Waipaoa B block allocation limit	2,000 L/s

* Assumes 5 m deep water

Table 29: Supply modelling variable parameters. All values are L/s.

Parameter	Baseline	Future upper limit
Waipaoa A block cease-take flow	1,300	2,800
Waipaoa B block cease-take flow	4,000	5,500
Environmental flow	5.1	173

The amount of Waipaoa A shortfall demand depends on Waipaoa River A block availability, so there are no additional demand modelling parameters beyond those in Section 6.2.1. To achieve 95% (or higher) supply reliability for new irrigation areas, the irrigated area was varied, so this was treated a variable demand modelling parameter. We also assessed the impact on ability to meet these irrigation demands with retention of water in the Pouarua dam to provide for municipal water supply buffering, using the range of volumes specified in Section 6.2.3.

6.4 SUPPLY-DEMAND MODELLING RESULTS

We performed the model simulations in

Table 30 and using the fixed variables in **Table 27** and **Table 29**. We also considered the impact of retaining storage to buffer municipal supply on the ability to meet irrigation demand. We present results by supply.

Table 30: Supply-demand modelling runs.

Supply	Demand	Variables				
		Variable grouping	A Block cease-take flow	B block cease-take flow	Environmental flow	Irrigated area
Catchment inflows + Waipaoa B block available allocation	Waipaoa A shortfall	Current	1,300 L/s	2,800 L/s	5.1 L/s	NA
		Assumed future	2,800 L/s	5,500 L/s	176 L/s	NA
	New irrigation area	Current	1,300 L/s	2,800 L/s	5.1 L/s	11,222 ha
		Assumed future	2,800 L/s	5,500 L/s	176 L/s	11,222 ha

Appendix 5 presents results per month/year.

This section contains results for the preferred NTWL 60 m dam option, with water harvested from the Waipaoa River B block taken into storage via a rising main pipeline.

Figure 53 shows annual supply (as catchment inflows and Waipaoa B block available allocation) ordered from smallest to largest. This shows inflows vary from 26.9 Mm³/year to 54.2 Mm³/year across the modelling period.



Figure 53: Annual supply based on catchment inflows and Waipaoa B block available allocation ordered from smallest supply (1997/98 water year) to largest supply (2005/06 water year).

Storage, inflows and releases over time

Figure 54 shows inflows and dam storage volume across the modelling period assuming no irrigation demand. The results presented are for the assumed future allocation rules; these are broadly similar to the results under the current allocation rules, but show the storage being operated over a greater range more often. The higher environmental flows and cease-take flows compared to the current allocation rules means the dam is full less often (73% of the time compared to 86%) but is never empty.

Figure 56 shows the impact on dam storage when introducing new irrigation demand with 95% reliability. This is equivalent to irrigating 100% of the new irrigation area or 11,222 ha. Figure 64 shows an increase in inflows (less water spilled). Modelling indicates that the dam would be at maximum capacity 13% of the time across the modelled period (25% under current rules), at minimum capacity 0.2% of the time (17 days, compared to 0.1% and 15 days under current rules), and there would be 410 days with unmet demand (181 days under current rules).

Figure 56 shows that at times stored water goes below the minimum operational level due to evaporation and environmental flows. Operational controls would be needed to prevent this occurring.

When the dam is at minimum capacity, there can be unmet demand, as shown in **Figure 57**. Where demand exceeds the maximum outflow rate, there can also be unmet demand.

Figure 58 shows the number of days per water year where there is unmet demand and Figure 59 shows the total unmet demand per water year.



Figure 54: Catchment inflows and Waipaoa B block available allocation to storage and total storage (assumed future allocation rules).

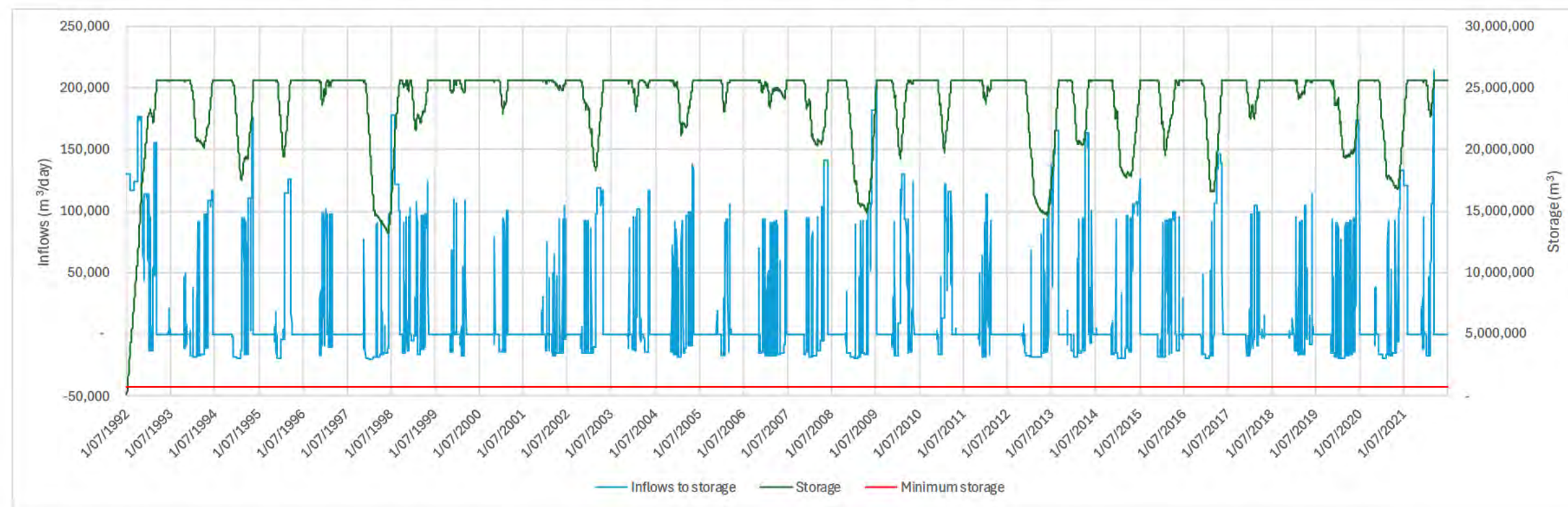


Figure 55: Catchment inflows and Waipaoa B block available allocation to storage and storage levels when addressing Waipaoa A shortfall demand (assumed future allocation rules).

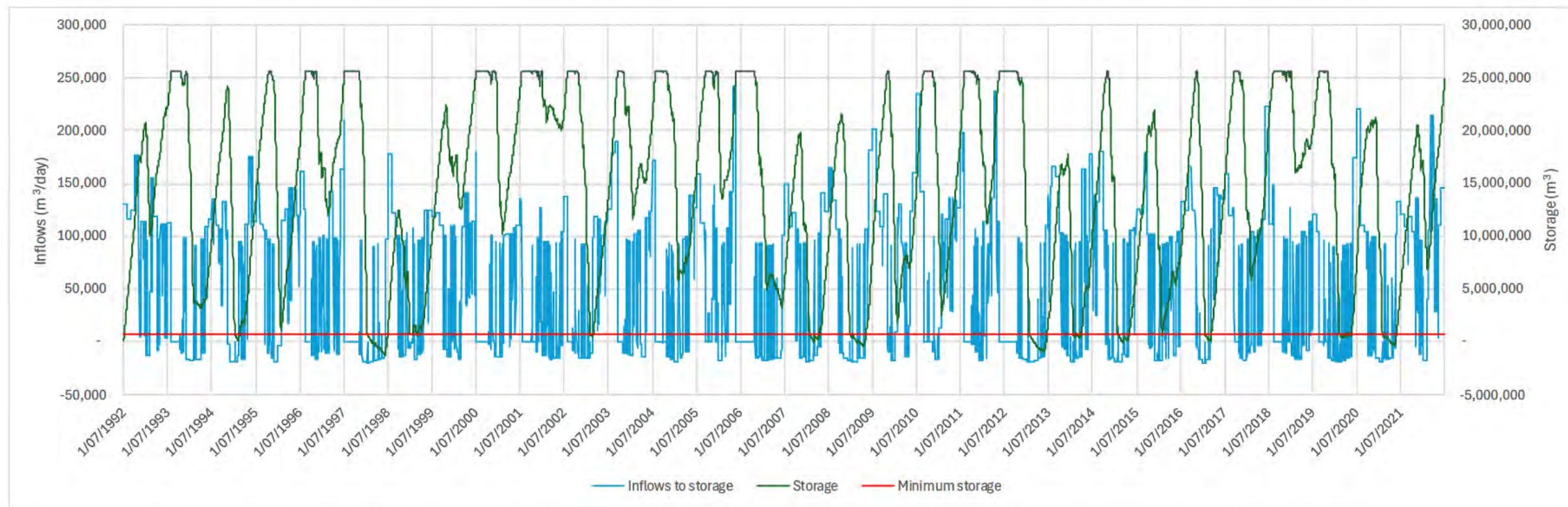


Figure 56: Catchment inflows and Waipaoa B block available allocation to storage and storage levels when providing for new irrigation demand at 95% reliability (assumed future allocation rules).

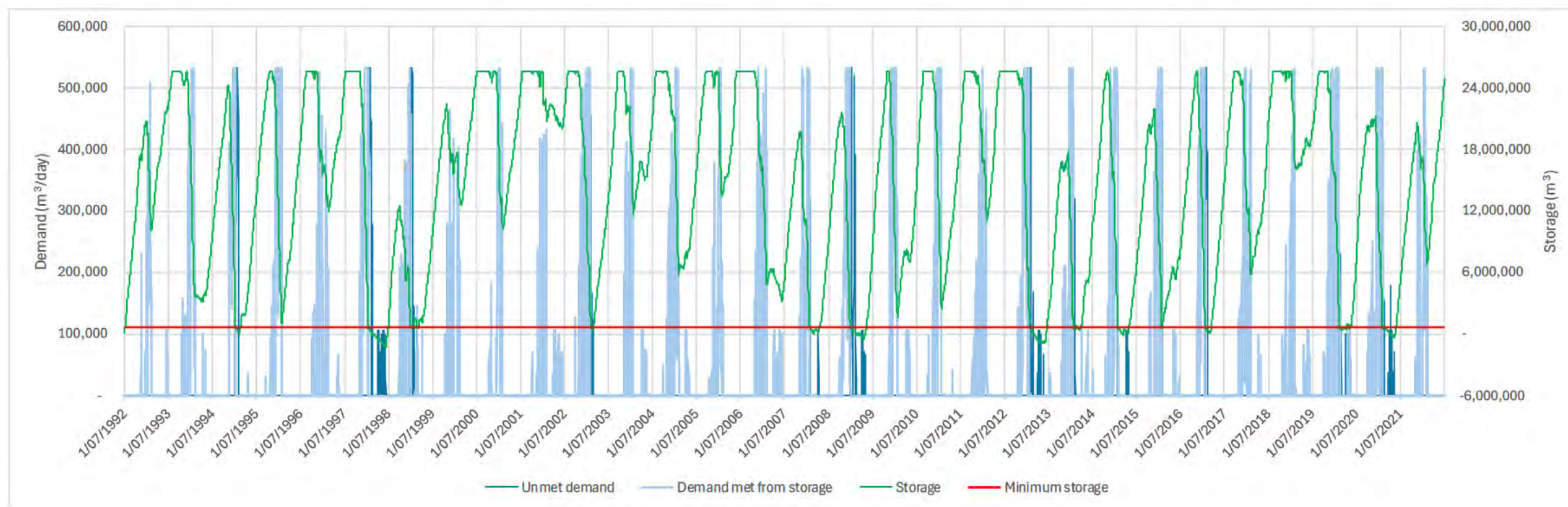


Figure 57: Met and unmet new irrigation demand relative to dam storage with catchment inflows and Waipaoa B block available allocation (assumed future allocation rules).

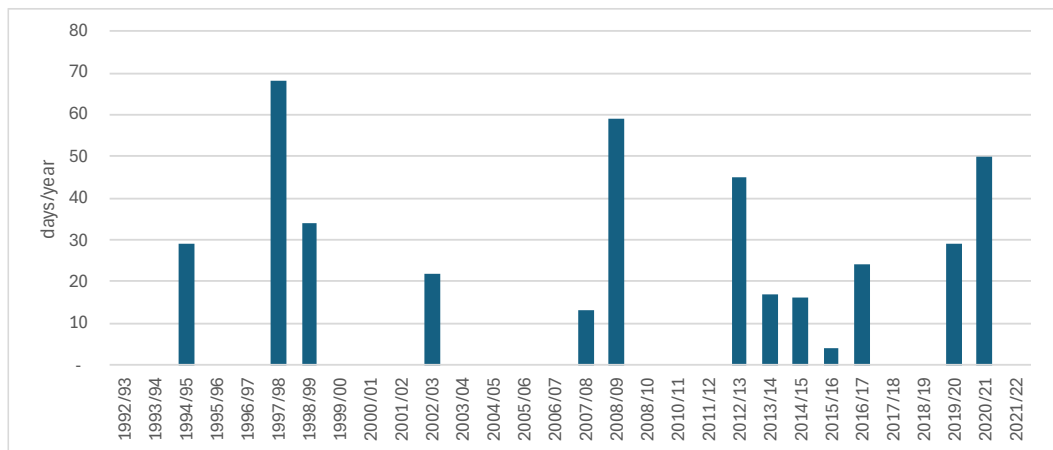


Figure 58: Number of days per water year where there is unmet new irrigation demand with catchment inflows and Waipaoa B block available allocation (assumed future allocation rules).

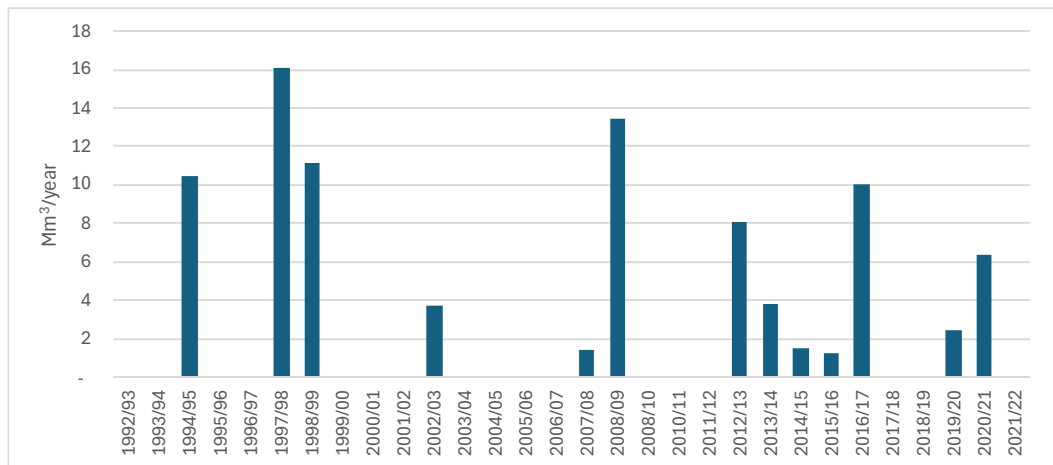


Figure 59: Total unmet new irrigation demand with catchment inflows and Waipaoa B block available allocation (assumed future allocation rules).

6.4.1 Impact of storage for reticulated supply

We have considered the impact of additional storage for reticulation supply buffering on the ability to meet irrigation demand. **Table 31** shows that storage for reticulation supply does not impact ability to meet Waipaoa A shortfall demand – i.e. it is possible for both irrigation and municipal demands to be met.

Table 31 shows that 100% of the new irrigation area can receive water at 95% reliability alongside provision of up to 5.8 Mm³ storage reserved for municipal supply (under both current and assumed future allocation rules) – i.e. at this level of supply reliability reserving storage for municipal supply does not substantially impact on the ability of the scheme to supply water for irrigation.

Table 31: Impact of storage for reticulated supply buffering on supply-demand based on catchment inflows and Waipaoa B block available allocation.

Scenario:		Current allocation rules			Assumed future allocation rules		
Storage reserved for municipal supply (Mm³):		0	5.8	12	0	5.8	12
New irrigated area to achieve 95% reliability	% new irrigation area	100*	100*	98.3	100*	98.8	85.3
	ha irrigated	11,222	11,222	11,031	11,222	11,087	9,572
Shortfall with new irrigation demand	Days with unmet demand	181	368	613	410	589	587
	Total (Mm³)	45	102	195	90	143	112
	Average per year (Mm³/year)	1.50	3.40	6.49	2.99	4.77	3.72

* Could supply more than 100% of the area at 95% reliability

6.4.2 Deficits experienced with 95% supply reliability

While we have selected 95% as a baseline reliability to model for new irrigation, it may be desirable to provide a higher level of supply reliability to support high-value land uses. This section illustrates the level of supply deficits that would be experienced at 95% supply reliability, and the following section explores the impact on the total irrigable area of providing higher reliability.

Figure 60 shows the proportions of new irrigation able to be met from direct run-of-river supply (the Waipaoa B block) and storage releases, and the remaining deficit. This is based on average annual supply reliability level of 95%, with the baseline modelling assumptions regarding allocation rules and storage.

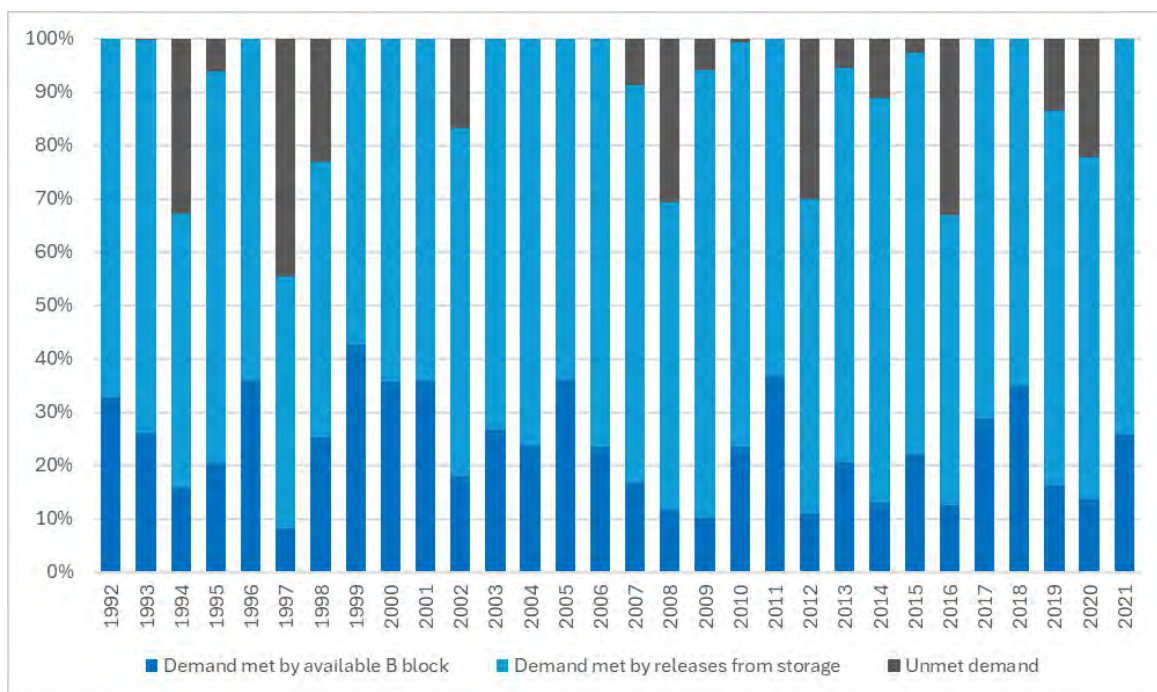


Figure 60: Annual demand met from run-of-river supply and storage, and unmet demand.

Out of the 30 years modelled, 13 years have no supply deficit – i.e. all irrigation demand was able to be supplied from a mix of direct run-of-river supply and releases from storage. On average 10% of demand is un-met at this reliability level²⁵. Ten years out of 30 have an annual deficit of more than 10% of annual demand, with the maximum deficit of 45% occurring in the 1997/98 irrigation season.

Figure 61 shows the performance of the storage in the 1997-98 irrigation season (the worst season of the period that has been modelled). The figure shows the stored volume, the demand met from B block water and storage respectively, and the remaining deficit after storage is depleted. In this case, the storage was full at the beginning of the irrigation season, some B block water was available throughout November and December and storage was fully depleted by early January.

²⁵ Note that this is different from supply reliability, as it does not consider times during the irrigation season when demand is zero.

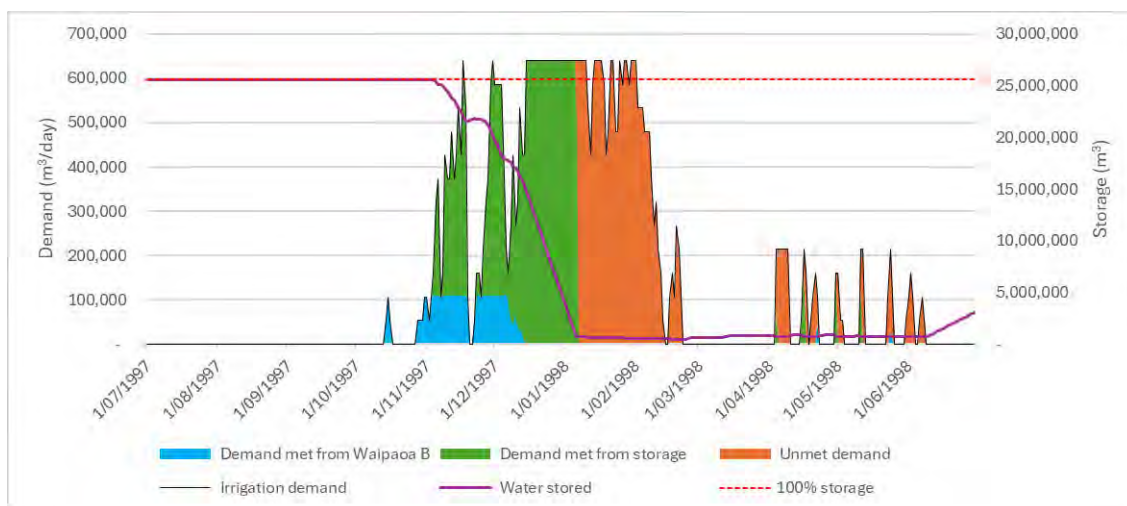


Figure 61: Storage performance for the 1997-98 irrigation season

The length of time without water in seasons such as 1997-98 may be unacceptable for high-value horticultural land uses, in which case an average reliability level of greater than 95% would be necessary. The implications of this are discussed in the following section.

6.4.3 Impact of higher supply reliability on irrigable area

We have modelled the impact of varying the average supply reliability target on the total area of new irrigation that can be supplied. **Figure 62** below shows the total area (hectares) of new irrigation able to be supplied from the NTWL 60 m dam (with different volumes reserved for municipal supply) when the supply reliability target is varied from 95% to 100%.²⁶

²⁶ i.e. no supply deficit over the period that was modelled. Modelling over a longer period or with different assumptions may result in less than 100% reliability.

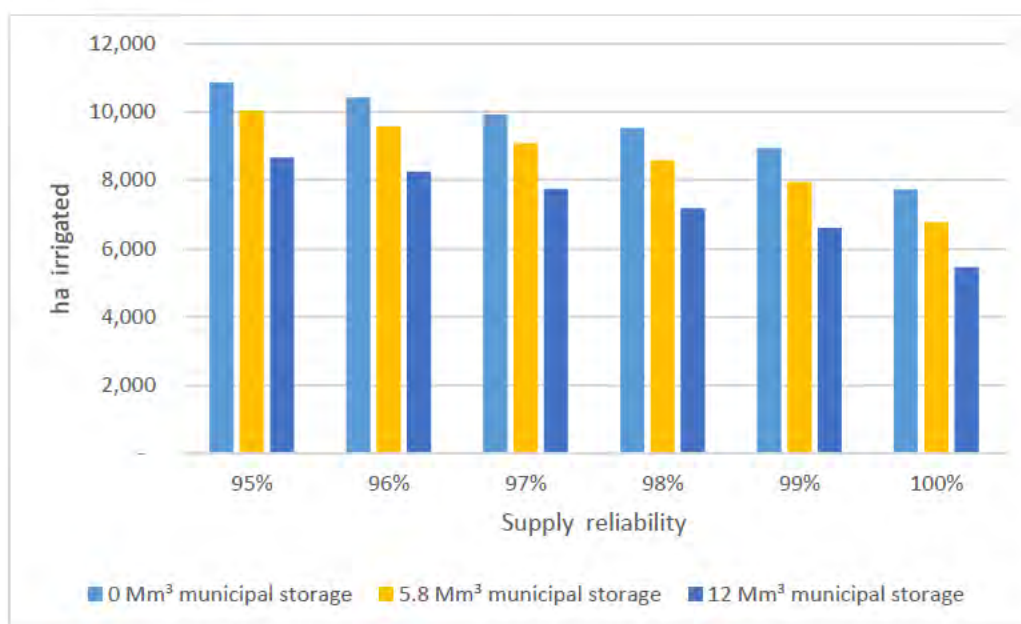


Figure 62: Effect of varying supply reliability and municipal storage volume on new area able to be irrigated (NTWL 60 m dam; future allocation rules).

With no storage reserved for municipal supply, increasing the supply reliability from 95% to 100% results in a 26% reduction in the new area that can be reliably irrigated. If 12 Mm³ of storage (i.e. approximately 2 years' supply) is reserved for municipal supply, the area that can be reliably irrigated reduces by 37%.

Results for all combinations of municipal storage volume and allocation rules are included in Appendix 6.

6.4.4 Summary

Table 32 summarises the supply-demand modelling results. This shows that increasing storage reserved for municipal supply and/or using the assumed future allocation rules slightly reduces the total irrigated area that can be serviced at 95% supply reliability. While supplying existing and new areas has been modelled as separate scenarios at this stage, in practice a combination of the two can be supplied.

Table 32: Supply-demand modelling results summary.

Cease-take and environmental flows	Storage for municipal supply	Waipaoa A shortfall demand			New irrigation area (95% reliability)			
		% of modelling period dam at maximum capacity	% of modelling period dam at minimum capacity	Days with unmet demand	Area irrigated (ha)	% of modelling period dam at maximum capacity	% of modelling period dam at minimum capacity	Days with unmet demand
Current allocation rules	0 Mm ³	67%	0%	-	11,222	25%	0.1%	181
	3 Mm ³	67%	0%	-	11,222	27%	0%	279
	12 Mm ³	67%	0%	-	11,031	36%	0%	613
Assumed future allocation rules.	0 Mm ³	54%	0%	-	11,222	13%	0.2%	410
	3 Mm ³	54%	0%	-	11,222	16%	0%	504
	12 Mm ³	54%	0%	-	9,572	32%	0%	587

6.5 PRICE OF WATER

The price of water will depend on several factors, including:

- > The overall cost of the storage development and associated infrastructure (and how this is financed);
- > Existing and potential future water users' price expectations based on current water access arrangements; and,
- > The ability of current and future land uses to afford investment in water supplies.

6.5.1 Distribution network costs

Dam construction costs have been considered in Section 5.7.

As a rule of thumb, the capital cost of water distribution infrastructure (i.e. pipe networks, excluding intakes, storage, etc) can be assumed to cost \$5,000 per irrigated hectare, based on based on 2021 national-scale estimates by Aqualinc for MPI.²⁷ Actual distribution costs for a specific scheme depend on how widespread the irrigated area is within the overall command area – i.e. length of pipe per irrigated hectare.

A concept-level distribution network design and high-level cost estimate has been completed, based on:

- > Pipeline connecting the proposed Porarua storage dam (dam) to the buffer pond (pond); and
- > Delivery pipeline from dam / pond to the new irrigation area.

Key design details are as follows:

- > Proposed new irrigation area of up to approximately 11,222 ha.
- > Peak release from storage is 5.96 m³/s (5,960 l/s).
- > Pipeline from dam to pond has been sized to supply the full flow of 5,960 l/s.
- > Peak flow for distribution network is 5,960 l/s. A diversification factor of 80% has been applied to distribution network so that peak distribution flow is 4,800 l/s.
- > A peak flowrate of 1,255 l/s is available from the pond to fill the dam.

²⁷ <https://www.mpi.govt.nz/dmsdocument/47773-Water-Availability-and-Security-National-Scale-Assessment/>

Dam water levels:

- > NTWL of 60 m.
- > Minimum water level of 34 m (5 m above dam toe of 29 m).

Pond water level:

- > Maximum water level of 21 m (estimated from contours).
- > Minimum water level of 19 m (pond assumed to be 2 m deep).

Dam to Pond pipeline

The rising main from the pump station to the dam is discussed in Section 5.6.4. This pipe can be sized appropriately to deliver water from the dam to the distribution network under gravity.

Dam/Pond Delivery Pipeline to Proposed Irrigated Area

The indicative layout of the delivery pipeline has been designed to reach as many properties as possible by following road alignments and prioritizing connections to larger clusters of irrigated areas. Smaller, isolated irrigated areas have not been included in the initial design but can be incorporated if required in subsequent stages of investigation. The target irrigated area for the concept-level distribution network is approximately 9,600 ha, based on excluding an area further upstream that requires a long pipe length for a relatively small increment of irrigated area, which would skew the per-hectare cost of distribution. However, pipe network design has still been based on supplying a flow of 4,800 l/s, as discussed above. This provides some flexibility in where water is delivered within the pipe network, given that demand for water at a property scale is unknown at present.

The modelling approach for pipe diameter design has been to select pipe diameter based on a maximum velocity of 1.5 m/s to balance pipe friction losses and pipe cost. Some smaller diameter pipes have been upsized (i.e. lower pipe velocity) due to high pipe friction losses over short distances.

It has been assumed that the pipeline will cross Rivers using existing bridges.

The delivery pipeline bill of materials and estimated costs are provided in Table below. The layout is shown in **Figure 63** below.



Figure 63: Indicative pipe distribution network design for full irrigated area

The pumping requirements for when the delivery pipeline is supplied from either the Dam or the Pond is provided in Table below. If supplying water from the pond (i.e. run-of-river water supplied directly to the scheme), a pump head of approximately 40 m is required to pump water around the scheme. When supplying water from the dam, when the water levels in the dam are in the upper part of the operating range then the scheme will operate under gravity. When the water levels are lower pumping is required (pump head ranging from 0 to 30 m, depending on reservoir level and delivery pressure requirements).

Further investigation is required on the following:

- > Optimisation of pipe diameters. With further modelling, it may be possible to reduce pumping cost, but this may be offset with higher pipe capital costs.
- > Pipe pressures to determine appropriate pipe pressure classes (maximum pipe pressures are expected to be less than 90 m).
- > Pumping requirements from either Dam or Pond to ensure that sufficient pressures delivered throughout scheme even at times of low water levels.

Table 33: Delivery Pipeline bill of materials and estimated costs

Pipe diameter (mm)	Approximate Installed Cost / m	Pipe Length (m)	Direct Cost
1,800	987	6300	\$ 6,214,963
1,600	875	2600	\$ 2,274,386
1,400	763	900	\$ 686,723
1,200	651	13,500	\$ 8,792,388
1,000	540	4,900	\$ 2,643,795
900	484	5,500	\$ 2,660,246
800	428	4,900	\$ 2,096,279
700	372	5,200	\$ 1,934,104
600	316	3,200	\$ 1,011,437
500	260	1,000	\$ 260,205
450	232	9,700	\$ 2,253,024
375	190	10,800	\$ 2,055,983
300	148	5,700	\$ 846,262

Pipe diameter (mm)	Approximate Installed Cost / m	Pipe Length (m)	Direct Cost
250	121	3,300	\$ 397,757
225	107	19,700	\$ 2,099,335
200	93	4,600	\$ 425,951
175	79	5,000	\$ 393,154
125	51	300	\$ 15,209
Total Direct Cost Estimate			\$ 37,061,199
Total Direct Cost Estimate / ha (9,600 ha)			\$ 3,860

Table 34: Pump duty

Pump Duty	Dam delivery	Pond Delivery
Flow	4,800 l/s	
Head	0 to 30 m	40 m

The estimated distribution cost of \$3,860/ha (which is a direct capital cost estimate, i.e. excluding P&G, design and contingency) is comparable to the national-scale estimate of \$5,000/ha. While the cost will not scale exactly with irrigated area, it is a reasonable basis at this stage for estimating the cost of different scales of development.

It should be noted that if development of the scheme is done in stages, early stages of the distribution network are likely to require over-sizing to allow later expansion.

6.5.2 Existing water prices

The Patutahi Pipeline, which supplies irrigation water from the Waipaoa A block to a number of properties, charges users for water on a volumetric basis at \$0.60/m³ supplied plus a fixed annual charge. An average all-in rate of \$0.65/ m³ has been estimated as the basis of the current market price of reliable irrigation water. At approximately 3,500 m³/ha/yr for an average year or 4,800 m³/ha/yr for a 1-in-10 dry year (based on modelled annual irrigation demand for kiwifruit and apples), this represents an annual cost of \$2,275 - \$3,120 /ha/yr that irrigators are currently paying.

6.5.3 Ability to pay

As part of the national-scale assessment of water availability and storage for MPI in 2021, the ability of various land-uses to pay for water infrastructure development was assessed by The Agribusiness Group using farm financial models.²⁸ Key financial model results for likely land-uses for new irrigation are summarised in **Table 35**. Where a Gisborne-specific model did not exist, a Hawke's Bay one was used as a proxy. The model calculates the ability of a land-use to pay for water infrastructure as:

Available for Water Infrastructure=Net Cash Position- interest cost of development

Table 35: Gross farm revenue and ability to pay for water, for key land uses.

Farm Financial Model	Gross Farm Revenue (\$/ha/yr)	Available for water (\$/ha/yr)
Kiwi Green Gisborne / Hawke's Bay	\$49,800	\$1,955
Kiwi Gold Gisborne / Hawke's Bay	\$150,798	\$54,598
Citrus Gisborne	\$49,000	\$7,824
Vegies Hawke's Bay	\$20,080	\$3,542
Pipfruit Hawke's Bay	\$87,949	\$38,947

Comparing the ability to pay to the existing water prices, on a per-hectare basis for an average year, green kiwifruit may struggle to afford water for new irrigation, however all other land uses considered in **Table 36** would be able to afford irrigation water (by a substantial margin for gold kiwifruit and pipfruit).

6.6 POTENTIAL TO INTEGRATE THE SCHEME

The potential to integrate the Scheme with existing irrigation schemes in the area, as discussed in Section 6.2.1, demand for stored water may come from existing irrigators that require a higher level of supply reliability, with this requirement driven by conversion to higher-value crops and / or changes to the Waipaoa minimum flows that will erode water users' current supply reliability.

²⁸ Ibid.

Existing water intakes, including the Patutahi Pipeline, have their own intakes on the Waipaoa River. These are typically infiltration gallery / collector well structures. It is likely that the most effective way of integrating the scheme with existing irrigation water takes / schemes is to use the Waipaoa River for conveyance – i.e. water from the dam is released into the river, and an equivalent volume is taken by individual water users using their existing infrastructure.²⁹ Existing Waipaoa River A block users upstream of WPTs’ buffer pond would need to be connected to a distribution network.

On the eastern side of the Waipaoa River a managed aquifer recharge (“**MAR**”) scheme has been trialled and consented. The concept of the MAR scheme is to inject Waipaoa River water into the Makauri Aquifer to address declining water levels in the aquifer and the risk of saline intrusion, and to ensure that it remains an ongoing sustainable source of water for irrigation. While we have not specifically modelled the use of water from the MAR scheme as a demand in the supply-demand modelling, this could represent a proportion of the new irrigation demand that we have modelled. The key potential benefits in taking water from storage to integrate with the MAR scheme are:

- > Availability of water for injection into the MAR scheme during prolonged dry periods; and
- > The ability to release clean water from storage, avoiding issues with injection bores clogging due to high sediment loads.³⁰

In order to realise the benefits of clean water released from the dam, it would be preferable to deliver water to the MAR scheme via a pipe distribution network rather than using the river for conveyance as described above. If the pipe network is predominantly on the west side of the Waipaoa River, a river crossing would be required to get clean water into the MAR scheme. GDC have an existing water main (mapped as both 125 mm and 200 mm pipes) that crosses the Waipaoa River at the end of Onslow Road, connecting the Waipaoa treatment plant (see further discussion on the treatment plant below). The feasibility of utilising this pipeline could be considered as part of more detailed investigations, particularly if municipal supply is also being integrated into the scheme.

6.6.1 The potential to integrate the Scheme with the GDC municipal supply

At the most basic level, water could be released from the dam into the Waipaoa River and re-taken by GDC downstream.

²⁹ This is equivalent to the arrangement that has been in place for some time for releases from Lake Coleridge in central Canterbury.

³⁰ Our understanding is that the use of treated water from GDC’s Waipaoa treatment plant has been contemplated, which is likely to be expensive.

This option is potentially effective in terms of water availability at low flows, but does not overcome sediment load issues, so may not be preferable from an overall resilience perspective.

GDC's main water supply pipeline (525 mm diameter) crosses the Waipaoa River on the SH2 bridge (**Figure 64** below). The indicative pipe distribution network for irrigation supply extends to this point. It should be noted, however, that the GDC pipeline is conveying treated water, so for a supply from the dam to connect into the pipeline treatment plant would need to be provided.

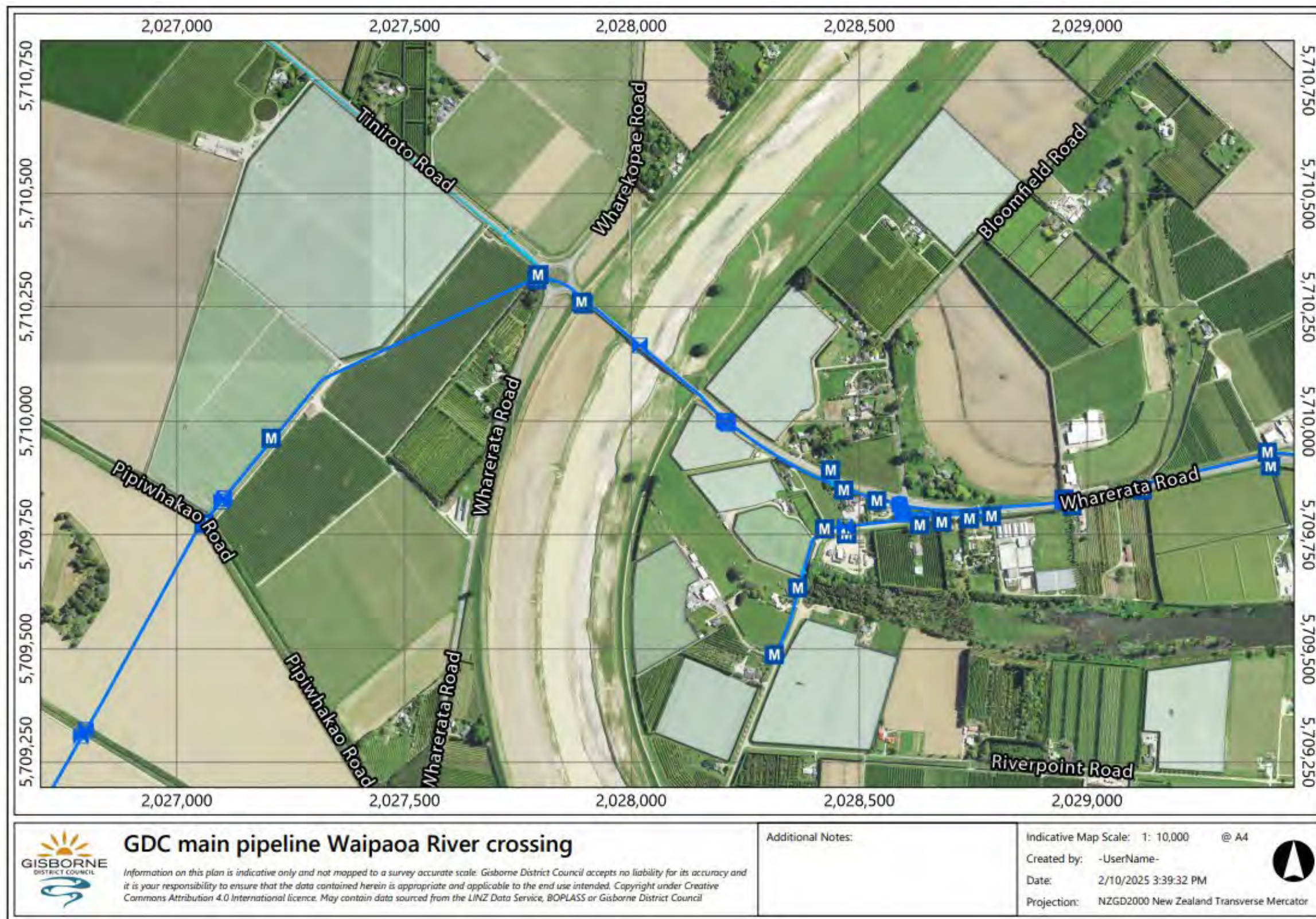


Figure 64: GDC's main pipeline, Waipaoa River crossing (from Tairāwhiti Maps).

The Waipaoa water treatment plant (currently used as a back-up / augmentation supply) is further upstream, on Bushmere Road near Bolitho Road (**Figure 65** below). The details of the intake for this plant are unknown. There is an existing pipe across the Waipaoa River, supplying water to the Patutahi area.

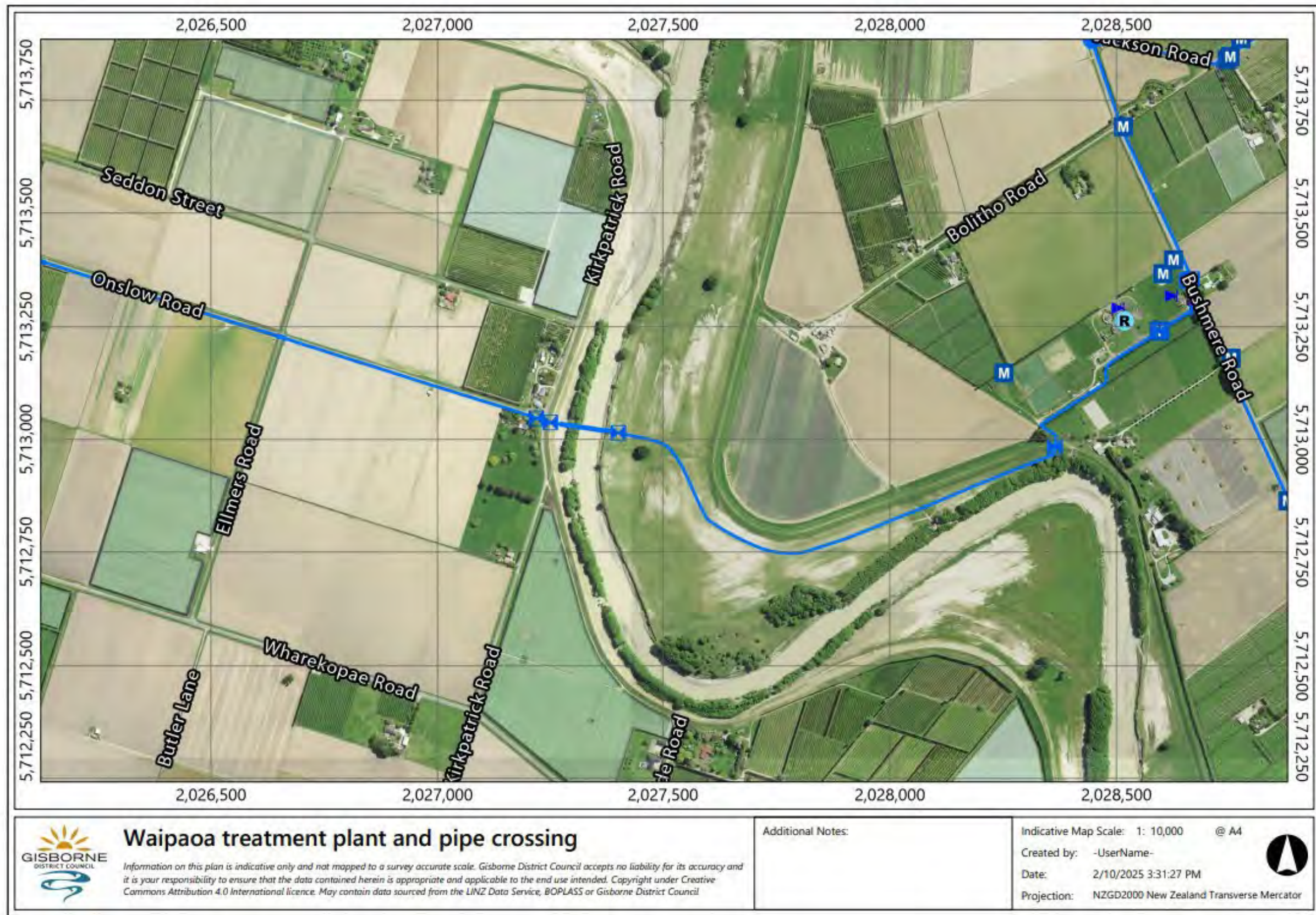


Figure 65: Waipaoa treatment plant (marked 'R') and secondary pipe crossing. From Tairāwhiti Maps.

In terms of the need to supply treated municipal water into GDC's existing supply network, it may be preferable to integrate the scheme with the existing Waipaoa treatment plant (rather than needing to build additional treatment capacity in order to join into the existing main pipeline). Options for network integration should be explored with GDC in more detail, alongside getting a better understanding of stored water volumes that would be useful to GDC.

6.7 POTENTIAL REVENUE

If water is priced on the same basis as the Patutahi Pipeline (i.e. a volumetric charge as described in Section 6.5.2) then the potential revenue from sale of irrigation water can be estimated directly from the outputs of the supply-demand modelling.

On the basis of a charge of \$0.65 per m³, we have estimated the potential annual revenue from:

- > Water supplied from storage to existing A-block irrigators
- > Water supplied from storage to new irrigated areas
- > Water supplied on a run-of-river basis via a distribution network.

As the estimated volumetric charge is based on the run-of-river supply from the Patutahi Pipeline, we have not differentiated between the cost of water from storage and run-of-river sources for new irrigated areas.

Estimated annual volumetric water charge revenue is summarised in Table 36. The largest component is from releases from storage for new irrigation.

Table 36: Estimated annual volumetric water charge revenue, based on 11,222 ha of new irrigation.

	Waipaoa A block supplementary supply from storage	Run-of-river supply for new irrigated area	Release from storage for new irrigation
min	\$271,640	\$2,206,066	\$9,120,928
max	\$5,826,935	\$7,242,768	\$19,592,911
average	\$2,486,595	\$5,006,152	\$15,179,804

Under scenarios with smaller irrigated areas, the revenue derived from new irrigated areas will reduce approximately in proportion to the irrigated area, although there will be some rebalancing of the proportions from run-of-river and storage, and higher revenue per irrigated hectare for higher reliability levels of supply reliability.

For comparison, Central Plains Water Ltd in Canterbury, which supplies water to 45,000 ha, reported revenue of \$41M (\$911/ha) in 2024. Although the land uses, infrastructure and economies of scale mean that a direct comparison is not possible, on a per-hectare basis this is around half the revenue estimated above.

Revenue from supply of municipal water has not been considered at this stage; this source of revenue would be an upside for the scheme's financial viability. A revenue model for municipal supply will need to be determined as part of considering this option in more detail with GDC. If the storage is used as a main supply, then a volumetric charging model on a similar basis to irrigation supplies would be appropriate. If the supply is used as a backup to provide resilience, then another charging model may be more appropriate.

6.8 SUMMARY OF FINDINGS

Concept-level supply-demand modelling shows that it is hydrologically feasible to supply water from storage to meet the following demands:

- > Shortfalls from Waipaoa River A block to supplement existing irrigators' during periods when they would otherwise have their supplies restricted.
- > New irrigated areas on the Poverty Bay flats, within a total command area of 11,222 ha.
- > Municipal supply for GDC to provide greater resilience than existing supplies.

Supplying water to meet shortfalls from the Waipaoa A Block has been treated as a separate set of modelling scenarios to supplying water to meet new irrigation demands at this stage. Further stages of investigation could explore combinations of these sources of demand. The current modelling indicates that, particularly for the larger reservoir that has been considered, both existing and new water users could be supplied to some extent.

The ability to supply new irrigation from the storage-based scheme is substantially supported by water harvesting from the Waipaoa B block. The availability of this water during winter for harvesting plays a large role in the scheme's hydrological feasibility.

While other options have been considered (and results are available if required in future), the focus of supply-demand modelling has been on the NTWL 60 m dam with up to 1255 l/s of supplementary inflow harvested from the Waipaoa B block, based on the findings of Section 5.

It has been assumed that all shortfalls in Waipaoa A block supply are met from storage – i.e. existing users (3,000 ha) would achieve a supply reliability of 100%.

A baseline reliability of 95% was set for new irrigated areas (beyond the existing area). In practice, existing and new irrigated areas could be supplied in a way that equalises their supply reliability; the current assumptions are a simplification appropriate to the current stage of investigation.

Municipal demand has been treated as a reserved volume of storage, ranging from zero up to approximately two years of demand based on GDC's measured usage (allowing for an inter-year drought where the storage does not refill adequately over winter). The volume reserved for municipal supply resilience affects the new irrigated area that can be reliably supplied.

The volume required to meet shortfalls in the existing A block supply and the total new area that can be irrigated from B block water and storage depend on the Waipaoa River allocation rules. The full command area (11,222 ha) can be irrigated under the current allocation rules, with only a small reduction in area if up to 12 Mm³ of storage is reserved for municipal supply. With the increased minimum flow scenario, the area reduces to 9,572 ha. This has been modelled as new irrigated area, but in practice could be a mixture of new areas and supplementary supply to improve supply reliability for existing irrigators.

At 95% supply reliability some years would still have significant water supply shortfalls, which may not be acceptable for the high-value land-uses that have the potential to be developed on the Poverty Bay flats. At higher supply reliability levels, a smaller irrigated area can be serviced – a reduction of up to 37%, depending on how much storage is reserved for municipal supply.

Note that at this stage all supply-demand modelling has been based on historical climate over a 30-year period from 1992 – 2022. Further stages of investigation should also consider future climates.

Pricing for water supplied from the scheme will need to be set based on consideration of what is acceptable to the current market, what is required to make the storage development and associated infrastructure financially viable, and the ability of potential land-uses to pay for water. Based on the current volumetric charges for the Patutahi Pipeline, green kiwifruit may struggle to afford new irrigation, but it is likely to be affordable for vegetables, gold kiwifruit, citrus and pipfruit.

Water that is released from storage to meet supply shortfalls for existing A block irrigators can be conveyed via the Waipaoa River and abstracted via existing intakes, subject to this concept being acceptable to GDC under their Regional Plan rules.

New irrigated areas are likely to require a piped distribution network. This can be integrated to some extent with the scheme's intake and rising main infrastructure. When available, run-of-river water from the Waipaoa B block can be supplied directly to new irrigated areas, supplemented with releases from storage. Some areas further upstream are unlikely to be economic to supply due to the length of pipe required to service a relatively small area. Removing these areas reduces the command area to approximately 9,600 ha, which aligns well with the area that can be reliably supplied under the assumed future allocation rules, with storage reserved for municipal supply. The cost of distribution needs to be considered alongside the cost of storage and associated infrastructure (see Section 7).

Integrating the scheme with GDC's municipal supply is likely to require either a raw water pipe across the river to supply water from storage to the existing Waipaoa treatment plant, or additional treatment capacity on the western side of the Waipaoa River, joining the existing treated water pipe crossing at the SH2 bridge. Conveying water for municipal supply via the river channel is unlikely to be favourable as stored water will have a lower sediment load than river water. As part of further investigation stages, engagement will be required with GDC to determine the refine the assumptions regarding the volume of water required for municipal supply and how water from the scheme could be integrated into GDC's treatment and distribution systems.

If water supply is charged on a volumetric basis, the potential revenue is directly proportional to the volume supplied. If both the storage and distribution infrastructure are developed as part of the same scheme, then run-of-river water supplied from the B block to new irrigated areas can be charged on the same basis as water released from storage. If water is priced at the same rate as the Patutahi Pipeline, annual revenue is approximately \$20M for irrigation of the full command area. The revenue model along with other commercial matters will need to be refined as part of further stages of investigation.

7. CONCLUSION

The MWD and KRTA conducted comprehensive studies during the early to mid-1980s examining water storage options for Tairāwhiti, Gisborne. These investigations identified the Pouarua Dam site at WPT's Tangihanga Station as the preferred location for water storage infrastructure.

This scoping report has reassessed the viability of the mid-1980s concept, considering significant advancements in dam engineering, changes in economic conditions, and evolving water allocation planning frameworks. The analysis has examined environmental, economic, and engineering perspectives to determine whether the Pouarua Dam site remains a viable option for development, while also exploring implementation pathways, cost estimates, and consenting timeframes for WPT's consideration.

The key findings on this report illustrate that the TWSS based on the Pouarua Dam site concept identified in the mid-1980s continues to demonstrate significant merit for development in 2025, with water harvesting being a key requirement for viability.

With water harvesting, the TWSS can supply land with water for irrigation and provide additional resilience to the Gisborne community potable water supply.

From review of the scheme at a concept level, no issues were identified relating to technical feasibility.

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Francis D, Geological Research Ltd. (2012). Drilling at Tangihanga Limestone Quarry site, Patutahi, Gisborne. Report for Wi Pere Trust ltd.



APPENDIX 1

General Arrangement Overall Layout
Plan



Graphic Scales 1:35 000

Original Sheet Size A3 (420x297)



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APPENDIX 2

City of Gisborne letter to Wi Pere Trust
regarding Pouaura Dam 1984

City of Gisborne				
All Communications to be Addressed to: THE TOWN CLERK P.O. Box 740 GISBORNE TELEPHONE 52 547 (3 Lines)		<table border="1" style="float: right;"><tr><td>OUR REF: W5/1</td></tr><tr><td>YOUR REF: _____</td></tr></table> <i>Town Clerk's Office, Fitzherbert Street, Gisborne, N.Z.</i>	OUR REF: W5/1	YOUR REF: _____
OUR REF: W5/1				
YOUR REF: _____				
3 September 1984				
The Secretary Wi Pere Trust Estate P O Box 545 <u>GISBORNE</u>				
Dear Sir				
<u>POUARUA WATER SCHEME</u>				
Council at a Special Meeting on 3 September 1984 considered various options concerning the improvement of its water supply.				
Of the options available to it Council has resolved to adopt the option known as the Pouarua Scheme in principle. Attached is a copy of a map which shows the land which will be affected by this scheme.				
You will note that some of your property could be affected. Whilst the Pouarua Scheme has been adopted in principle there will need to be more investigation and discussion before it can proceed.				
This letter is to advise you of the development before it is made public. Council will keep you advised of progress in this matter as and when it occurs to ensure you are fully informed.				
Should you wish to discuss this matter please feel free to contact me as I shall be only too happy to explain the scheme in more detail.				
Yours faithfully 				
S. P. MARTIN <u>Town Clerk</u>				
MS:ae				



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APPENDIX 3

RMA Statutory Assessment of Pouarua
Dam Site Concept

Appendix 3

Resource Management Act Statutory Assessment of Pouarua Dam Site Concept

1. RESOURCE MANAGEMENT ACT 1991

The Resource Management Act 1991 (“**RMA**”) is the legislative document for managing the use, development and protection of natural and physical resources in a way that achieves the ‘sustainable management’ principle.

Part 2 outlines the purpose of the RMA, which is to promote "sustainable management" of natural and physical resources. Part 2 (Section 5 to 8) of the RMA is considered below for completeness. However, it is noted that case law in the Court of Appeal decision on *RJ Davidson Family Trust v Marlborough District Council* CA97/2017 (2018) NZCA 316 determined that:

“If a plan that has been competently prepared under the Act it may be that in many cases the consent authority will feel assured in taking the view that there is no need to refer to pt 2 because doing so would not add anything to the evaluative exercise. Absent such assurance, or if in doubt, it will be appropriate and necessary to do so. That is the implication of the words “subject to Part 2” in s 104(1), the statement of the Act’s purpose in s 5, and the mandatory, albeit general, language of ss 6, 7 and 8.”

This decision confirms that it can be appropriate to consider Part 2 when assessing a resource consent in specific circumstances but otherwise an assessment against Part 2 will not add to the evaluative exercise. The Tairāwhiti Resource Management Plan (“**TRMP**”) was prepared having regard to Part 2 of the RMA.

1.1 SECTION 5

The purpose of the RMA is to promote the sustainable management of natural and physical resources. Section 5 of the RMA states its purpose as follows:

- (1) *The purpose of this Act is to promote the sustainable management of natural and physical resources.*
- (2) *In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while—*
 - (a) *sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
 - (b) *safeguarding the life-supporting capacity of air, water, soil, and*

ecosystems; and

- (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.*

A water storage project could be considered consistent with the purpose of the RMA in that it is providing a water resource to meet the reasonably foreseeable social and economic needs of future generations. Technical input will be required to ensure that any adverse effects on the environment are avoided, remedied or mitigated and that the life-supporting capacity of the Waipaoa River ecosystem, in particular, was safeguarded.

1.2 SECTION 6

In achieving that purpose, there must be recognition and provision for several “matters of national importance”, including (as relevant to this project):

- > *6(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:*
- > *6(b) the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:*
- > *6(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*
- > *6(d) the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:*
- > *6(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:*
- > *6(f) the protection of historic heritage from inappropriate subdivision, use, and development:*
- > *6(g) the protection of protected customary rights:*
- > *6(h) the management of significant risks from natural hazards.*

There are no identified outstanding natural features and landscapes within the site or on directly adjoining land. The water storage project will not be highly visible beyond the site and adjoining land. However, it is recommended that a landscape and visual assessment is undertaken as part of the consent preparation to understand any effects on any landscape values in the wider area and natural character values of rivers and their margins. If required, recommendations would be made on how effects on these values could be avoided, remedied or mitigated. Consistency with 6(a) and 6(b) could be achieved.

It is recommended that an ecological assessment would be undertaken as part of consent preparation to identify any natural inland wetlands and areas of significant indigenous

vegetation and significant habitats of indigenous fauna and if required, how these areas could be avoided, remedied or mitigated. Consistency with 6(a), 6(c) and 6(e) could be achieved.

No change to public access to rivers will result from this proposal. As such there is consistency with 6(d).

Engagement with mana whenua and a review of iwi management plans is key to ensuring that recognition and provision is given to historic heritage, customary rights and the relationship of Maori and their culture and traditions during the preparation of resource consent. This will ensure consistency with 6(e), 6(f) and 6(g).

Risks from natural hazards in particular seismic hazards in this instance are required. With suitable design measures as advised by Damwatch, it is likely that the project will not result in any significant risk from natural hazards. This will ensure consistency with 6(h).

1.3 SECTION 7

In achieving the purpose of the act particular regard shall be had to (as relevant to this project):

- > *7(a) kaitiakitanga:*
- > *7(aa) the ethic of stewardship:*
- > *7(b) the efficient use and development of natural and physical resources:*
- > *7(c) the maintenance and enhancement of amenity values:*
- > *7(d) intrinsic values of ecosystems:*
- > *7(f) maintenance and enhancement of the quality of the environment:*
- > *(g) any finite characteristics of natural and physical resources:*
- > *(h) the protection of the habitat of trout and salmon:*
- > *(i) the effects of climate change:*

Engagement with mana whenua and a review of iwi management plans is key to ensuring that recognition and provision is given to historic heritage, customary rights and the relationship of Maori and their culture and traditions during the preparation of resource consent. This will ensure consistency with 7(a) and 7(aa).

The water storage project is considered an efficient use of natural and physical resources, providing for irrigation (where water access is increasingly being restricted) and potentially resilience in potable water supplies for the local community.

While the site of the project is relatively isolated and a water storage dam will not be widely visible, a landscape and visual assessment is recommended to assess the amenity effects as part of the resource consent package. Consistency is considered likely with 7(c).

It is recommended that an ecological assessment would be undertaken as part of consent preparation to identify any intrinsic values of ecosystems, maintenance of water quality and

any effects of trout and salmon. If required, the technical assessment would recommend how these areas could be avoided, remedied or mitigated. Consistency with 7(d), 7(f) and 7(h) could be achieved.

Water is a finite resource and there is growing pressure and demand on the resource. The water storage project recognises this and could provide relief. As such consistency with 7(g) would be achieved.

Climate change has an impact on water supply through increased drought periods. The water storage project recognises this and could provide relief. As such consistency with 7(h) would be achieved.

1.4 SECTION 8

Section 8¹ of the RMA states that

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

Engagement has begun with relevant iwi. Ongoing engagement, consideration of any iwi management plans and preservation of identified cultural values will assist with taking into account the principles of the Treaty of Waitangi.

2. NATIONAL POLICY STATEMENTS

National Policy Statements (“NPSs”) are national direction that lower order policy statements and plans (i.e. the TRMP) must give effect to, and which are highly relevant to consent processes.

There are several NPSs currently in effect as regulations. With the information at hand, the following are relevant in this instance:

- > National Policy Statement for Indigenous Biodiversity;
- > National Policy Statement for Freshwater Management 2020;
- > National Policy Statement on Urban Development 2020; and
- > National Policy Statement Highly Productive Land 2022.

¹ It is noted that this section of the Act does not require consideration if a consent approval is sought under the FTAA.

2.1 NATIONAL POLICY STATEMENT FOR INDIGENOUS BIODIVERSITY 2023

The objective of the National Policy Statement for Indigenous Biodiversity 2023 (“**NPS-IB**”) is to maintain indigenous biodiversity across New Zealand and, looking forward, to have a no net loss outcome. Local authorities are required to implement and give effect to the NPS-IB within their regions and districts.

The presence of Significant Natural Areas would be highly relevant because of the emphasis the NPS-IB gives to their protection. However, there are no known Significant Natural Areas identified at or directly surrounding the Pouarua Dam Site.

An ecological assessment is required to confirm the degree of application that the NPS-IB would have at this site. However, given that the site is currently grazing land and there are no identified Significant Natural Areas identified in the TRMP, it is unlikely that the project would be considered contrary to the objectives and policies of the NPS-IB.

2.2 NATIONAL POLICY STATEMENT FOR FRESHWATER MANAGEMENT 2020

The NPS-FM came into force on 3 September 2020 and provides direction to local authorities and resource users regarding activities that affect the health of freshwater and sets out a national objective and various supporting policies for freshwater management under the RMA. The NPS-FM has been amended several times, most recently in October 2024.²

The NPS-FM provides for the management of freshwater through the fundamental concept of Te Mana o te Wai. Te Mana o te Wai pervades the NPS-FM and is relevant to all freshwater management, not just those aspects referred to in the NPS-FM.

Freshwater must be managed in a way that gives effect to Te Mana o te Wai (Policy 1) and each regional council must give effect to Te Mana o te Wai (clause 3.2). Te Mana o te Wai refers to the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. It protects the mauri of the wai (water) and is about restoring and preserving the balance between the water, the wider environment, and the community.

The Resource Management (Freshwater and Other Matters) Amendment Act 2024 (the Amendment Act) amended sections 92, 104, and Schedule 4 of the RMA to exclude consideration of the hierarchy of obligations contained in clauses 1.3(5) and 2.1 of the NPS-FM from resource consent applications, and from resource consent decisions.

The policies in the NPS-FM likely to be applicable to this scheme are considered to be:

Policy 1: Freshwater is managed in a way that gives effect to Te Mana o te Wai.

² The Government has signaled that another update of the NPS-FM in 2025/2026, with consultation on this underway.

Te Mana o te Wai is a concept that refers to the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. Early and ongoing engagement with mana whanua will ensure alignment with this policy.

Policy 2: Tāngata whenua are actively involved in freshwater management (including decision making processes), and Māori freshwater values are identified and provided for.

Policy 2 is primarily for regional councils to implement. However early and ongoing engagement with mana whanua will ensure alignment with this policy.

Policy 3: Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.

Policy 4: Freshwater is managed as part of New Zealand's integrated response to climate change.

Policy 5: Freshwater is managed through a National Objectives Framework to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.

Policy 6: There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.

Policy 7: The loss of river extent and values is avoided to the extent practicable.

Policy 9: The habitats of indigenous freshwater species are protected.

Policy 10: The habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.

Policy 13: The condition of water bodies and freshwater ecosystems is systematically monitored over time, and action is taken where freshwater is degraded, and to reverse deteriorating trends.

Policy 14: Information (including monitoring data) about the state of water bodies and freshwater ecosystems, and the challenges to their health and well-being, is regularly reported on and published.

There is a need to appropriately mitigate adverse in-stream ecological effects by maintaining appropriate river flows.

Protection of wetlands is a priority and requires further investigation is required to determine if there are any natural inland wetlands as defined in the NPS-FM under Clause 3.21(1).

The project would require a high flow take which should ensure ecological effects are avoided. An ecological assessment will be a requirement for any consenting process taken forward to ensure that there is no inconsistency with these policies.

Policy 11: Freshwater is allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided.

The project could help to resolve water demand and allocation pressures experiences currently in Block A.

Policy 15: Communities are enabled to provide for their social, economic, and cultural well-being in a way that is consistent with this National Policy Statement.

The project is expected to align with Policy 15 in that it will provide for:

- > The social, economic and cultural well-being of mana whenua;
- > The social and economic well-being of Wi Pere Trust; and
- > The social and economic well-being of the balance of the community in terms of strengthening the region's water supply security and helping it to meet future local and regional growth.

2.2.1 Summary of Alignment with the NPS-FM

Protection of wetlands is a priority and requires further investigation is required to determine if there are any natural inland wetlands as defined in the NPS-FM under Clause 3.21(1).

High flow takes to supplement water storage are considered feasible under the allocation available in B Block. An ecological report would be required to confirm ecological impacts associated with this.

Water storage from this scheme would improve the health needs of people in that it could supplement the supply of potable drinking water.

A project of this nature would contribute to people and communities providing for their social, economic, and cultural well-being, now and in the future. This is because water storage and supply for irrigation, opens wider economic growth and employment opportunities for land in the region. Water supply resilience has been identified as a priority for GDC, especially given the impact Cyclone Gabrielle had on the existing network.

2.3 NATIONAL POLICY STATEMENT HIGHLY PRODUCTIVE LAND 2022 (NPSHPL)

The objective of the National Policy Statement for Highly Productive Land 2022 (“**NPS-HPL**”) states:

Highly productive land is protected for use in land-based primary production, both now and for future generations.

Policy 8 is particularly relevant to this project and states:

Highly productive land is protected from inappropriate use and development.

The Pouarua Dam Site is currently within Highly Productive Land Use Category Class 3 (“**LUC Class 3**”) as shown on Figure 2.

As it stands, the project would fall into the definition of ‘specified infrastructure’³ as it is regionally or nationally significant. As such, the use or development of this land would not be considered inappropriate under clause 3.9(2)(j)(i) and (d) of the NPS-HPL.

In addition, it is understood that late 2025/early 2026, LUC 3 is likely to be removed from consideration as Highly Productive Land. Government consultation on this matter has just concluded.

The Scheme is not considered inconsistent with the relevant provisions of the NPS-HPL. Even if the NPS-HPL is not amended to remove LUC 3, it is not considered an impediment to consenting this project.

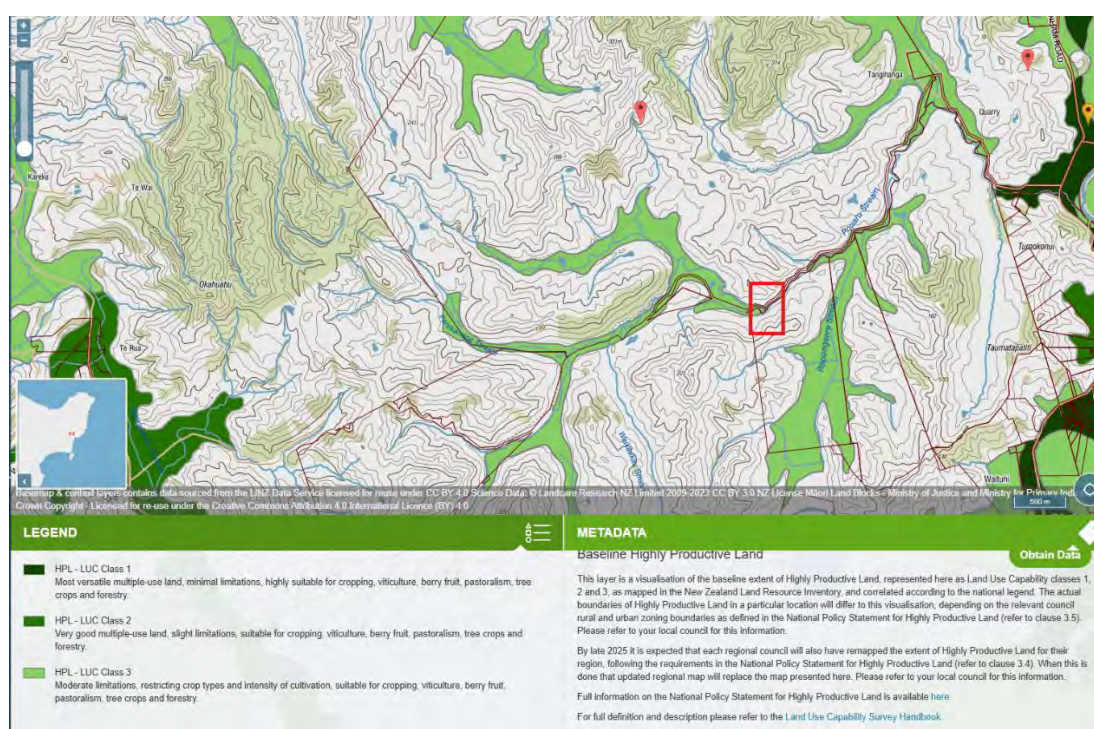


Figure 1: Highly Productive Land Mapped in the NZ Land Resource Inventory (with Pouarua Dam site shown in red box)

2.4 NATIONAL POLICY STATEMENT ON URBAN DEVELOPMENT 2020

The National Policy Statement on Urban Development 2020 (“**NPS-UD**”) recognises the national significance of:

- > Having well-functioning urban environments that enable all people and communities to provide for their social, economic, and cultural well-being, and for their health and safety, now and into the future;

³ Specified infrastructure refers to infrastructure with a significant public benefit, including lifeline utility services, and infrastructure identified as regionally or nationally significant in national or regional planning documents.

- > Providing sufficient development capacity to meet the different needs of people and communities; and
- > Ensure urban environments support reductions in greenhouse gas emissions and are resilient to the current and future effects of climate change.

A water storage project of this nature would play a key role in supporting and enhancing the resilience of water supply to industry and urban environments located in the Gisborne region. This enables people and communities to provide for their social, economic, and cultural well-being, and to improve their health, safety and overall well-being.

The project would be in alignment and in support of the NPS-UD.

2.5 NEW ZEALAND COASTAL POLICY STATEMENT (“NZCPS”)

The NZCPS is a national policy statement under the RMA. The purpose of the NZCPS is to state policies in order to achieve the purpose of the RMA in relation to the coastal environment of New Zealand.

The site is not located within the coastal environment. As such, the NZCPS is not considered an impediment to consenting this Scheme.

2.6 OTHER MATTERS

It is noted that the National Policy Statement for Infrastructure is currently being consulted on and if gazetted, would be of assistance in the consenting process for this project.

3. NATIONAL ENVIRONMENTAL STANDARDS AND REGULATIONS

National Environmental Standards (“**NESs**”) are national regulations that set consistent technical rules and methods for activities that affect the environment and are highly relevant to consent processes.

There are several NESs and Regulations currently in effect, that will require consideration through any consenting process. With the information at hand, the following are considered potentially relevant in relation to this project:

- > National Environmental Standards for Freshwater 2020 (“**NES-F**”);
- > National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health (“**NES-CS**”);
- > National Environmental Standards for Sources of Human Drinking Water 2007 (“**NES-DW**”); and
- > Resource Management (Measurement and Reporting of Water Takes) Regulations 2010.

3.1 NATIONAL ENVIRONMENTAL STANDARDS FOR FRESHWATER 2020

The NES-F prescribes standards for activities that pose risks to freshwater and freshwater ecosystems. The Scheme is considered ‘specified infrastructure’ for the purposes of consideration under the NES-F.

To understand if the regulations of the NES-F apply, an ecological assessment will be required to understand if there are any natural inland wetlands present and any works in proximity to them (i.e. earthworks, vegetation clearance, take/use/damming/diversion of water or discharge). Regulation 45 of the NES-F will need to be considered in this regard.

The design of the scheme should incorporate expert ecological recommendations, as relevant to the consideration of the NES-F. With this in place, the NES-F is not likely to be an impediment to granting of resource consents for the project.

3.2 NATIONAL ENVIRONMENTAL STANDARD FOR ASSESSING AND MANAGING CONTAMINANTS IN SOIL TO PROTECT HUMAN HEALTH 2011

The NES-CS requires landowners to identify, assess, and if necessary, remediate or contain soil contaminants to ensure land is safe for human use before it is redeveloped or changed.

The GDC maps do not identify any “hazardous activities and industries” sites within the site or on the surrounding sites.

The land has been a working farm for many years. A woolshed is present, where a sheep dip may have been historically located. Sheep dips are listed on the Hazardous Activities or Industries List (“**HAIL**”), making them a site of potential contamination. However, given the significant distance between the woolshed location and the Pouarua Dam site (and any earthworks that may be associated with this activity), contaminated soils are highly unlikely to be encountered.

Historic aerial photos from Retrolens do not show the site hosting any other activities that are “more likely than not” to have been on the HAIL.

The NES-CS is not therefore considered to create an impediment to the granting of resource consents sought for the project.

3.3 NATIONAL ENVIRONMENTAL STANDARDS FOR SOURCES OF HUMAN DRINKING WATER 2007

The NES-DW sets requirements for protecting sources of human drinking water from becoming contaminated and unsafe for drinking.

Regulations 7 and 8 of the NES-DW must be considered when assessing any water or discharge permit application that may affect a registered drinking water supply providing 501 or more people with drinking water for 60 or more calendar days each year.

The water services authority Taumata Arowai maintains a list of registered drinking water sources to assist with implementation of the NES-DW.

The closest registered drinking water supply (to over 501 people) to the Pouarua Dam Site are the Te Karaka Community Supplementary Supply (serving a population of approximately 550-700) and the Waipaoa Water Treatment Plant (serving a population of approximately 39,000) as identified in Figure 1 below. Both supplies are treated before consumption by the public.

In spring and summer when peak demand exceeds the available supply, water is sourced from the Waipaoa River (and treated at the Waipaoa Water Treatment Plant) to augment the municipal water supply.

For Te Karaka, the source water is groundwater abstracted from the Waipaoa Gravel Aquifer through shallow bores adjacent to the Waipaoa River. The water is then treated at the Te Karaka Treatment Plant, before directly piped (under low pressure) into the rainwater tank on each property connected to the reticulation network.

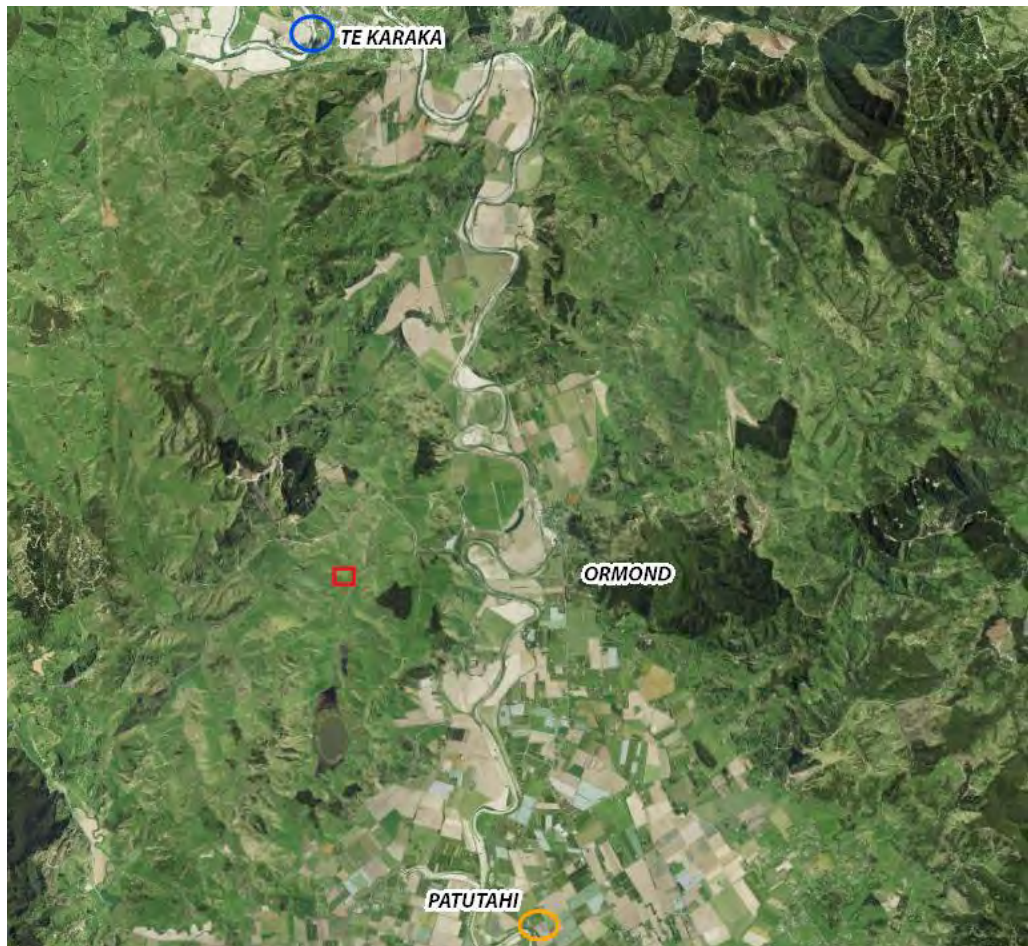


Figure 2: Map of approximate location of municipal water supply and community water supply at Te Karaka (blue circle) and Waipaoa Water Treatment Plant (orange circle), with Pouarua Dam site (red square).

Regulation 7 of the NES-DW states:

A regional council must not grant a water permit or discharge permit for an activity that will occur upstream of an abstraction point where the drinking water concerned meets the health quality criteria if the activity is likely to—

- (a) introduce or increase the concentration of any determinands in the drinking water, so that, after existing treatment, it no longer meets the health quality criteria; or*
- (b) introduce or increase the concentration of any aesthetic determinands in the drinking water so that, after existing treatment, it contains aesthetic determinands at values exceeding the guideline values.*

The only community water supply downstream of the site (being the Waipaoa Water Treatment Plant) is treated to meet health quality criteria as required by Regulation 7(a). The Drinking Water Standards for New Zealand (“DWSNZ”) are prepared by the Ministry of Health and aim to protect public health. The standards set out requirements for safe drinking water and apply only to water that has been treated. Water treatment plants must comply with these standards.

NES-DW is not anticipated to present an impediment to the granting of the resource consents sought for the project.

3.4 RESOURCE MANAGEMENT (MEASUREMENT AND REPORTING OF WATER TAKES) REGULATIONS 2010

These regulations were amended in 2020 to introduce stricter regular measuring and reporting requirements for holders of water permits. The stricter measures were introduced in a staged manner, with water takes of over 20 l/s subject to the requirements from 3 September 2022.

Implementation of the project would require conditions to ensure measure and reporting on the volume of water in a manner consistent with these regulations (particularly Regulation 6 to 9).

With appropriate conditions in place, the project would remain consistent with the requirements of these relevant regulations.

4. TAIRĀWHITI RESOURCE MANAGEMENT PLAN

The TRMP is a combined unitary plan under section 80 of the RMA. The TRMP integrates provisions that would typically be found in separate regional policy statements, regional plans (including regional coastal plans), and district plans, into one document.

4.1 TRMP PLAN REVIEW PROCESS

The TRMP (and associated catchment plans) have been under review since 2021. Of relevance to this scheme are the Phase 1 revisions to the TRMP which include a review of the Regional Policy Statement provisions and the continued implementation of regional freshwater planning

provisions and catchment plans required under the National Policy Statement for Freshwater Management 2020.

The Waipaoa Advisory Group has been working on the Waipaoa Catchment Plan and drafting provisions were underway. These changes include alterations to minimum flows in the Waipaoa River. The review of the TRMP including the Waipaoa Catchment Plan was due for public notification by the end of 2026.

The Government has recently announced temporary halt to RMA plan changes and reviews, preventing councils from notifying these plan changes. These changes are part of a broader transition to a new resource management system⁴ expected to be in place from 2027.

GDC can't notify any of the plan changes under the TRMP review unless they are granted an exemption from the Minister. After local elections in October 2025, GDC will confirm with the incoming Council their priorities for the review programme, any exemptions to seek from the Minister and the approach for transitioning to a new system.

Given the new science available, it is almost certain that the minimum flow will alter when the new water allocation plan is finally progressed.

4.2 RELEVANT REGIONAL POLICY STATEMENT OBJECTIVES AND POLICIES

The Regional Policy Statement (“**RPS**”) sits within the TRMP and provides high-level direction through policies and objectives setting the framework for the rest of the TRMP.

The key objectives and policies of relevant RPS sections are discussed generally, noting that a thorough assessment of these provisions would be undertaken at the at the time of consenting, when preliminary design details are known and technical assessments available.

Relevant chapters of the RPS include:

> B1 Tangata Whenua

The objectives and policies in this section require that the principals of the treaty are exercised. Consultation has commenced with iwi and hapu groups.

> B6 Freshwater

The scheme is considered well aligned with many of the objectives within B6.2.1.

Freshwater is available, within limits, to meet the present and future needs of communities to support the social, cultural and economic wellbeing of the region. This scheme would provide a much-needed water supply to support this objective and potentially ease any over-allocation of water.

⁴ Resource Management (Consenting and Other System Changes) Amendment Act 2025.

The objectives require that land and freshwater is sustainably managed in a way that safeguards the life-supporting capacity of freshwater, including ecosystem processes and indigenous species, and the health of people and communities. It is noted that the location of the Pouarua Dam is not within an outstanding waterbody. An ecological assessment will be required to assess the impacts that the scheme may have on downstream freshwater ecosystems. If any are found, it is recommended that these would be avoided, remedied or mitigated through conditions and/or management plans as appropriate.

Freshwater has a cultural, historic and spiritual importance to iwi and hapū of the region. Consultation has commenced with iwi and hapu to understand the importance of water.

> **B5 Environmental Risk Including Natural Hazards**

The objectives and policies of B5 are relevant to this scheme, given the seismic context of this area. The dam will not be located within an avoidance zone around any active fault. Through dam design, the risk to infrastructure and other property from seismic hazards can be appropriately mitigated.

For these reasons, the scheme is unlikely to be inconsistent with any relevant objective or policy of the RPS.

4.3 RELEVANT TRMP OBJECTIVES AND POLICIES

The TRMP provides specific policies and objectives which give effect to the RPS. The key objectives and policies of these sections are discussed generally below, noting that a thorough assessment of these provisions would be undertaken at the at the time of consenting, when preliminary design details are known and technical assessments available. Relevant chapters of the TRMP to this scheme include those set out below.

C2.1 – Infrastructure, Works and Services

Objective C2.1.3 O1 encourages infrastructure that enables people and communities to provide for and enhance their environmental, social, cultural and economic well-being. Objective O2 requires that adverse effects are avoided, remedied and mitigated. O3 requires that infrastructure in an integrated and coordinated manner.

In this regard, the scheme would remain consistent in that water supply would provide benefits to the economic wellbeing. Technical specialists will be engaged and where required any identified adverse effects would be either avoided, remedied or mitigated through conditions and management plans. Stakeholder engagement has commenced to discuss integration of water supply with irrigation schemes and GDC potable water supplies.

C4.1 – Cultural Heritage

In regard to cultural heritage and archaeology protection as required by objectives and policies within C4.1, the Dam site does not impact on any identified site or waahi tapu. Engagement

with mana whenua has commenced to ensure values are understood and considered. It would be recommended that a general archaeological authority be sought and accidental discovery protocols closely followed during future construction.

C5.1 – Contaminated Land

C5.1.3 Objective 3 does not preclude use and development of contaminated land. However, the activities undertaken must be appropriately controlled to ensure that this is done with due caution. While sheep dips are likely to have been present within the land, they are at a significant distance from the location of the Pouarua Dam site. Precautionary conditions could be applied as part of the consenting package to appropriately manage any potential risk to human health.

C6.1 – Water Quantity and Allocation

In regard to water quality and allocation, any new activity would be considered against C6.1.1 Policy 1 which states:

When considering any application, the consent authority must have regard to the following matters:

- a) the extent to which the change would adversely affect safeguarding the life-supporting capacity of fresh water and of any associated ecosystem; and*
- b) the extent to which it is feasible and dependable that any adverse effect on the life-supporting capacity of fresh water and of any associated ecosystem resulting from the change would be avoided.*

High flow take (for water harvesting) would be required as part of this scheme to store for later use. The purpose of high flow takes is to balance water use with the needs of instream ecosystems by only diverting water when flows are naturally high. High flow take limits are designed to preserve the natural variation in river flows, which is crucial for the health of the river's ecosystem. If high flow takes exceeded the limitations of the TRMP, an ecological assessment would be required to determine effects of a high flow take and support any application for such a take, before alignment with this policy could be confirmed.

C6.2 – Water Quality and Discharges to Land and Water

During dam construction, potential discharges to water include diverted flows, accidental spills, and construction water, which may contain sediment and contaminants. To manage these, construction plans must include measures to prevent erosion and manage sediments, such as diversion culverts to maintain stream flow, and systems to filter out contaminants. As such, it is considered that consistency could be achieved with the general water quality policies in C6.2.

C6.3 – Activities in the Beds of Rivers and Lakes

C6.3.1 policies relate to structures in the beds of rivers and lakes. Sediment generation is to be minimised and works within outstanding waterbodies are avoided. Fish passage effects will be a key consideration by the project ecologist during the consenting process. Fish passage through dams is generally enabled by engineered solutions and is likely to ensure consistency with these policies. It is noted that since 1983, under the Freshwater Fisheries Regulations 1983, culverts, fords, dams and diversion structures that impede fish passage may also require approval from the Department of Conservation or can be applied for through the FTAA if required.

C6.4 – Riparian Margins, Wetlands

The policies set out in C6.4 relate to the protection of any significant values of wetlands and their margins, including the significant values of small wetlands, from the inappropriate effects of land and water use. Any potential effects on identified wetlands in and around the scheme will be a key consideration by the project ecologist during the consenting process to ensure consistency with these policies and the requirements of the NES-F and NPS-FW.

C6.5 – Watercourses

C6.5 states that no person shall, without the written consent of the Authority, obstruct or damage any watercourse, or obstruct the flow of flood waters therein, or impede the maintenance of the watercourse or floodway. Consent would be required for the scheme and as such, necessary approvals would be sought for the dam structure.

C7.1 – Soil Conservation

Earthworks required to construct the dam would need to take into account the objectives and policies of C7.1. Erosion in areas covered by Land Overlays 2 and 3 (including 3A) is particularly sensitive to landuse and the management of the adverse effects of landuse activities. While some Land Overlay 2 may require earthworks for future dam construction, erosion control and land rehabilitation will be a key consideration to ensure consistency with the objectives and policies of C7.1.

C8.1 – Natural Hazards

The dam will not be located within an avoidance zone around any active fault. Through dam design requirements, the risk to infrastructure and other property from seismic hazards can be appropriately mitigated.

For these reasons, the scheme is unlikely to be inconsistent with any relevant objective or policy of C8.1.

DD4.3 - Rural Zone

Objectives outline that Council provides for use and development provided adverse environmental effects can be avoided, remedied or mitigated and that rural amenity values are maintained.

The relevant Rural Zone policies require that regard is had to:

- > Effect of the activity on the natural landform characteristics;
- > Effect on significant indigenous vegetation and significant habitats of indigenous fauna;
- > Effect on biodiversity, water quality, land stability and erosion;
- > The location, scale and nature of the proposed activity and its effect on the balance of the land and on adjoining properties;
- > Alternative methods and locations available to carry out the works or activities;
- > Physical constraints to the site such as separation by rivers or roads, site configuration and layout;
- > Any adverse effect that the activity may have on existing rural activities;
- > Whether covenants, buffer zones or separation distances between activities would assist in mitigating adverse environmental effects; and
- > When managing effects on rural character, particular regard should be had to traffic generation, noise and visual impact.

At resource consent stage, a suite of technical assessments will identify effects and appropriate ways to avoid, remedy and mitigate those effects.

The site is not identified as an area of significance for amenity or landscapes or highly visible from any area used by the public. The visual impacts on rural amenity and character are expected to be mitigated through the position of the Dam within a gully, surrounded and screened by hill country. The activity will put areas of farmland into water storage, and while large scale, the land use is not out of character in a rural setting and rural activities will continue on the balance of the land. Adjoining neighbours have been consulted in regard to the scale, nature and location of the scheme and the impacts of the scheme on their landholdings.

The site has been reviewed geotechnically and seismically by Damwatch, and is considered appropriate for dam construction, without impacting on land stability.

Water quality could be effectively mitigated during construction using best practice methodologies including erosion and sediment controls. Supplementary surface water takes would occur at high flow, limiting impacts on biodiversity within waterbodies.

While further investigation will be undertaken at consenting stage, it is likely that the scheme could remain consistent with the relevant objectives and policies of the Rural Zone.

DF1.4.2.2 - Water Quantity Objectives

The water quantity objectives for the Waipaoa River are as follows:

1. *Summer low flows in the Waipaoa River provide for a moderate level of ecological health, based on the flow requirements of adult long finned eels.*
2. *The B block allocation during higher flows provides for water storage and irrigation needs without affecting freshes and flushing flows within the Waipaoa River.*
3. *The Waipaoa River continues to be both a key source of water for the Gisborne municipal water supply and a major source of water for irrigation uses.*
4. *Allocations of water made through resource consents in the Poverty Bay Flats reflect the reasonable use test.*
5. *The Matokitoki and Makauri Aquifers are allocated at a level which does not result in significant decline.*
6. *The Te Hapara Sands Aquifer is allocated at a level which does not result in salt water intrusion.*
7. *A survival water allocation block and minimum flow is provided for rootstock of permanent horticultural and viticultural crops.*

These objectives are key considerations in regard to this project. The project would support many of these objectives (particularly Objective 1, 2, 3, 4 and 7) and could assist with MAR in regard to Objective 5.

DF1.4.2.1 Water Quality Objectives

Water quality objectives for the Waipaoa River are summarised as follows:

- > Periphyton - Occasional blooms occur reflecting low enrichment and/or alteration of the natural flow regime or habitat.
- > Macroinvertebrate Community Index - Maintain a healthy macro-invertebrate community.
- > Dissolved Oxygen - No stress caused by low dissolved oxygen on any aquatic organisms that are present at reference (near-pristine) sites.
- > Nitrate toxicity - High conservation value system. Unlikely to be toxicity effects on even the most sensitive organisms.
- > Amonia toxicity - 95% species protection level. Starts impacting on the 5% most sensitive species.
- > E.Coli - People are exposed to a low risk of infection (less than 1% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).

- > Physical habitat - Physical habitat, riparian margins and flow are modified but provide areas for some invertebrates and birds, and for some native fish species to spawn and live. Habitat primarily provides for less sensitive species such as shortfin and longfin eel (tuna) and inanga, including inanga spawning habitat...cont.
- > Clarity - In the Waipaoa River mainstem (as for its tributaries Waingaromia and Mangatu) improve current water clarity over the long term.
- > Fish - A range of generally less sensitive native fish species live in the lowland waterways. The river remains a national stronghold for longfin eel (tuna). The protection or restoration of inanga spawning habitat can provide an important component to the regional whitebait fishery, and the ecological functioning of the Waipaoa, Te Arai and other lowland waterways in Turanganui a Kiwa.

These objectives will need to be considered in detail once technical assessment of the project has been completed. It is not anticipated that there would be any inconsistency with these objectives with appropriate environmental mitigation in place.



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APPENDIX 4

Potential Pouarua Dam Supply Area
(Aqualinc)

APPENDIX 4: POTENTIAL POURARUA DAM SUPPLY AREA

The command area (i.e. maximum extent of potentially irrigable land) that could be serviced without significant pumping capacity in addition to what would be required for water harvesting was estimated based on the elevation of the reservoir.

It is our understanding that Wi Pere Trust would pump water from their existing pond at Ormond to the dam. We determined the elevations at the points shown in Figure 1 (Table 1).

- Using a 2023 1 m LiDAR DEM¹ shows the Ormond Pond is flat, that where the Pouarua River crosses the proposed dam location is 9.7 m above the Pond, and that the north and south ends of the dam are 32.5 m to 32.7 m above the Pond respectively.
- Using a 2012 8 m DEM² shows a slight slope to Ormond Pond, and that where the Pouarua River crosses the proposed dam location is 21 m above the Pond, and that the north and south ends of the dam are 39.5 m to 37.5 m above the Pond respectively.

The differences in elevation values reflect the impact of averaging data across different resolutions.

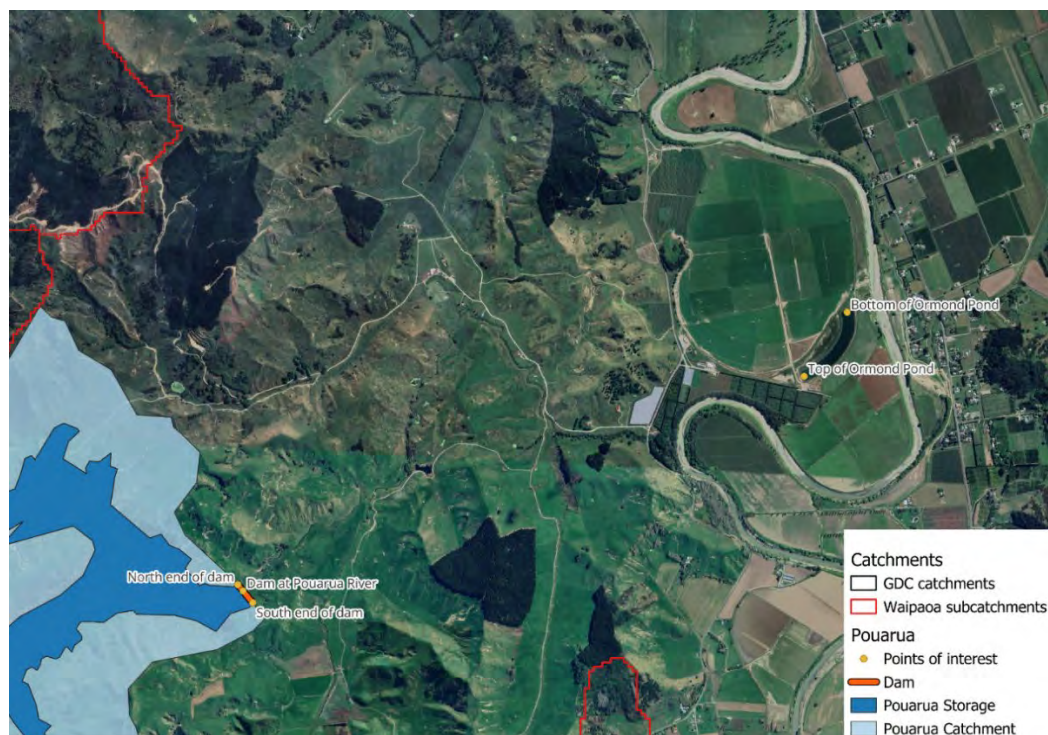


Figure 1: Pouarua points of interest.

¹ <https://data.linz.govt.nz/layer/115847-gisborne-lidar-1m-dem-2023/>

² <https://data.linz.govt.nz/layer/51768-nz-8m-digital-elevation-model-2012/>

Table 1: Pouarua points of interest elevation (NZVD 2016).

Point of interest	Elevation: 1 m LiDAR 2023 (m NZVD, 2016)	Difference from Ormond Pond (m)	Elevation: 8m NZ DEM 2012 (m NZVD, 2016)	Difference from Ormond Pond (m)
Bottom of Ormond Pond	21.698		20.006	
Top of Ormond Pond	21.698		20.030	
North end of dam	54.200	+32.502	59.522	+39.504
Dam at Pouarua River	31.440	+9.742	40.975	+20.957
South end of dam	54.372	+32.674	57.595	+37.577

We understand that water storage behind the dam would be equivalent to 27 m vertical³. Assuming this 27 m is above the Pouarua River (rather than 27 m above the highest topographic point of the potential dam site), this would suggest that water (from Ormond Pond to the top of water level) would need to achieve a 47.957 m vertical lift (to 67.975 m) based on the 8 m DEM. We have used the 'Dam at Pouarua River' value(s) for the bottom water level.

As a preliminary estimate of command area, we clipped the 8 m DEM⁴ to 68 m elevation⁵ to identify the maximum potential area that could be supplied from this pump. We refined these areas to the Waipaoa catchment⁶, removed urban areas⁷, and removed small, disconnected areas to give a potential supply area (≤68 m elevation) of 11,222 ha, as shown in Figure 2.

³ Maximum top water level of RL 62 m at bottom level of RL 35 m.

⁴ We used this coverage despite the greater resolution of the 1 m LiDAR DEM due to processing efficiency.

⁵ Note that this is slightly higher than the range of dam sizes considered in the report. This is to avoid excluding areas that could be economically supplied with a small amount of on-farm pumping.

⁶ Assuming water delivery to Southern or Uawa catchments would be uneconomical.

⁷ Based on Land Cover Database 2018 classifications: Built-up area, Herbaceous Freshwater Vegetation, Lake or Pond, River, Surface Mine or Dump, Urban Parkland/Open Space.

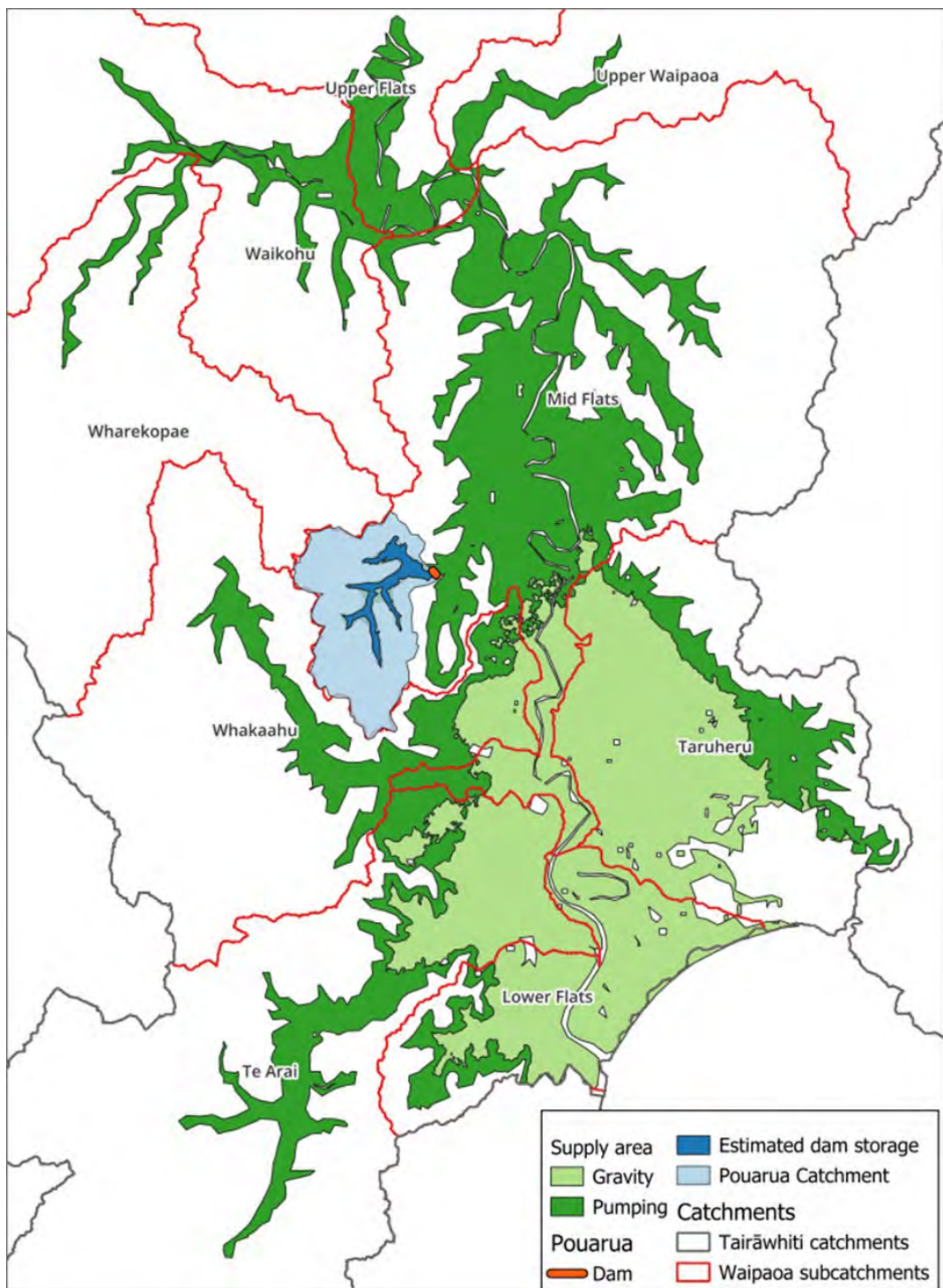


Figure 2: Supply area (based on pumping to 68 m elevation (using 8 m DEM values) to fill the proposed dam to top of water level from the Waipaoa River B block).

A large, stylized number '5' in a dark blue color is centered on a black background. To the left of the '5' is an orange L-shaped bracket, and to the right is another orange L-shaped bracket. Below the '5' is a horizontal orange line.

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APPENDIX 5

Supply-Demand Modelling Values
(Aqualinc)

APPENDIX 5: SUPPLY-DEMAND MODELLING VALUES

APPENDIX 5.1: MONTHLY MODELLED SUPPLY VALUES

Table 2 Catchment inflows and Waipaoa B block available allocation (Mm³), current allocation rules.

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
1992/93	4.49	4.06	4.16	5.93	3.84	3.98	3.36	4.25	4.13	3.36	3.92	2.39	47.86
1993/94	3.96	4.26	4.40	3.42	3.40	3.20	1.10	0.65	-0.02	2.67	3.27	3.94	34.24
1994/95	4.65	3.87	3.63	4.58	3.61	1.85	0.56	2.05	1.37	3.66	5.89	3.86	39.58
1995/96	5.13	3.89	3.61	3.46	3.22	2.02	2.01	3.74	3.50	4.80	4.94	4.03	44.34
1996/97	5.47	4.34	3.71	3.40	2.74	3.27	3.58	2.13	4.64	3.38	3.42	5.34	45.40
1997/98	6.97	4.44	4.10	4.23	3.31	0.87	-0.17	0.10	0.13	0.41	0.14	2.38	26.91
1998/99	5.98	4.23	3.47	2.82	3.16	3.12	1.70	1.02	2.06	2.57	4.30	4.19	38.62
1999/00	4.13	4.26	3.73	3.59	2.63	3.79	3.52	0.78	3.71	4.68	3.93	3.86	42.61
2000/01	6.04	3.80	4.24	3.72	3.43	3.31	2.77	3.20	3.62	3.50	3.79	3.75	45.16
2001/02	4.63	4.39	4.13	3.89	3.40	4.40	3.40	3.02	0.84	0.76	1.28	2.63	36.77
2002/03	4.73	5.99	3.43	3.38	0.65	3.07	1.14	0.44	4.14	3.94	3.58	3.85	38.34
2003/04	4.36	5.99	6.14	4.33	3.35	3.20	2.57	3.23	3.03	0.11	3.35	4.13	43.82
2004/05	5.79	4.91	3.64	4.15	3.19	2.32	0.48	1.61	1.71	2.77	4.42	4.25	39.26
2005/06	5.38	3.94	3.61	5.89	4.88	3.81	2.67	2.84	2.47	4.70	7.95	6.06	54.21
2006/07	7.32	4.81	3.67	3.94	3.03	3.33	2.43	2.25	1.08	0.70	0.18	2.36	35.10
2007/08	5.08	3.85	4.08	3.75	2.51	2.31	0.95	-0.06	1.11	1.69	4.52	4.14	33.92
2008/09	5.55	4.60	3.65	3.48	1.07	0.08	0.69	0.11	1.08	0.69	3.66	5.90	30.56
2009/10	6.69	4.28	3.70	4.80	2.88	0.82	1.84	4.05	3.24	1.35	3.15	5.23	42.04
2010/11	7.73	4.88	4.56	5.82	3.41	1.93	2.02	3.06	4.05	4.31	4.59	4.26	50.63
2011/12	6.58	4.94	3.97	3.74	3.40	2.56	3.98	3.10	4.68	7.54	3.97	3.78	52.24
2012/13	5.64	6.95	3.66	3.49	2.63	0.14	0.58	-0.02	-0.11	0.50	1.52	3.28	28.27
2013/14	4.61	5.58	5.13	3.65	3.46	3.08	0.72	1.07	0.87	4.80	2.49	5.79	41.25

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
2014/15	4.42	4.43	5.85	3.73	2.17	1.27	0.15	-0.12	0.89	1.17	3.72	3.66	31.33
2015/16	4.35	4.20	5.82	3.61	3.50	2.11	1.02	2.88	3.17	3.37	1.72	3.35	39.10
2016/17	4.57	4.31	5.43	4.32	3.51	2.23	-0.16	0.45	3.00	4.83	4.77	4.48	41.74
2017/18	5.39	4.18	4.24	3.47	3.21	2.27	3.16	2.81	3.22	3.42	4.07	7.12	46.55
2018/19	3.89	5.03	5.83	3.52	3.36	4.38	3.31	1.53	1.01	3.07	2.13	3.14	40.21
2019/20	4.09	3.68	3.49	4.48	2.46	2.34	1.04	0.21	0.97	0.92	2.45	5.66	31.77
2020/21	7.30	3.87	3.57	3.40	3.41	1.28	-0.10	0.54	0.14	0.28	2.17	4.42	30.27
2021/22	4.18	3.84	4.00	3.68	4.51	3.43	0.86	2.71	6.49	4.48	3.85	4.81	46.84
Average	5.30	4.53	4.22	3.99	3.11	2.53	1.71	1.79	2.34	2.81	3.44	4.20	39.96

Table 3 Catchment inflows and Waipaoa B block available allocation (Mm³), assumed future allocation rules.

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
1992/93	4.04	3.61	3.72	5.48	3.40	3.53	2.70	3.02	3.68	2.78	3.47	1.52	40.96
1993/94	3.51	3.81	3.96	2.39	2.81	2.38	0.08	-0.02	-0.51	1.66	2.58	3.50	26.15
1994/95	4.20	3.42	3.19	4.13	3.17	0.65	-0.11	1.49	0.29	3.05	5.44	3.42	32.35
1995/96	4.68	3.44	3.17	3.01	2.56	0.26	1.29	3.32	2.55	4.37	4.49	3.59	36.72
1996/97	5.02	3.89	3.27	2.95	1.60	1.96	2.77	1.18	4.09	2.95	1.74	4.90	36.33
1997/98	6.52	3.99	3.67	3.78	2.82	-0.11	-0.62	-0.32	-0.45	-0.25	-0.46	1.94	20.51
1998/99	5.53	3.78	3.03	2.07	1.86	1.98	1.17	0.09	1.06	2.07	3.85	3.75	30.24
1999/00	3.68	3.81	3.30	2.92	1.30	2.89	2.89	-0.28	3.26	4.25	3.48	3.43	34.91
2000/01	5.59	3.35	3.81	3.08	2.80	2.36	1.83	2.34	3.17	3.06	3.34	3.32	38.05
2001/02	4.18	3.94	3.69	3.44	2.97	3.95	2.95	1.90	-0.29	0.04	0.09	1.85	28.71
2002/03	4.28	5.54	3.00	2.28	-0.27	2.00	0.37	0.03	3.69	3.50	3.13	3.42	30.98
2003/04	3.91	5.54	5.70	3.88	2.75	2.03	1.27	2.44	2.07	-0.33	2.61	3.69	35.57
2004/05	5.34	4.46	3.12	3.70	2.22	1.06	-0.20	1.04	1.26	1.53	3.96	3.82	31.31
2005/06	4.93	3.49	3.18	5.44	4.45	3.36	1.18	2.02	1.36	4.27	7.50	5.63	46.81
2006/07	6.87	4.37	3.23	3.45	2.02	2.61	1.24	1.34	0.13	-0.06	-0.41	1.91	26.69
2007/08	4.63	3.40	3.65	3.30	1.35	1.12	-0.13	-0.52	0.21	0.97	3.99	3.71	25.67
2008/09	5.10	4.15	3.21	2.86	0.01	-0.46	0.04	-0.45	-0.06	0.04	3.11	5.46	23.00
2009/10	6.24	3.83	3.27	4.36	1.76	0.09	1.20	3.65	1.91	0.27	2.54	4.80	33.91
2010/11	7.28	4.43	4.12	5.38	2.76	0.09	1.49	2.51	3.33	3.52	4.14	3.82	42.88
2011/12	6.13	4.49	3.53	3.29	2.47	0.79	3.33	2.10	3.84	7.10	3.52	3.35	43.95
2012/13	5.19	6.50	3.22	3.04	1.90	-0.42	-0.13	-0.52	-0.56	-0.04	0.04	2.76	20.99
2013/14	3.64	5.13	4.70	3.20	2.67	2.24	-0.04	0.21	0.25	4.34	1.07	5.35	32.75
2014/15	3.72	3.92	5.42	3.28	1.01	0.33	-0.45	-0.53	0.22	0.46	3.19	3.22	23.79
2015/16	3.90	3.75	5.38	3.16	3.06	0.48	0.17	1.71	1.85	2.61	0.65	2.32	29.05
2016/17	4.12	3.86	5.00	3.87	3.07	1.02	-0.61	-0.07	2.55	4.39	4.32	4.05	35.57

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
2017/18	4.94	3.73	3.80	3.02	2.77	0.76	2.42	1.85	2.32	2.19	3.62	6.68	38.12
2018/19	3.44	4.58	5.39	3.07	2.93	3.93	2.27	0.35	0.27	2.13	0.79	1.93	31.08
2019/20	3.34	3.23	3.05	4.03	1.19	1.58	0.03	-0.32	0.16	0.24	1.71	5.22	23.46
2020/21	6.85	3.42	3.14	2.93	2.74	0.27	-0.59	0.01	-0.41	-0.24	1.54	3.98	23.65
2021/22	3.74	3.39	3.56	3.23	4.08	2.80	-0.38	2.30	5.36	4.04	3.40	4.37	39.90
Average	4.82	4.08	3.78	3.47	2.34	1.52	0.92	1.06	1.55	2.16	2.75	3.69	32.14

APPENDIX 5.2: MONTHLY MODELLED DEMAND VALUES

Table 4 Waipaoa A block shortfall demand: current Waipaoa River cease-take flows (Mm³).

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
1992/93	-	-	-	-	0.01	0.01	0.29	0.03	-	-	-	-	0.35
1993/94	-	-	-	0.06	0.03	0.25	0.33	0.01	-	-	-	-	0.68
1994/95	-	-	-	-	0.16	0.36	0.36	0.01	-	-	-	-	0.88
1995/96	-	-	-	0.005	0.06	0.32	0.29	-	-	-	-	-	0.67
1996/97	-	-	-	0.06	0.15	0.16	0.07	0.04	-	-	-	-	0.49
1997/98	-	-	-	-	0.16	0.34	0.40	0.14	-	-	-	-	1.04
1998/99	-	-	0.0002	0.15	0.13	0.19	0.23	0.01	0.001	-	-	-	0.72
1999/00	-	-	-	0.03	0.14	0.07	0.06	0.03	-	-	-	-	0.33
2000/01	-	-	-	0.07	0.02	0.19	0.21	0.03	-	-	-	-	0.53
2001/02	-	-	-	0.02	0.01	0.05	0.14	0.03	-	-	-	-	0.25
2002/03	-	-	0.002	0.02	0.14	0.20	0.29	0.10	-	-	-	-	0.76
2003/04	-	-	-	-	0.14	0.12	0.17	-	-	-	-	-	0.43
2004/05	-	-	-	0.02	0.10	0.09	0.33	0.02	-	-	-	-	0.57
2005/06	-	-	-	0.002	0.08	0.07	0.27	0.01	-	-	-	-	0.43
2006/07	-	-	-	0.04	0.20	0.14	0.23	0.03	-	-	-	-	0.64

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
2007/08	-	-	-	0.00004	0.14	0.10	0.25	-	-	-	-	-	0.49
2008/09	-	-	-	0.08	0.21	0.31	0.20	0.06	-	-	-	-	0.86
2009/10	-	-	-	-	0.10	0.28	0.25	-	-	-	-	-	0.63
2010/11	-	-	-	0.02	0.07	0.26	0.28	-	-	-	-	-	0.63
2011/12	-	-	-	0.05	0.08	0.20	0.18	0.02	-	-	-	-	0.52
2012/13	-	-	-	0.08	0.06	0.34	0.34	0.08	-	-	-	-	0.89
2013/14	-	-	-	0.07	0.03	0.21	0.33	0.01	-	-	-	-	0.66
2014/15	-	-	-	0.02	0.16	0.15	0.31	-	-	-	-	-	0.64
2015/16	-	-	-	0.07	0.01	0.31	0.25	-	-	-	-	-	0.63
2016/17	-	-	-	-	0.12	0.30	0.41	0.12	-	-	-	-	0.95
2017/18	-	-	-	0.02	0.08	0.32	0.18	0.04	-	-	-	-	0.63
2018/19	-	-	-	0.03	0.04	0.04	0.19	0.05	-	-	-	-	0.36
2019/20	-	-	-	0.01	0.11	0.19	0.26	0.12	-	-	-	-	0.70
2020/21	-	-	-	0.06	0.02	0.28	0.26	0.08	-	-	-	-	0.71
2021/22	-	-	-	0.01	0.06	0.10	0.17	0.04	-	-	-	-	0.38
Average	-	-	0.0001	0.03	0.09	0.20	0.25	0.04	0.00003	-	-	-	0.61

Table 5 Waipaoa A block shortfall demand: assumed future Waipaoa River cease-take flows (Mm³).

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
1992/93	-	-	-	-	0.01	0.01	0.29	0.03	-	-	-	-	0.35
1993/94	-	-	-	0.06	0.03	0.25	0.35	0.02	-	-	-	-	0.71
1994/95	-	-	-	-	0.16	0.37	0.39	0.01	-	-	-	-	0.92
1995/96	-	-	-	0.005	0.06	0.32	0.30	-	-	-	-	-	0.69
1996/97	-	-	-	0.06	0.15	0.16	0.07	0.04	-	-	-	-	0.49
1997/98	-	-	-	-	0.16	0.37	0.43	0.14	-	-	-	-	1.10

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
1998/99	-	-	0.0002	0.15	0.13	0.19	0.26	0.02	0.002	-	-	-	0.76
1999/00	-	-	-	0.03	0.14	0.07	0.06	0.03	-	-	-	-	0.34
2000/01	-	-	-	0.07	0.02	0.19	0.22	0.03	-	-	-	-	0.53
2001/02	-	-	-	0.02	0.01	0.05	0.14	0.03	-	-	-	-	0.25
2002/03	-	-	0.002	0.02	0.15	0.20	0.31	0.11	-	-	-	-	0.81
2003/04	-	-	-	-	0.14	0.12	0.18	-	-	-	-	-	0.44
2004/05	-	-	-	0.02	0.10	0.10	0.36	0.02	-	-	-	-	0.60
2005/06	-	-	-	0.002	0.08	0.07	0.27	0.01	-	-	-	-	0.44
2006/07	-	-	-	0.04	0.20	0.14	0.24	0.03	-	-	-	-	0.65
2007/08	-	-	-	0.00004	0.15	0.10	0.26	-	-	-	-	-	0.51
2008/09	-	-	-	0.08	0.23	0.35	0.22	0.06	-	-	-	-	0.94
2009/10	-	-	-	-	0.11	0.30	0.26	-	-	-	-	-	0.67
2010/11	-	-	-	0.02	0.07	0.26	0.31	-	-	-	-	-	0.66
2011/12	-	-	-	0.05	0.08	0.20	0.18	0.02	-	-	-	-	0.52
2012/13	-	-	-	0.08	0.06	0.37	0.36	0.09	-	-	-	-	0.95
2013/14	-	-	-	0.07	0.03	0.21	0.36	0.01	-	-	-	-	0.68
2014/15	-	-	-	0.02	0.16	0.17	0.34	-	-	-	-	-	0.69
2015/16	-	-	-	0.07	0.01	0.31	0.27	-	-	-	-	-	0.66
2016/17	-	-	-	-	0.12	0.30	0.44	0.12	-	-	-	-	0.99
2017/18	-	-	-	0.02	0.08	0.32	0.18	0.04	-	-	-	-	0.64
2018/19	-	-	-	0.03	0.04	0.04	0.19	0.05	-	-	-	-	0.36
2019/20	-	-	-	0.01	0.12	0.20	0.27	0.13	-	-	-	-	0.74
2020/21	-	-	-	0.06	0.02	0.30	0.28	0.09	-	-	-	-	0.75
2021/22	-	-	-	0.01	0.06	0.10	0.18	0.05	-	-	-	-	0.40
Average	-	-	0.0001	0.03	0.10	0.21	0.27	0.04	0.0001	-	-	-	0.64

Table 6 New irrigation area: 100% of new irrigation area (11,222 ha) (Mm³).

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
1992/93	-	-	-	0.11	2.29	1.76	14.92	2.40	-	1.81	0.43	1.07	24.79
1993/94	-	-	-	3.09	2.35	11.35	16.68	1.01	-	1.71	0.85	-	37.05
1994/95	0.53	0.16	0.48	0.11	9.59	17.54	17.16	0.91	-	0.53	0.53	-	47.55
1995/96	-	-	0.32	0.64	3.41	15.24	14.44	-	-	1.76	0.05	0.43	36.30
1996/97	-	-	0.11	3.20	7.84	8.05	6.29	2.98	-	1.71	0.96	-	31.13
1997/98	-	-	-	0.48	8.69	16.63	18.60	6.02	-	2.29	1.17	0.59	54.48
1998/99	-	-	0.85	5.97	6.29	10.39	11.78	1.76	0.32	1.60	1.23	0.05	40.24
1999/00	-	-	-	1.65	7.36	3.41	6.24	2.67	-	1.28	1.28	0.53	24.41
2000/01	0.11	-	-	3.62	1.39	10.45	11.83	1.12	-	1.87	0.91	-	31.29
2001/02	-	-	0.27	1.44	1.76	3.78	8.74	1.44	0.11	1.71	1.44	1.33	22.01
2002/03	-	-	1.12	1.17	6.82	9.91	14.92	5.22	-	1.92	0.21	0.43	41.74
2003/04	-	-	-	0.37	7.25	6.66	9.06	0.21	-	2.67	0.43	0.53	27.18
2004/05	-	-	0.43	1.39	5.28	4.85	17.06	0.75	-	2.03	0.32	0.43	32.51
2005/06	-	-	0.11	0.75	4.96	4.42	14.44	0.75	-	2.13	0.05	1.23	28.84
2006/07	-	-	0.11	2.45	9.97	6.61	13.17	1.87	0.32	2.13	1.71	1.07	39.39
2007/08	-	-	-	0.64	7.94	5.49	13.49	0.43	-	0.64	-	-	28.62
2008/09	0.43	-	0.59	3.57	10.34	13.59	10.93	3.25	-	2.35	0.53	-	45.57
2009/10	-	-	0.11	-	6.77	12.74	11.41	-	-	2.35	0.32	-	33.69
2010/11	-	-	0.64	1.92	4.10	12.26	14.13	0.32	-	1.60	0.53	-	35.50
2011/12	0.11	-	0.21	2.45	4.53	9.49	10.07	1.76	-	0.85	0.32	0.32	30.12
2012/13	-	-	0.32	3.41	4.37	14.66	16.36	4.26	0.05	1.49	0.27	-	45.20
2013/14	0.11	-	-	3.09	2.03	10.29	16.63	1.12	-	0.85	1.39	-	35.50
2014/15	0.53	-	-	0.96	8.63	7.52	15.46	-	-	1.92	0.85	0.43	36.30
2015/16	-	-	-	3.30	2.35	13.86	12.63	-	-	1.07	1.71	0.85	35.77
2016/17	-	-	-	-	7.73	13.81	19.40	4.80	-	0.85	0.43	-	47.01

Water year	July	August	September	October	November	December	January	February	March	April	May	June	Total
2017/18	-	-	0.21	1.12	5.06	14.13	10.29	1.71	-	2.45	0.43	-	35.39
2018/19	-	-	-	1.65	2.98	2.03	12.15	2.88	-	0.96	1.71	0.75	25.11
2019/20	-	-	0.43	1.60	6.77	7.89	14.87	6.24	-	2.08	0.80	-	40.67
2020/21	-	-	0.43	3.09	3.20	13.38	12.15	4.26	0.21	2.98	0.85	-	40.56
2021/22	-	0.11	-	0.43	4.85	5.28	10.55	2.13	-	2.03	0.43	-	25.80
Average	0.06	0.01	0.22	1.79	5.56	9.58	13.20	2.08	0.03	1.72	0.74	0.33	35.32



6

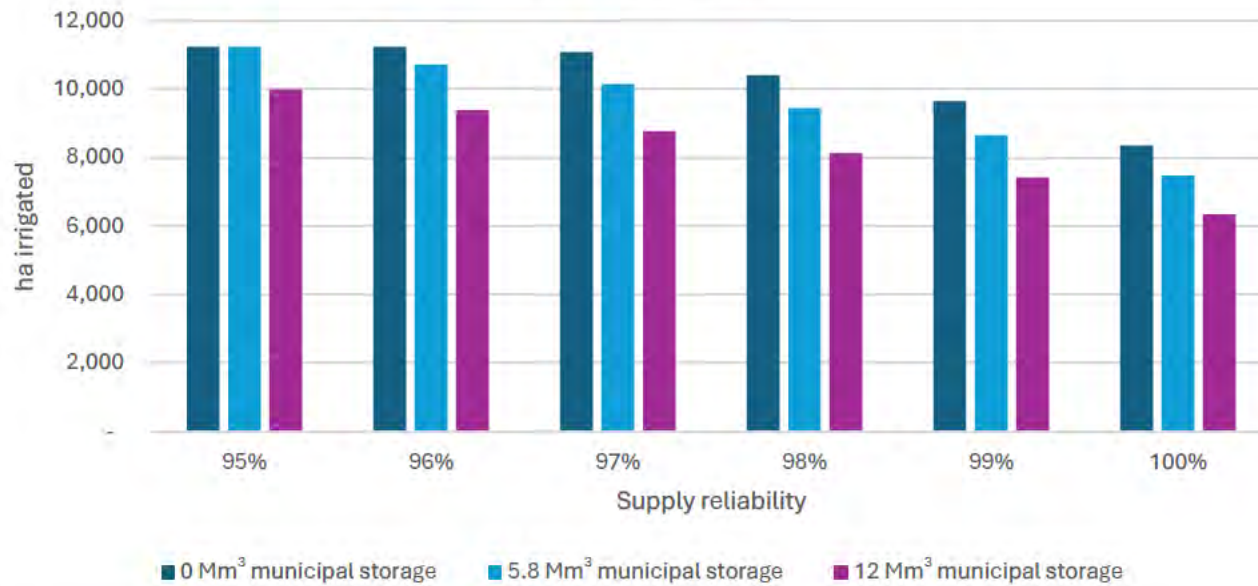
APPENDIX 6

Irrigated Areas with Varying Supply
Reliability (Aqualinc)

APPENDIX 6: IRRIGATED AREAS WITH VARYING SUPPLY RELIABILITY

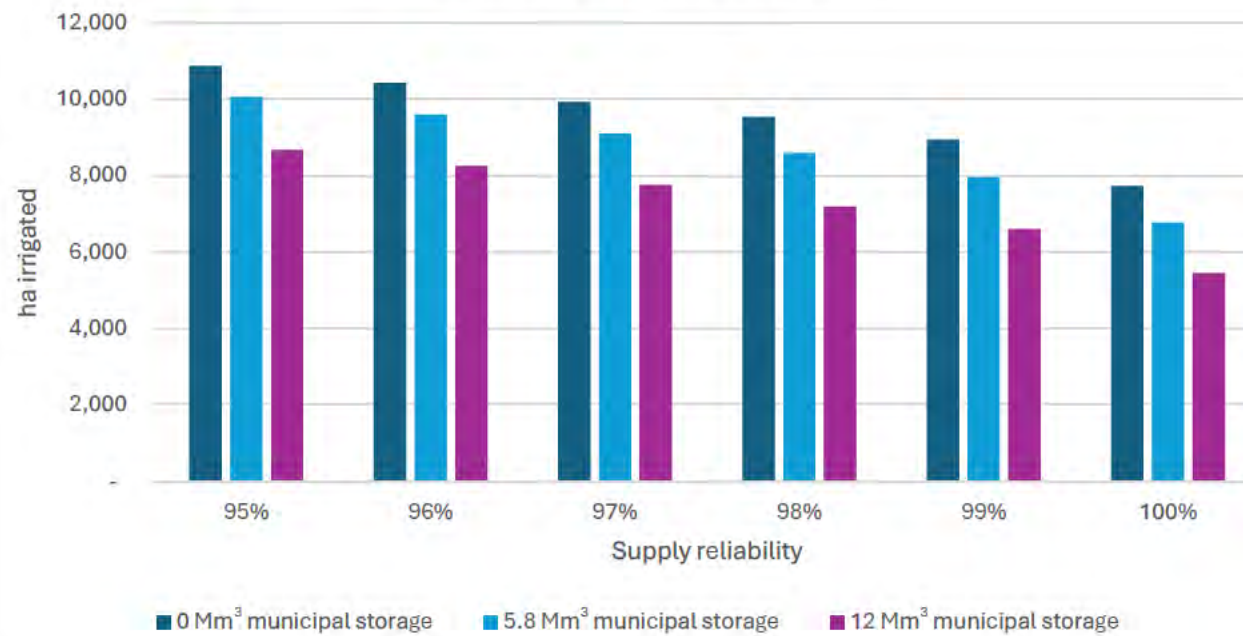
			New irrigated area (ha) achievable with varying supply reliability					
Supply	Flows		95%	96%	97%	98%	99%	100%
Catchment inflows and Waipaoa B available allocation	Current	0 Mm ³ municipal storage	11,222	11,222	11,076	10,402	9,639	8,338
		5.8 Mm ³ municipal storage	11,222	10,705	10,133	9,437	8,641	7,462
		12 Mm ³ municipal storage	9,976	9,381	8,764	8,113	7,406	6,329
	Assumed future	0 Mm ³ municipal storage	10,862	10,414	9,920	9,527	8,932	7,720
		5.8 Mm ³ municipal storage	10,043	9,583	9,089	8,584	7,945	6,767
		12 Mm ³ municipal storage	8,663	8,248	7,743	7,182	6,598	5,442

Supply: catchment inflows and Waipaoa B block available
allocation
Flows: current



Supply: catchment inflows and Waipaoa B block available
allocation

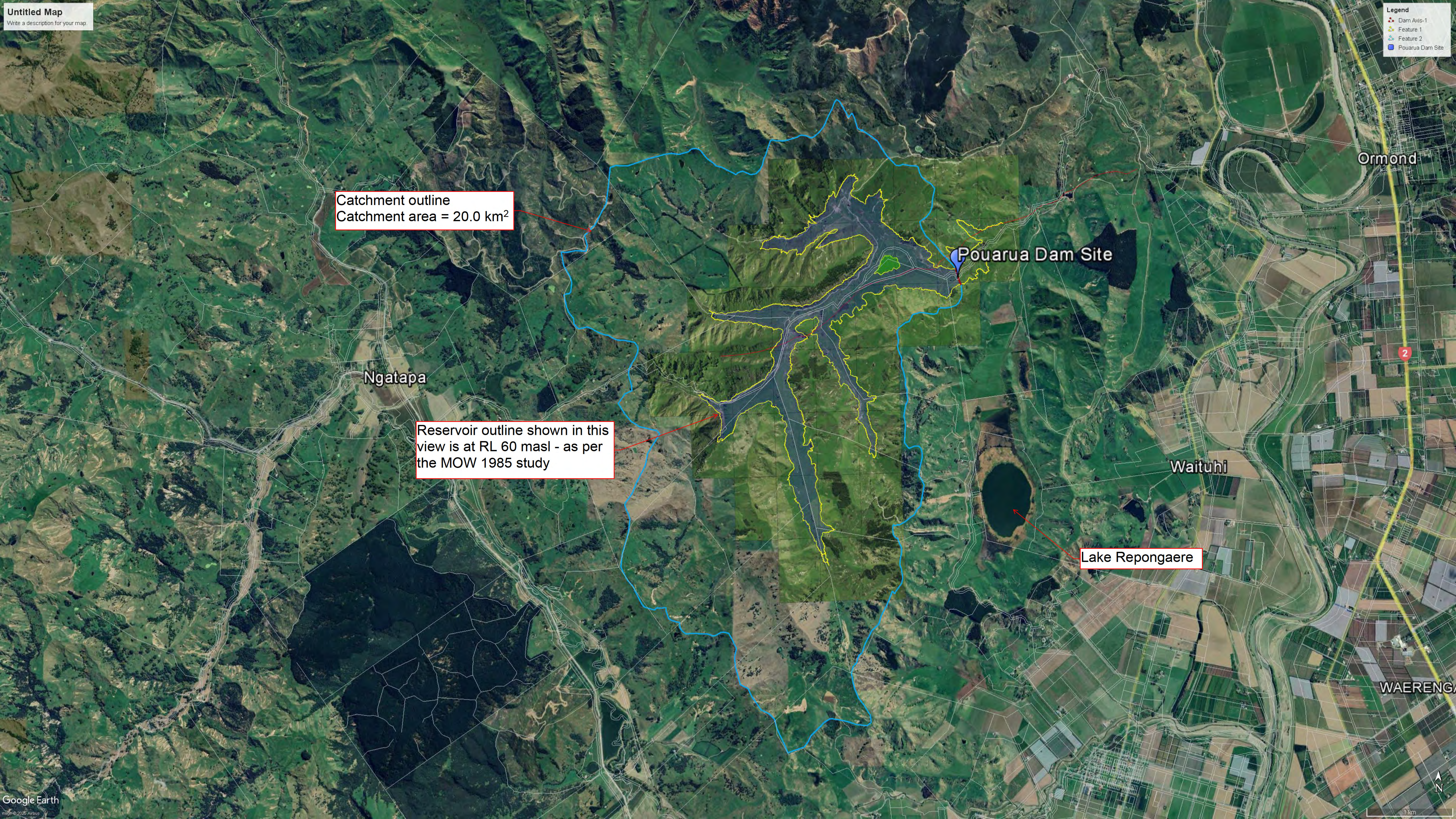
Flows: assumed future





APPENDIX 7

Reservoir Extents in Relation to
Adjoining Properties



Catchment outline
Catchment area = 20.0 km²

Reservoir outline shown in this
view is at RL 60 masl - as per
the MOW 1985 study

Lake Repongaere

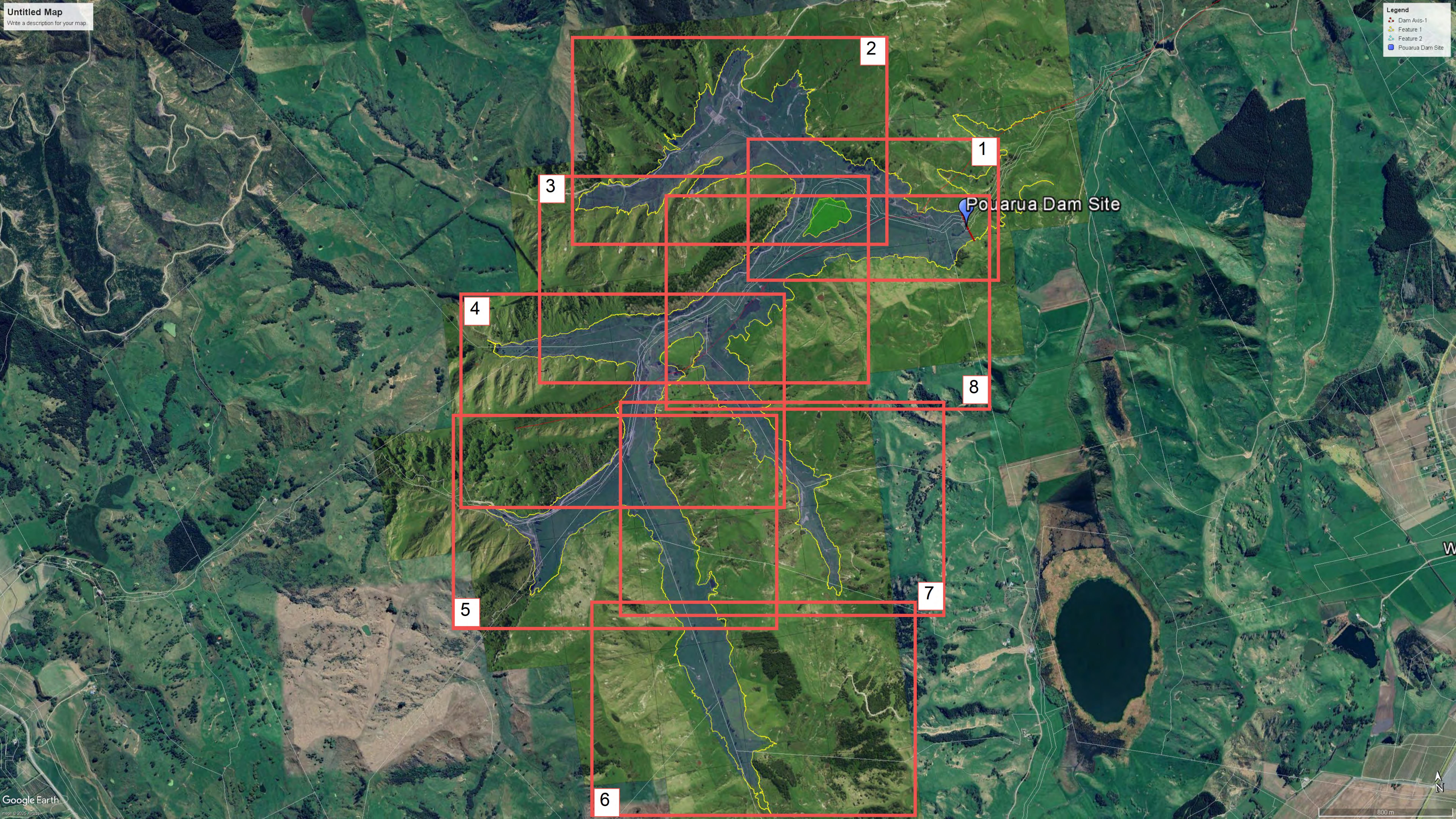
Reservoir outline shown in this view is at RL 60 masl - as per the MOW 1985 study

Pouarua Dam Site

Dam location based on interpretation of MOW 1985 Study:
- Reservoir water level RL 60 masl
- Assumed crest level RL 62 masl
- Assumed dam height 35m
- Reservoir volume = 25.5 Mm³ approx

The above parameters to be reviewed and reconfirmed as part of the study

Lake Repongaere





Pouarua Dam Site















Pouarua Dam



- 65m contour
- 60m contour
- 55m contour
- 50m contour

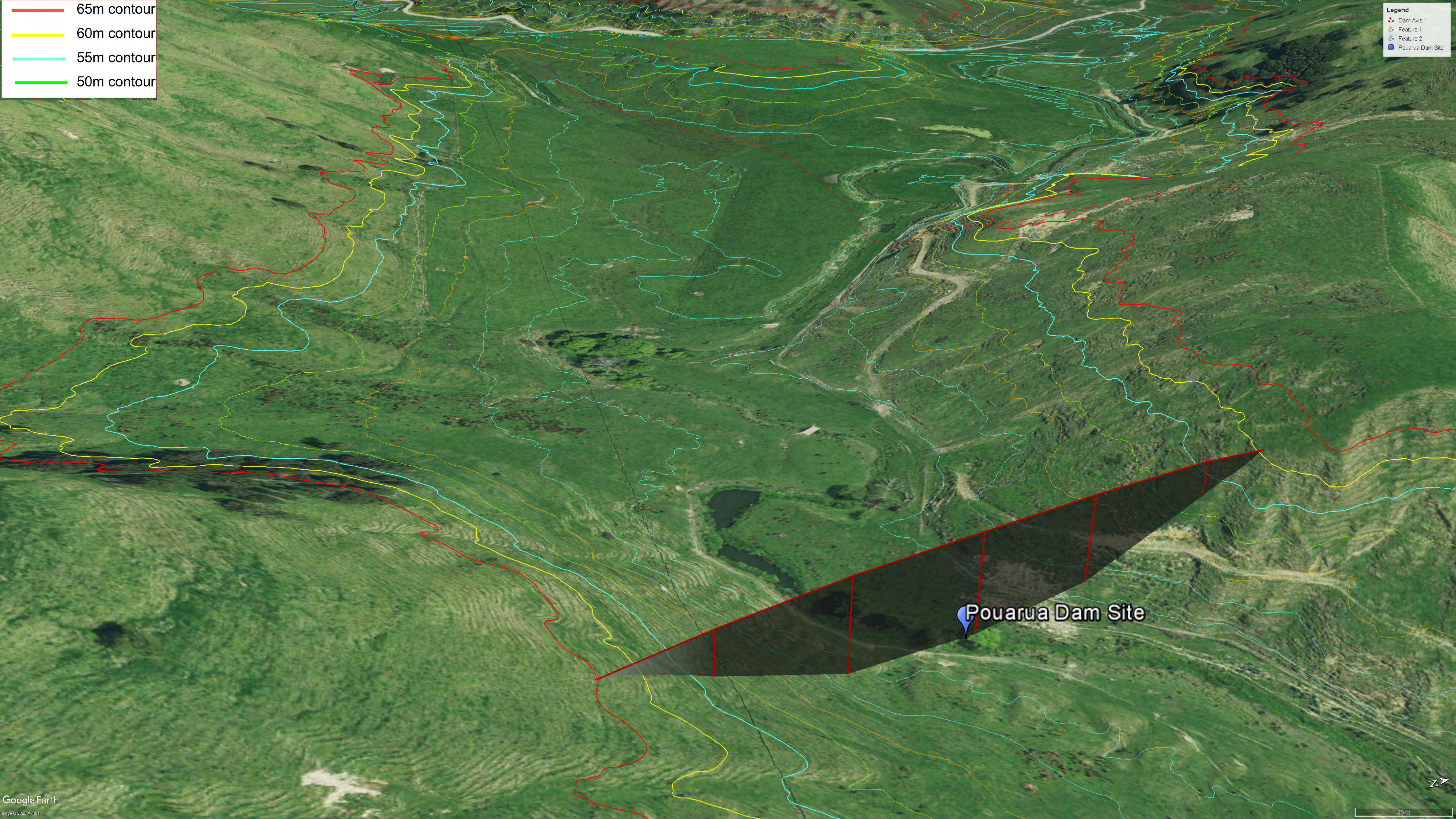
Legend

Pouarua Dam Site



- 65m contour
- 60m contour
- 55m contour
- 50m contour

- Legend
- Dam Axis-1
 - Feature 1
 - Feature 2
 - Pouarua Dam Site



- 65m contour
- 60m contour
- 55m contour
- 50m contour

- Legend
- Dam Axis-1
 - Feature 1
 - Feature 2
 - Pouarua Dam Site

Pouarua Dam Site