Te Kaunihera-ā-Rohe o Taratahi
CARTERTON
DISTRICT COUNCIL

AGENDA

Council Workshop

Date: **Wednesday, 17 December 2025**

Time: **1:00 pm**

Location: **Carterton Events Centre**
50 Holloway St
Carterton

Mayor S Cretney
Deputy Mayor G Ayling
Cr B Deller
Cr L Newman
Cr S Laurence
Cr S Gallon
Cr J Burns
Cr S Casey
Cr R Round

Notice is hereby given that a Council Workshop of the Carterton District Council will be held in the Carterton Events Centre, 50 Holloway St, Carterton on:

Wednesday, 17 December 2025 at 1:00 pm

Order Of Business

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4.1 Waingawa Water Storage Project (Council workshop) 6

5 Karakia Whakamutunga 299

1 KARAKIA TIMATANGA

Mai i te pae maunga, raro ki te tai

Mai i te awa tonga, raro ki te awa raki

Tēnei te hapori awhi ai e Taratahi.

Whano whano, haramai te toki

Haumi ē, hui ē, tāiki ē!

2 APOLOGIES

3 CONFLICTS OF INTERESTS DECLARATION

VIDEOCONFERENCE DETAILS

Microsoft Teams Need help?

Join the meeting now

Meeting ID: 494 672 792 980 47

Passcode: bK3pq6yA

Te Kaunihera-ā-Rohe o Taratahi
CARTERTON DISTRICT COUNCIL

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4 REPORTS

4.1 WAINGAWA WATER STORAGE PROJECT (COUNCIL WORKSHOP)

1. PURPOSE

For Council to consider the findings of the business case for the Waingawa Water Storage Project and to consider progressing through to the pre-construction stage of the project.

2. SIGNIFICANCE

The matters for decision in this report are not considered to be of significance under the Significance and Engagement Policy.

3. BACKGROUND

The Waingawa Industrial Park has been identified as a key area for future industrial growth in the Wairarapa and Greater Wellington region. Its favourable topography, proximity to the railway, access to renewable energy, and the recent establishment of a process water facility make it an attractive location for a variety of industries to consider setting up operations. According to a recent report released by the Wellington Regional Leadership Committee the Wellington Region is short of 698ha of industrial land.

On 19 February 2025, officers applied to the Ministry of Business, Innovation and Employment through the Regional Infrastructure Fund – Kānoa - for funding for the Waingawa Water Storage Concept Project. This application was approved by the Regional Infrastructure Fund as a Suspensory Loan in May 2025. To date none of the suspensory loan has been drawn.

In February 2025 Vitruvius conducted a project feasibility study along with a project business case which was finalised in May 2025. The project business case noted:

> *"The economic and financial case for the project demonstrates its significant long-term economic viability. The project is projected to deliver substantial benefits to the region… These benefits… confirm the project's potential to generate a positive return on investment and contribute to the Wairarapa's economic resilience."* – Waingawa Water Storage Facility Business Case (pg. 45).

Key findings:

- The Business Case is not dependent on grant funding.
- Benefit Cost Ratio (BCR): 2.1 (Option A) – pg. 36
- 352 new jobs – Economic stimulus of $38,991,166 per annum – pg. 27
- Net profit from Gravel - $1,790,000 – pg. 30

- Total net profit (undiscounted) at 40 years: $110,986,000 – pg. 45

Core Assumptions:

- Construction estimates include 50% contingency.
- Conservative uptake of 20 years.
- Extraction and sale of aggregate only focused on the dam area.
- Process water will be accessible from July 2025; therefore, uptake can commence.

The Business Case assumed that a suitable area of land can be acquired for the purpose of storing water that is within close proximity of the Water Race network and the Waingawa Industrial area.

The Business Case focuses on providing water to industrial users as the highest value user group. Providing water for agricultural irrigation is also a viable option, noting that agricultural users may take longer to invest in irrigation infrastructure.

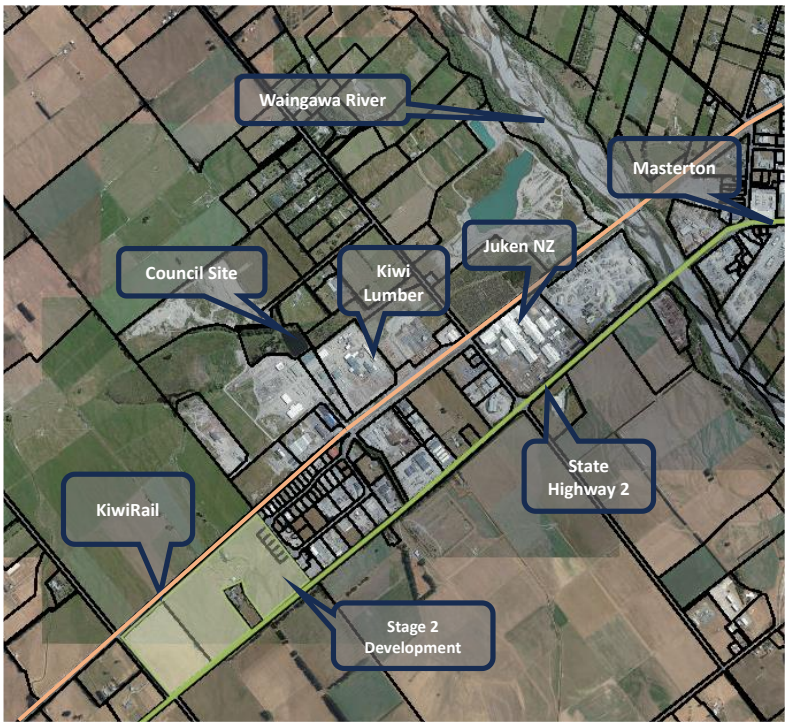
Management notes there is one low volume customer connected to the process water network at present and currently no significant demand for raw water. The key industrial users in the Waingawa Industrial area have not yet shifted water usage from potable water to raw water supply.

Demand analysis could be undertaken to determine the future demand for water from industrial and agricultural users. The low current demand and lack of take-up will make forecasting with accuracy difficult. Placing too much reliance on external demand forecasts may lead to suggestions of future water demand which does not eventuate, or eventuates much later than anticipated. Furthermore, businesses that may have demand for process water, may not be prepared to commit to investing in the Waingawa area until the water storage project is confirmed and under construction.

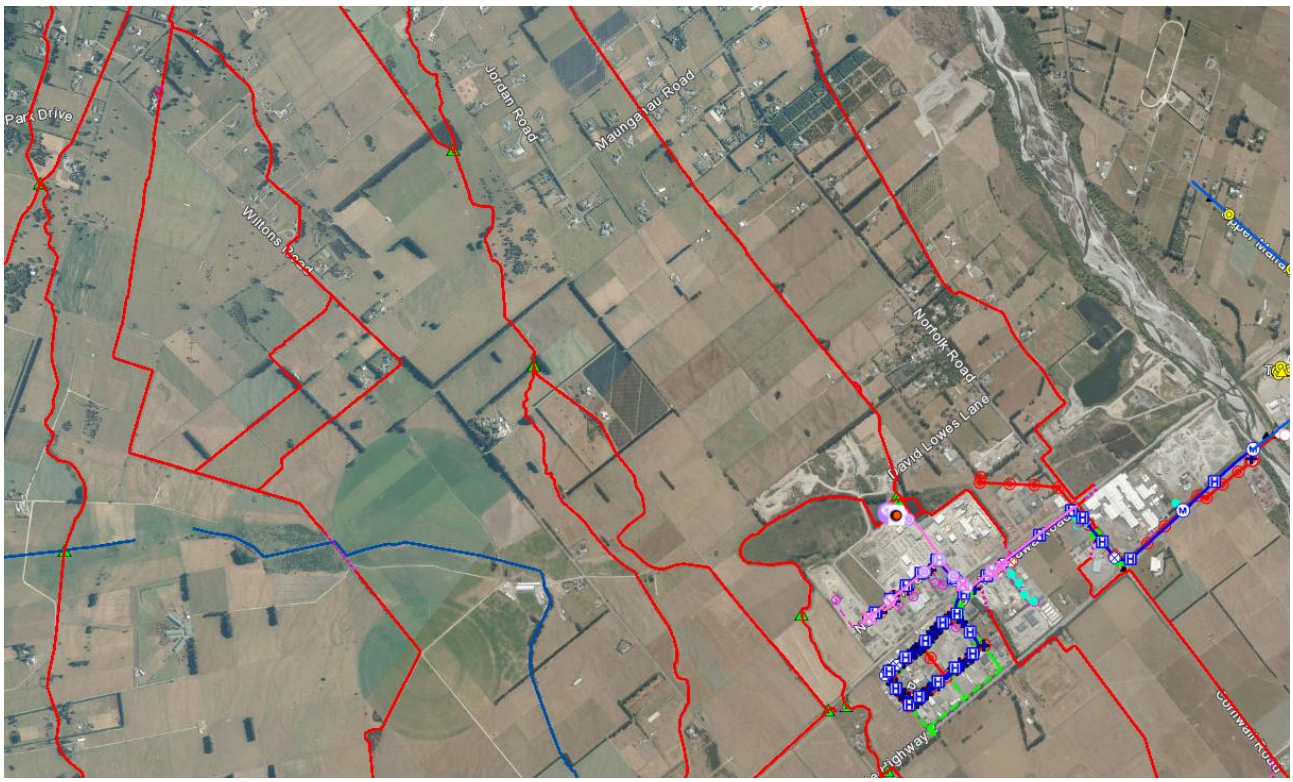
4. WAINGAWA INDUSTRIAL AREA

The Waingawa Industrial Area, SH2 Carterton is approximately 150ha of Industrial zoned land. A further 23ha of Industrial zoned land (Stage 2) remains undeveloped.

The main site users are Kiwi Lumber, Juken NZ, KiwiRail and large transport (fleet) operators, and there are a number of smaller industrial users on site. NZTA recently upgraded the State Highway installing three new roundabouts in the area to help with traffic flows.



The ideal site of the water storage facility is west of the Waingawa Industrial area and upstream (in the water race network) meaning that water to the Waingawa Industrial area could be fed by gravity.

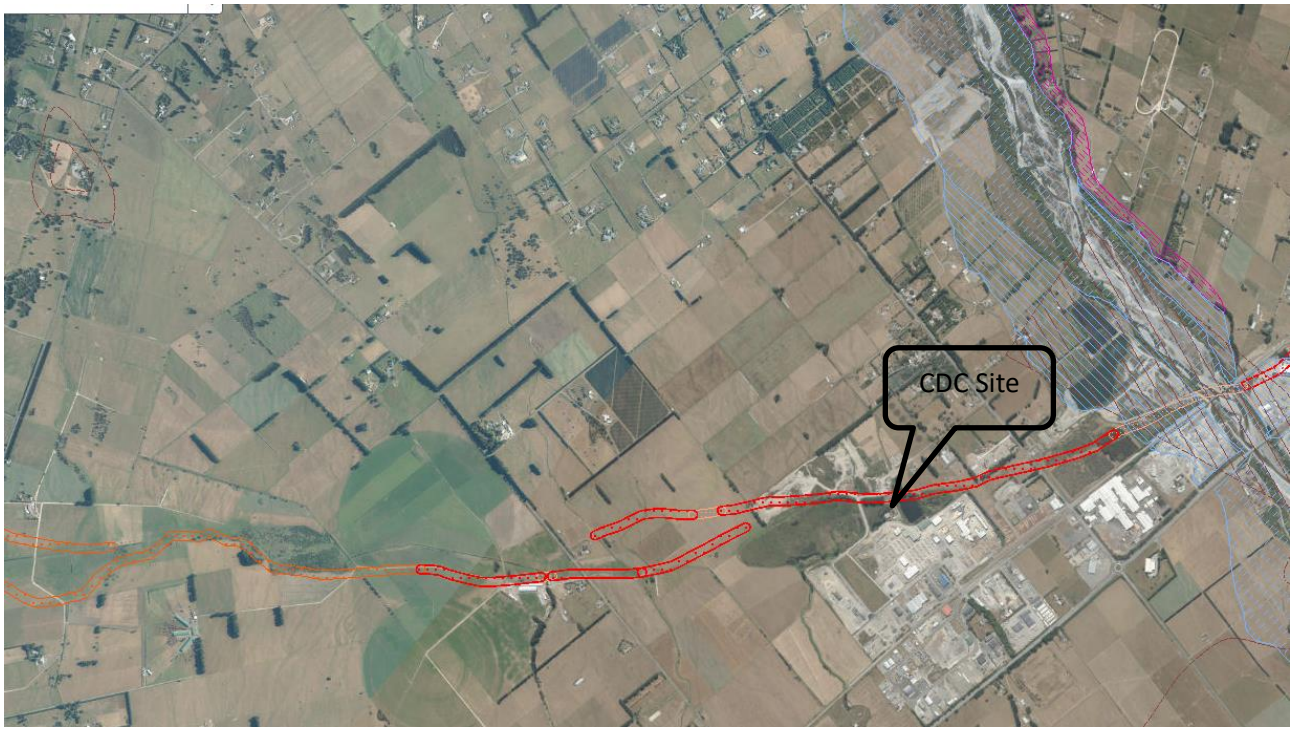


Waingawa Water Race network (red); Process water network (pink); MDC potable water network (blue); and Booths Creek (light blue)

The Taratahi Water Race network (shown in red above) guided the next phase of the land acquisition search. A number of sites were visited that had potential, including:

- a site a reasonable distance to the southwest
- smaller scale sites closer but still southwest
- sites to the east across the State Highway - and
- other sites to the west (upstream) of the Waingawa Industrial area.

When considering options a key criteria was the suitability of land for water storage dam development. The Waingawa Industrial area has an earthquake fault line running through it which is shown below in red. This earthquake fault line also runs directly through the existing CDC owned site and small dam at Waingawa.



Waingawa area earthquake fault lines (red); Flood hazard area (light blue)

Construction of a water storage dam will require a resource consent from Greater Wellington Regional Council. Overlaying known earthquake fault lines helped eliminate most sites to the southwest for consideration. Eliminating these sites also helped mitigate potential delays and risks in obtaining a resource consent from GWRC.

The final stage was to overlay property information – searching for potential sites for a large scale development of water storage (min 10ha, max 50ha) working upstream, away from the Waingawa Process Water Plant.

5. PROGRESS TO DATE

Following the consideration of the Waingawa Water Storage Business Case on 11 June 2025, Council agreed to proceed with the project in a phased approach.

Phase 1 – Land acquisition, and pre-construction.

Phase 2 – Procurement, construction and commissioning,

A further phase could be added to consider:

Phase 3 – Entity operating structure (council owned, community owned, mixed ownership)

Having secured land and completing the research and technical reports on the site, Council will soon be asked to consider the next steps, including approving the construction of a water storage facility on site.

This workshop paper is a pre-cursor to that decision, enabling Councillors to understand the project, it's impact and benefits, and consider options over the summer break.

5.1 Land Purchase

Securing a site to undertake the Waingawa Water Storage project is a critical element of Phase 1.

The initial proposed site was a privately owned parcel of land used for dairy grazing, west of the Waingawa Industrial area. Landowners support for the proposal was initially positive. However, over time support dwindled for selling a reduced parcel of land to support the project. After four months of negotiations there was no agreement on the possible location, area, or a broad timeline for the vendors to confirm a decision. The conditions of sale were expanding and negotiations on price had not started. Management exited the negotiations to focus on other more realistic acquisition possibilities.

Two further potential sites were identified and discussions started with both owners. Positively, both owners expressed interest in selling their properties to Council. Valuers were engaged to complete market valuations, as a way to inform price expectations for both parties.

<u>247 Norfolk Rd</u>

The property at 247 Norfolk Road had been granted permission for a 12 lot subdivision, however physical work on site had not been started. The negotiations focused on the owner's residential property and potential impacts of the water storage dam on their views – as their residence backed onto 247 Norfolk Road.

The valuation for this location was received while the owner was overseas for a month. Upon their return negotiations were successfully completed for the purchase of 247 Norfolk Road in late September 2025 for 43 ha at a price of $3,250,000, with settlement days later on 1 October 2025.

<u>70 Norfolk Road</u>

The second site is located at 70 Norfolk Road – and is owned by Higgins Contractors Ltd. Higgins is owned by Fletcher Construction, a publicly listed company. The site is a gravel quarry which has had approximately 200,000 m^3 of gravel extracted to between 3-5m below the surface. These gravel pits have inadvertently filled with groundwater and require permanent overflow relief to soak pits on site.

Higgins were keen to sell around 20ha of the 27ha site including the three large (water filled) gravel pits. The main condition was they could continue to extract gravel from the site once the water was removed.

The potential for the Higgins Site to be used for water storage is great, as the ponds have already been dug, and filled with water, and the Taratahi Water Race runs through the site. Being northeast of the CDC process water site will require slight pumping to site – a distance of approximately 1,500 meters.

Obtaining a valuation on the gravel site has been particularly difficult. Two valuers declined the engagement due to the complexity of the site and the cost of remediation. A valuer has finally been engaged and a report is expected before Christmas. Due to the current condition and remediation obligations (which we may not need to incur if we

retain the ponds, as ponds) we anticipate the land to be relatively low value compared to the purchase of 247 Norfolk Road.

Higgins have engaged with GWRC to discharge the water from the gravel pits - essentially seeking permission to lower the water levels to allow further gravel extraction. This is referred to as a *discharge* consent – discharging the water into the Waingawa River. Higgins have been working on this consent for the past two years.

If CDC acquires the site we would want to use the 200,000 m^3 of water, meaning we would need a water *use* consent from GWRC. We are working with GWRC to see if it is possible to change Higgins discharge consent to a water use consent. This process is not straightforward, cheap or quick. Consequently, we have advised Higgins that the ability to use the water in the quarry pits is a precursor that must be in place before Council could consider purchasing the site.

If GWRC allow the discharge consent application to be changed into a water use consent, this second site could represent a cheap, valuable addition to the overall Waingawa Water Storage plan. The Higgins site is connected to the section of Water Race network that is piped under SH2 and runs east along Cornwall Road, allowing for the expansion of the agricultural irrigation east of SH2.

5.2 Resource Consent Strategy and Assessment.

Boffa Miskell have been engaged to prepare the earthworks resource consent as well as consider the additional water take options and support any adjustments that could be required to the Taratahi Water Race resource consent. This work is still in early stages and will progress early 2026.

5.3 Field Investigations

In October 2025 the preliminary field investigations were completed to support the development of the concept design, review project budget, and inform detailed design for construction.

The GFR was completed by Geotechnical Professional Services firm, Riley Consultants with the support of local services providers Griffiths Drilling and Scott's Ag Contracting. The GFR collates geotechnical investigation and test results completed for the development of the concept and detailed dam design.

The scope of works was as follows:

- Site-walkover inspection.
- Five machine boreholes (MH), totalling maximum 100m of drilling.
- Up to 25 no machine excavated test pits (TP).
- In-situ strength tests comprising standard penetration test (SPT) in boreholes, and hand shear vanes in test pits.
- Groundwater observations in MH and TP during the investigation, including manual.
- measuring of water level in installed piezometers, and installation of water level loggers in piezometers for longer-term recording of water levels.
- Sampling of soils from test pits.
- Laboratory testing of selected samples.

The Geotechnical findings were positive and as anticipated and did not raise any concerns as to the suitability of the land or constructability of a dam in the location.

In addition to the geotechnical work, a topographical survey was completed by Adams and Shaw. The survey supported the development of the concept design and will be used in final design.

Both the geotechnical and topographical reports are ***attached*** to this paper.

5.4 Updated Project Cost Estimate.

Appropriately, project estimates used for the original business case were conservative. With the site now secured some risk and contingency factors included in the original business case can be reduced. Given the simplicity of the site and feedback from subject matter experts MMS and Riley Consultants, we have targeted water storage capacity of 1,000,000m³ for the concept design and engineers estimate. This is twice the original Option A estimated water storage capacity.

The WWS Project estimate was revised following the land purchase and updated engineers' estimates in December 2025. Revised project estimates indicate a total project cost of **$18,314,527** including the land purchase, and assuming a 20% contingency.

The original Vitruvius Business Case estimated the cost of developing a 500,000m^3 water storage dam (Option A) at $25.3m, excluding the cost of land purchase. If Council proceeds with the project as planned, it will double the available water storage capacity, and reduce the estimated cost by $7.0m *plus* the cost of the land purchase. Together the revised plan is forecast to cost more than $10m less than original estimate. This will further improve the Benefit Cost Ratio mentioned above.

The latest WWS project cost estimate is ***attached*** to this report.

It is important to note that the focus of the concept design is to store water taken from the water race and make it available at the outlet. The project estimate allows $2.5m for reticulation and pumping from the outlet if required. This cost provision will be finalised once water allocation uptake has been confirmed.

6. FINANCIAL IMPACTS

Borrowing

The total project estimates for both Phase 1 (pre-construction) and Phase 2 (construction and commissioning) has reduced from $25.0m excluding land purchase, to $18.3 including land purchase.

It is expected the project would be funded through:

1. CDC Local Government Funding Agency loan $3,700,000
2. Kānoa Preconstruction (suspensory) loan $3,000,000
3. Kānoa Construction loan $11,600,000

The Kānoa loans requires a minimum of 20% Co-Funding which – assuming a total cost of $18.3m – is $3.66m. Council approved the land purchase as a majority portion of CDC's co-investment. This was preferred as if the project does not proceed, CDC will be able to realise most, or all, of this investment through disposing of the surplus land.

The Kānoa loans, along with capitalised interest, will be finalised on completion of the construction phase. Repayment terms include annual principal and interest payments, which may be deferred for a period until new users are connected and being charged.

In the event the ownership of Waingawa Water Storage project changes to a Special Purpose Vehicle (SPV), Trust, Council Controlled Organisation or other entity, the loans can be re-assigned with prior permission from Kānoa.

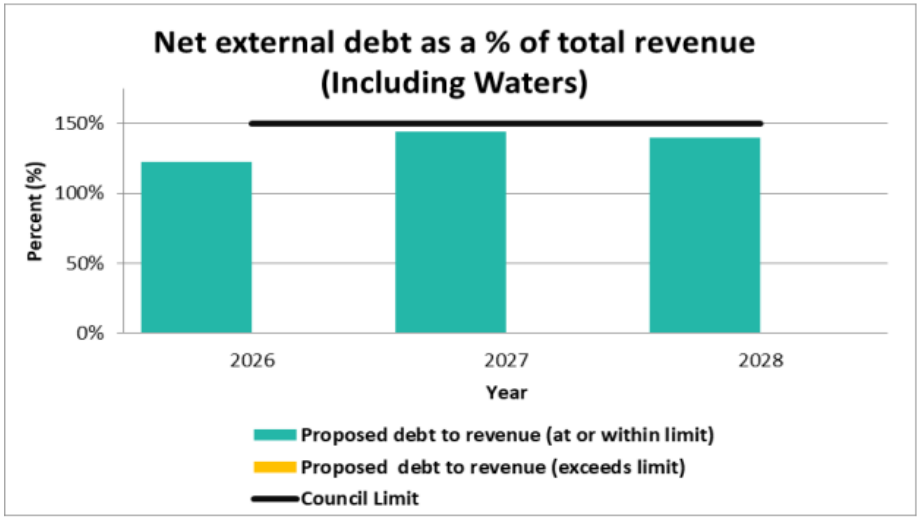
Impact on debt capacity and rates

The cost of incurring additional debt has been modelled to assess the impact on our borrowing capacity and average rates. The following assumptions have been used to prepared estimates:

- Drawdown of capital is based on the original total budget of $25m.
- A split of $15m in fiscal year 2025/26, with a further $10m in 2026/27.
- Base interest rate assumption of 5.2% is consistent with the LTP.
- Term of the loans is 15 years.
- Principal and interest repayments of the life of the loans.
- Depreciation on asset incurred from 2027/28 fiscal year.
- Removal of three waters revenue, expenditure and debt occurs on 1st July 2027
- Existing debt ceiling (Net external debt as a % of revenue) at 150% remains throughout.

Including Local Water Done Well

The modelling considered the impact of the WWS project including LWDW before and after the proposed LWDW Go-Live date. The first view below consolidates all debt within Council – a view likely taken by credit rating agencies in the first few years of the Water Services COO.

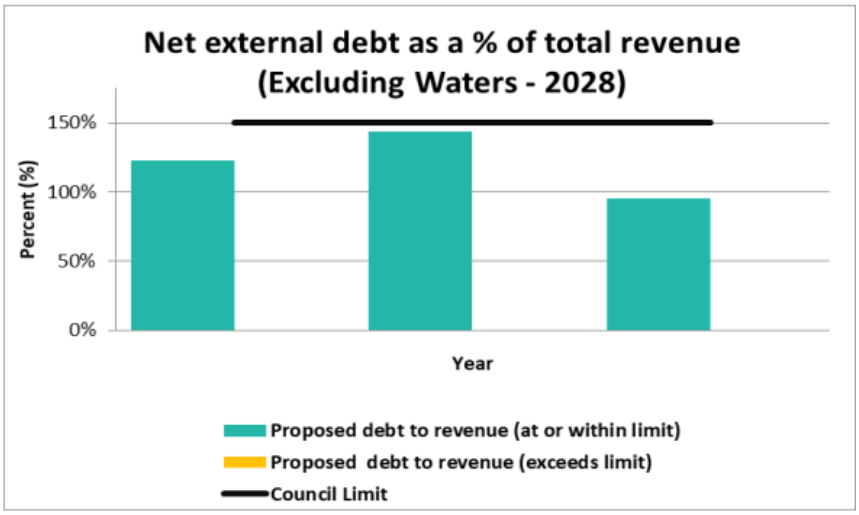


Under this scenario the additional $25m debt is not forecast to result in Council exceeding our debt capacity limits. The additional debt does however push close to the Council imposed limit - with 123% in 2026, rising to 144% in 2027 before principal repayments reduce this slightly in 2028 to 140%.

The rates impact under this scenario is estimated to have a small average increase of 1.2% in 2026, increase to 7.6% in 2027 and increase again to a maximum of 10.6% in 2028 and beyond.

Excluding Local Water Done Well

Removing three waters revenues from 1st July 2027 onwards does alter the picture for the remaining Council organisation.



Similarly, this scenario is not forecast to result in Council exceeding our self-imposed debt capacity limits. The additional debt does however push close to the Council imposed limit in 2026/27 - with 123% in 2026, rising to 144% in 2027 before LWDW reduces the net debt to revenue ratio to 96% in 2028.

The rates impact under this scenario is expected to have the same average increase of 1.2% in 2026 and 7.6% in 2027. However the rates impact of the project is forecast to increase significantly in 2028 to 17.7%, due to the loss of waters revenue.

Officers note the Council imposed 150% debt ceiling limit is lower than the LGFA limit of 175% net debt to revenue, for borrowers that do not have a credit rating.

7. OPTIONS

The procurement approach allows for flexibility in the way forward in terms of project budget and targeted volume water stored.

Option 1. – Smaller Volume Capacity

Despite the savings identified while progressing towards this next milestone, the burden of an additional $18.3m of debt on ratepayers is not to be dismissed lightly, especially when the benefits are concentrated in one geographic location.

Demand for raw water at Waingawa is low at present, and further work is needed to drive additional demand. Agricultural demand is often limited to summer seasons, while commercial and industrial demand is year-round.

Council could re-focus the project on a smaller capacity dam, while demand for raw water is being developed / encouraged. This would reduce the risk of the "build it and they will come" strategy delivering less than optimal up-take. Under this option a specific volume of water could be targeted (e.g. the original 500,000m^3) which could result in the project being delivered for less than $18.m.

Option 2 – Maximum Storage Capacity

A benefit of having a very standard dam design combined with simple site topography and robust procurement is that Council can scale the design volume water stored to fit the budget.

Based on the original project budget of $25,000,000 and using the updated cost forecast and contractor rates – recalculating to maximize dam size, with the

limitation being budget - suggests a dam with storage capacity of approximately 2,000,000m³ could be constructed.

This approach would further strengthen the Benefit Cost Ratio of the project and the potential impact the asset would have on the economy. Historically the total volume of water stored has always been a limiting factor in obtaining industry, community and iwi support.

Option 3 – Further Investigation

Understanding that the additional debt burden is not a decision to be taken lightly, Council could wish to take more time to consider the project importance given recent government announcements.

Council may wish to seek further information on how to mitigate some of the project risks. Of particular interest is the low demand at present for raw water in the Waingawa Industrial area.

Demand for raw water will be influenced by the state of the economy generally; changes in the climate and weather patterns; availability of water year-round; transportation further afield via the Water Race; the price of raw water, and the price of potable water being the next available alternative.

Council may also wish to investigate further the potential for alternative ownership models for the Waingawa Water Storage project. Officers note it is unlikely another organisation (other than the Crown) would underwrite the project during the construction and development phases. The potential for alternative ownership models is likely to more relevant once the water storage dams have been commissioned and are operational.

Council may also wish to engage further with Government, neighbouring Councils, business partners and iwi, seeking ways to progress the project for the good of all Wairarapa, while reducing the risks and burden on Carterton ratepayers.

8. RISKS

The Waingawa Water Storage project carries real risks to Council and our community, whilst delivering significant economic, employment and community benefits.

The availability of the Suspensory loan facility provided by Kānoa mitigates some risks in the event the project completes development work without the main construction project proceeding.

Council has also invested the majority of our co-funding portion in assets that could be on-sold to reduce debt.

Construction risks will always be present, and these will be mitigated as far as possible through robust and independent procurement practices and independent project oversight.

Risks remain around the future demand for raw water in the Waingawa industrial area and surrounding agricultural land. The low current demand may be due to lack of knowledge, and / or customers waiting to see if this water storage project actually proceeds (historically this has not been the case). A *"build-it-and-they-will-come"* approach is also inherently risky.

New equity partnerships and funding models could play a significant role in reducing the risks borne by Carterton ratepayers, as opposed to undertaking this project on our own.

The potential for this project to restrict Councils' other capital works, or emergency works – if required - over the next few years also should not be overlooked.

The impact of rates increases, forecast to be between 10.6% and 17.7% on additional borrowing of $25m also needs to be considered. This may become more crucial in light of recent Government announcements of rates capping.

9. RECOMMENDATION

That the Council workshop:

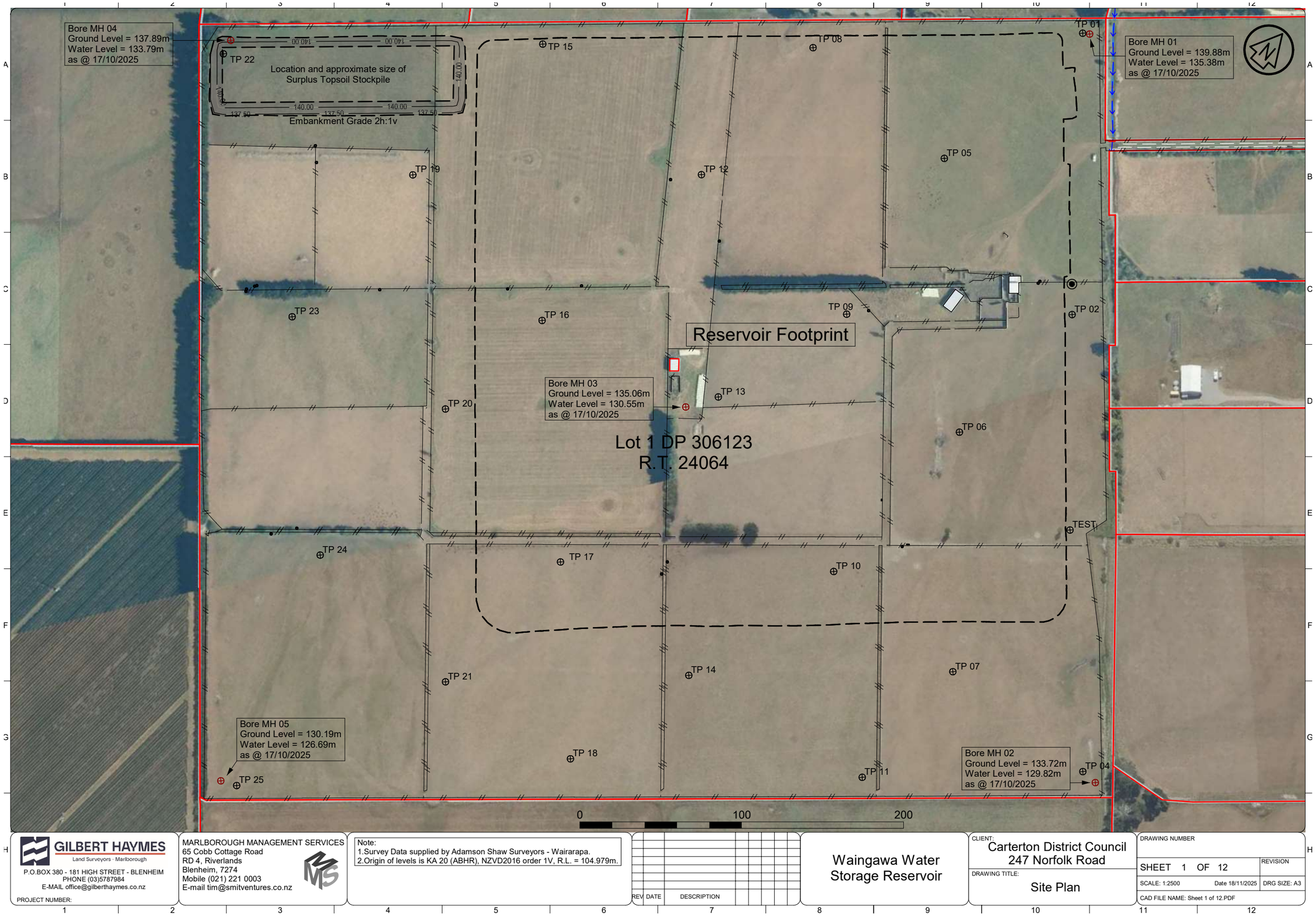
1. **Notes** the report.

File Number: **494083**

Author: **Geoff Hamilton, Chief Executive**

Attachments:

1. **1 - Concept Design Drawings** ⇩
2. **2 - Geotechnical Factual Report** ⇩
3. **3 - Adamson & Shaw Topographical Survey** ⇩
4. **4 - WWS Project Estimate** ⇩
5. **5 - Vitruvius Business Case 16 May 2025** ⇩
6. **6 - Waingawa Irrigation Report** ⇩
7. **7 - Waingawa Feasibility Study** ⇩



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Note:
1.Survey Data supplied by Adamson Shaw Surveyors - Wairarapa.
2.Origin of levels is KA 20 (ABHR), NZVD2016 order 1V, R.L. = 104.979m.

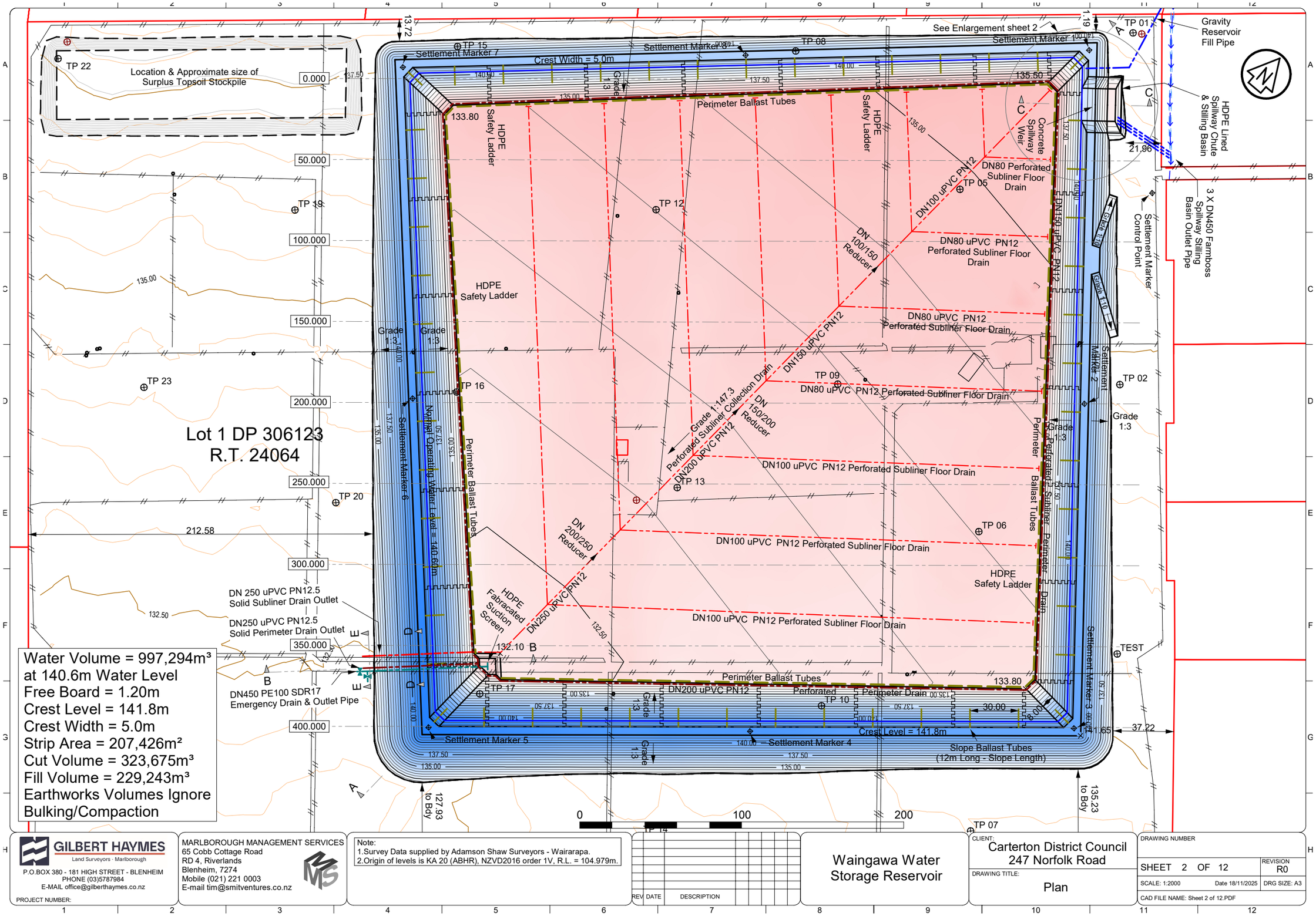
REV DATE DESCRIPTION

Waingawa Water Storage Reservoir

CLIENT:
Carterton District Council
247 Norfolk Road

DRAWING TITLE:
Site Plan

DRAWING NUMBER
SHEET 1 OF 12
REVISION
SCALE: 1:2500
Date 18/11/2025
DRG SIZE: A3
CAD FILE NAME: Sheet 1 of 12.PDF



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REV DATE DESCRIPTION

Waingawa Water Storage Reservoir

CLIENT: Carterton District Council
247 Norfolk Road

DRAWING TITLE: Plan

DRAWING NUMBER
SHEET 2 OF 12
REVISION R0
SCALE: 1:2000 Date 18/11/2025 DRG SIZE: A3
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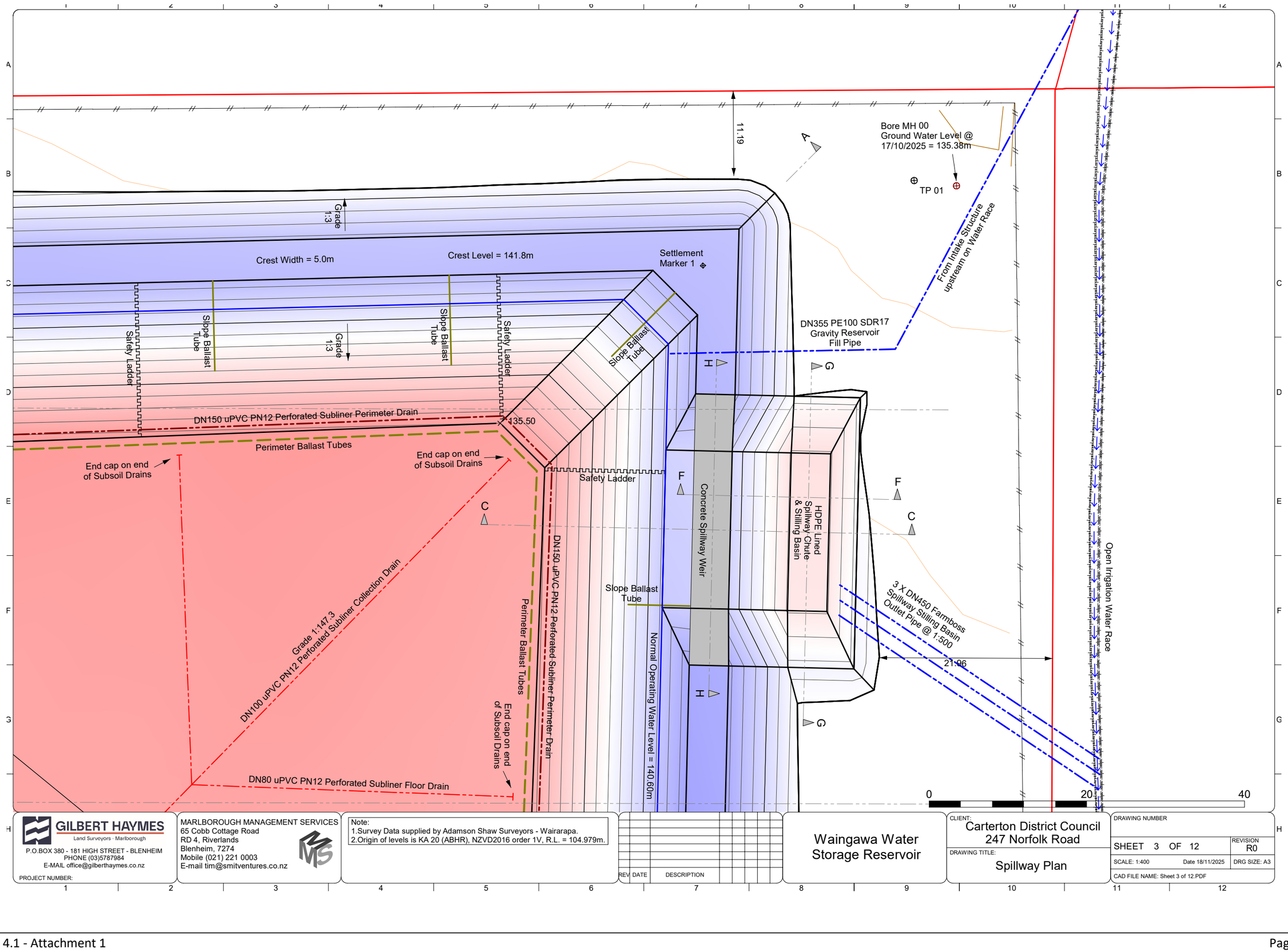

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2.Origin of levels is KA 20 (ABHR), NZVD2016 order 1V, R.L. = 104.979m.

REV DATE DESCRIPTION

Waingawa Water Storage Reservoir

CLIENT: Carterton District Council
247 Norfolk Road

DRAWING TITLE: Spillway Plan

DRAWING NUMBER
SHEET 3 OF 12
REVISION R0
SCALE: 1:400 Date 18/11/2025 DRG SIZE: A3
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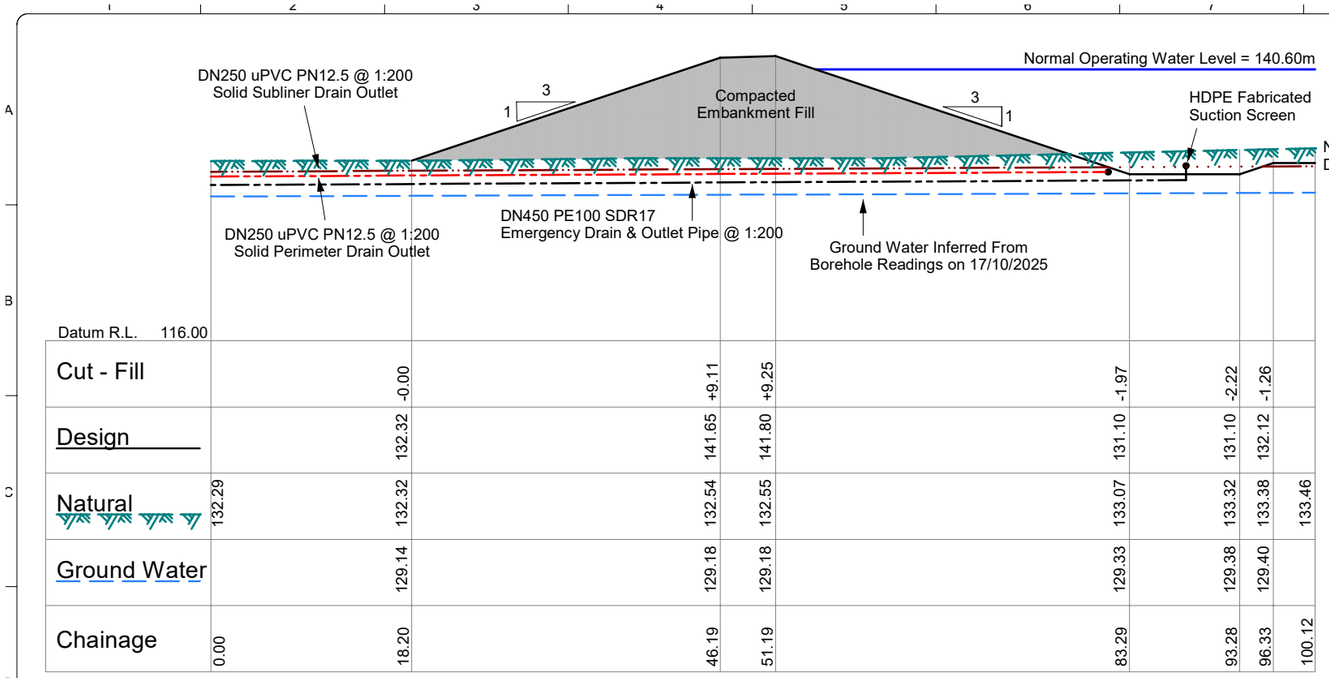

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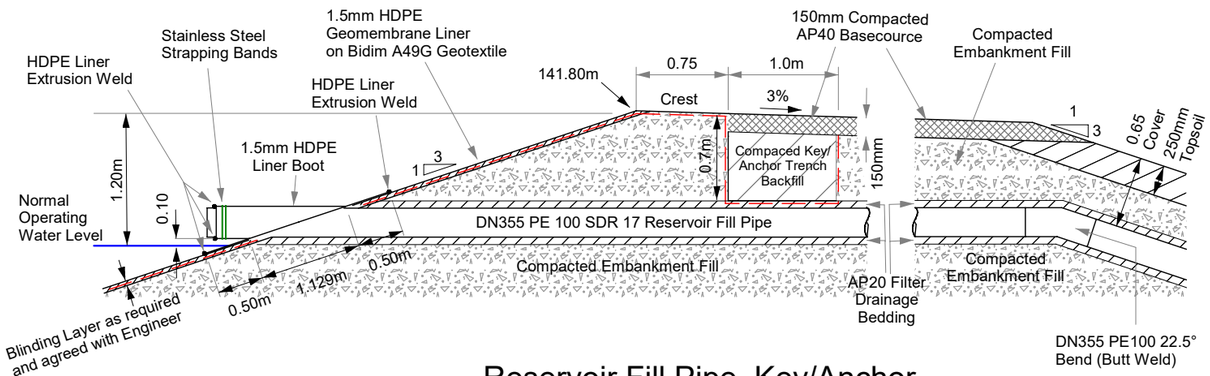
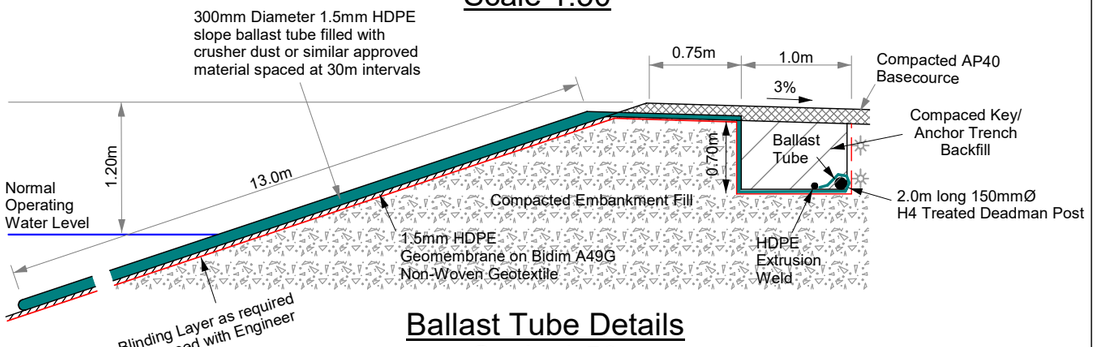


Reservoir Fill Pipe, Key/Anchor Trench & Crest Capping Detail
Scale 1:50



Ballast Tube Details
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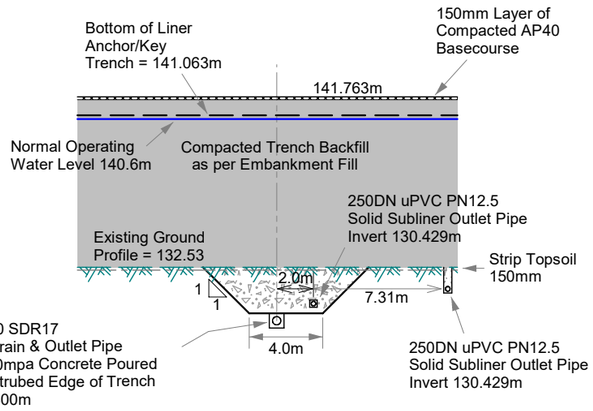
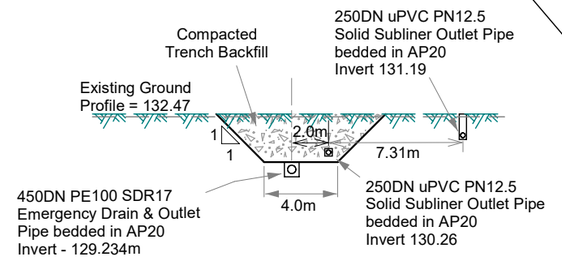


Cross Section D - D
Scale 1:30



Cross Section E - E
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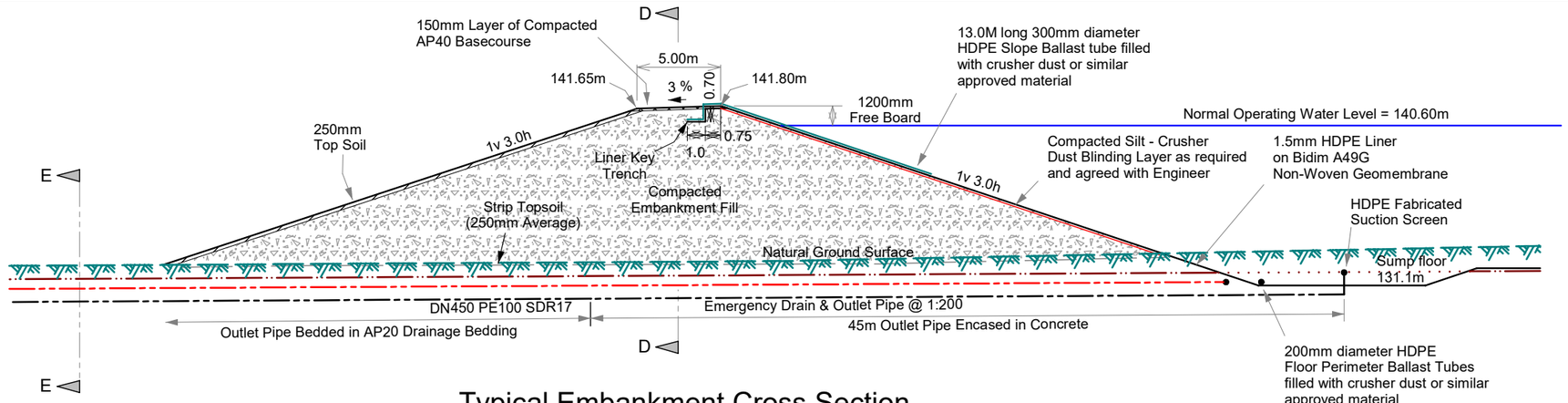

Typical Embankment Cross Section
Scale 1:300

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REV DATE DESCRIPTION

Waingawa Water Storage Reservoir

CLIENT: Carterton District Council
247 Norfolk Road

DRAWING TITLE: Cross Sections

DRAWING NUMBER
SHEET 5 OF 12
REVISION R0
SCALE: As Above
Date 18/11/2025
DRG SIZE: A3
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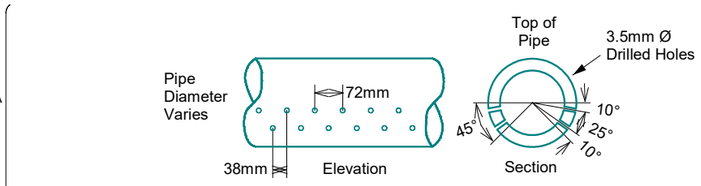
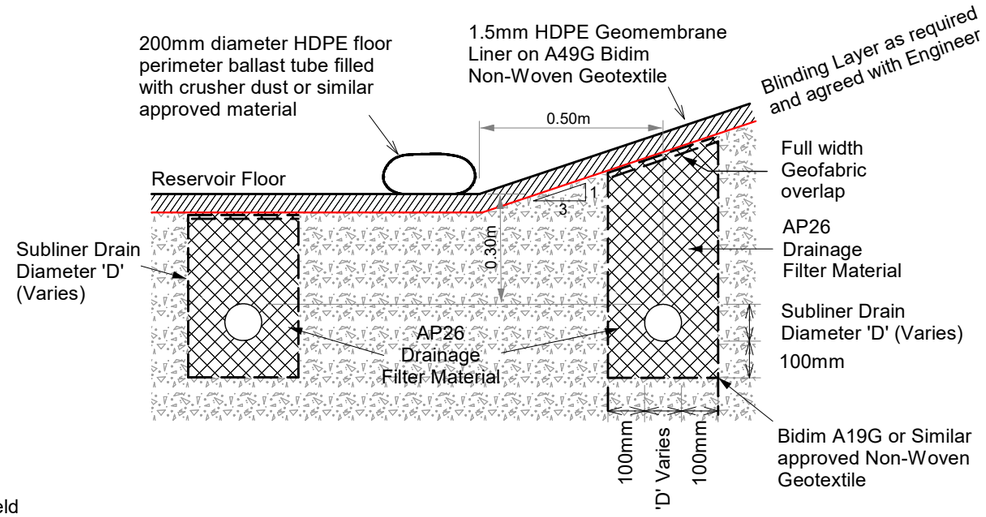
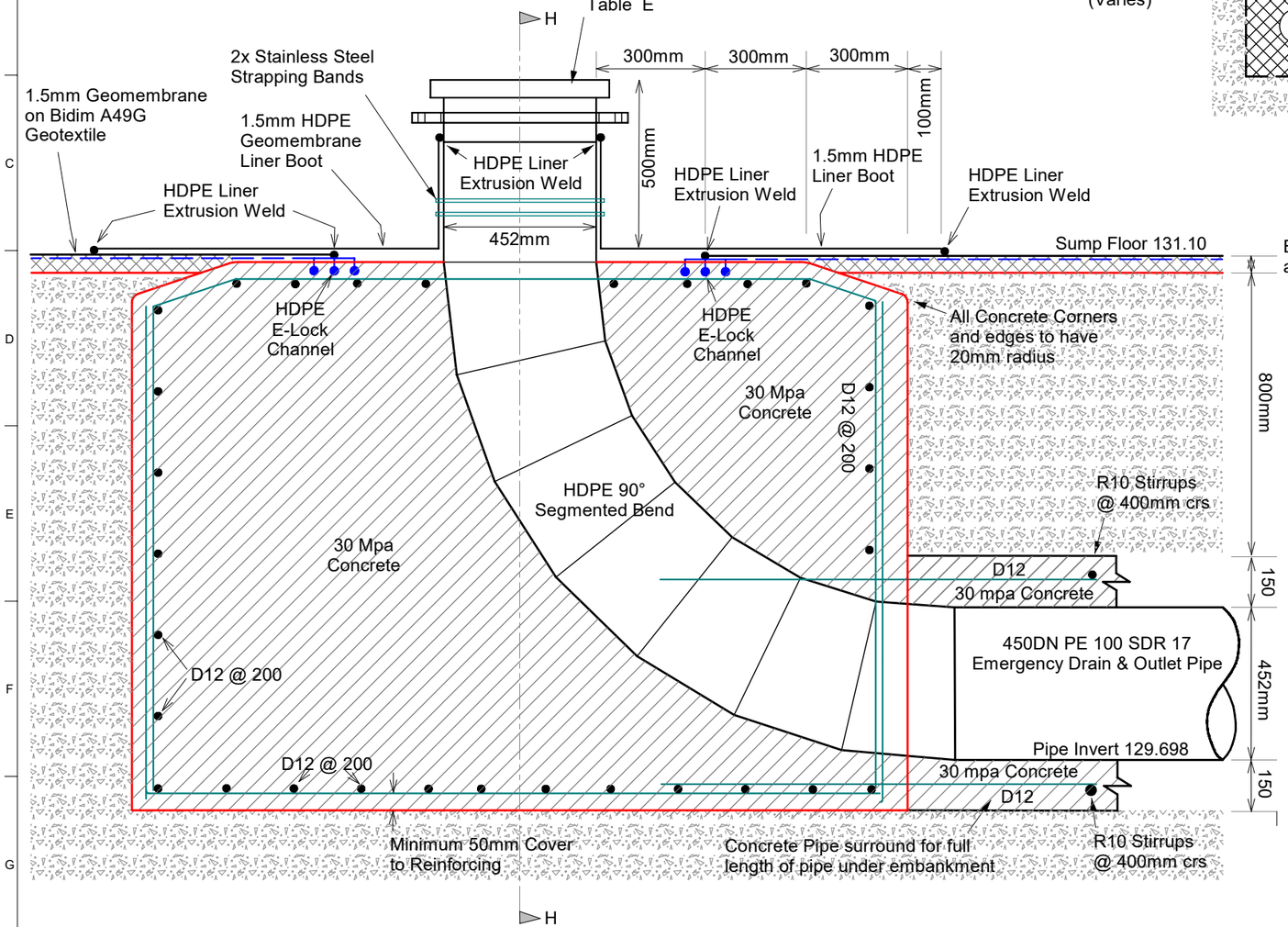


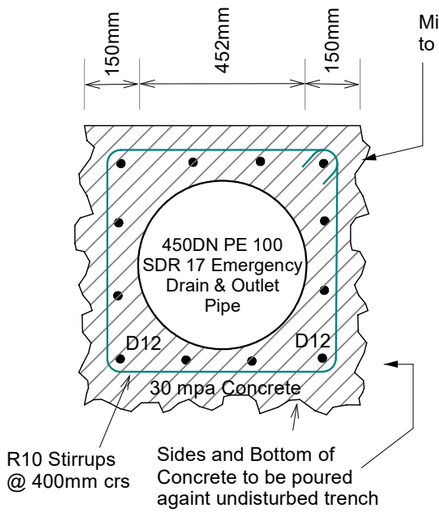
Subliner Drain Pipe
Drilling Details as per TNZ F/2
Scale 1:15



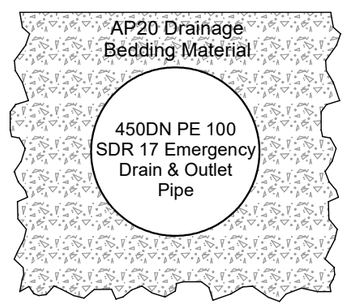
Subliner Drain Detail
& Perimeter Ballast Tube
Scale 1:15



Emergency Drain & Outlet Pipe Interface with liner
Scale 1:15



Concrete Encasement Detail
Upstream 2/3 of Pipe
Scale 1:15



AP 20 Bedding Detail
Downstream 1/3 of Pipe
Scale 1:15

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REV. DATE DESCRIPTION

Waingawa Water Storage Reservoir

CLIENT: Carterton District Council
247 Norfolk Road

DRAWING TITLE: Details Sheet

SHEET 6 OF 12 REVISION
SCALE: DRG SIZE: A3
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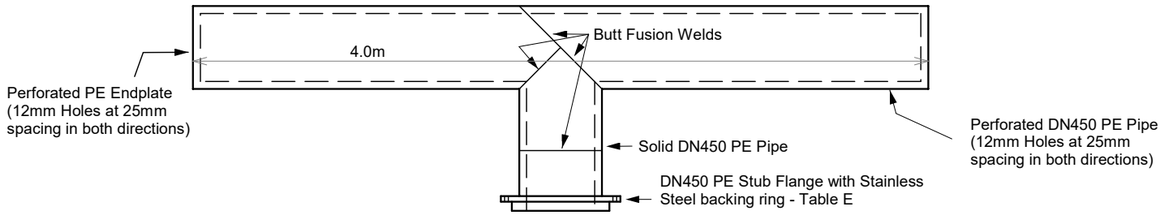
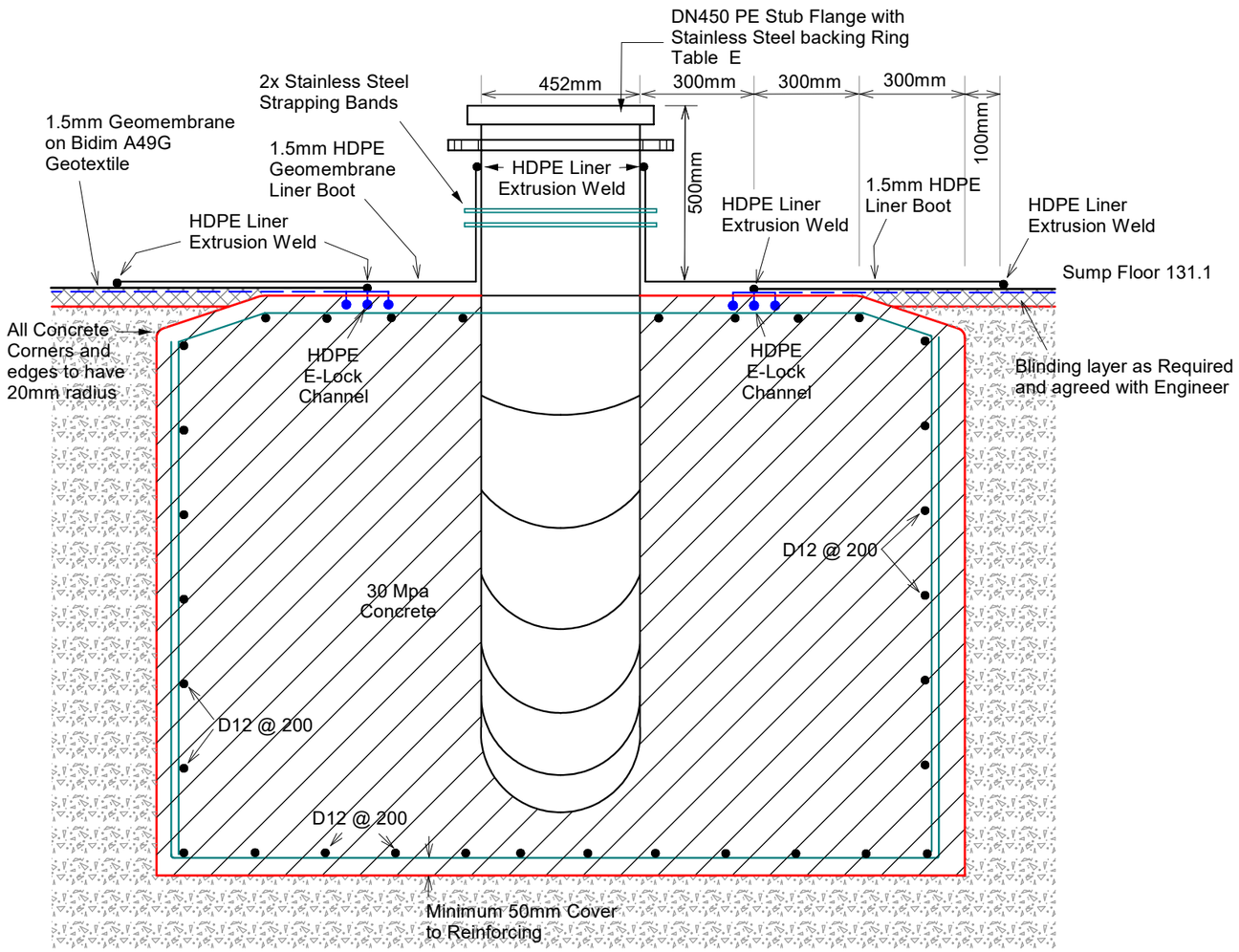


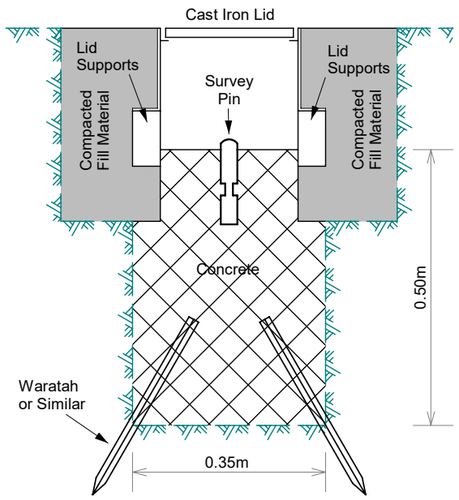
Emergency Drain & Outlet Pipe - Inlet Screen
Scale 1:30



Emergency Drain & Outlet Pipe - Section H - H
Scale 1:15



Typical Emergency Drain,
Outlet Pipe & Valve Details
(Not to Scale)



Settlement Marker Outlet
Scale 1:10

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REV DATE DESCRIPTION

Waingawa Water
Storage Reservoir

CLIENT: Carterton District Council
247 Norfolk Road

DRAWING TITLE: Details Sheet

SHEET 7 OF 12 REVISION
SCALE: As Above DRG SIZE: A3
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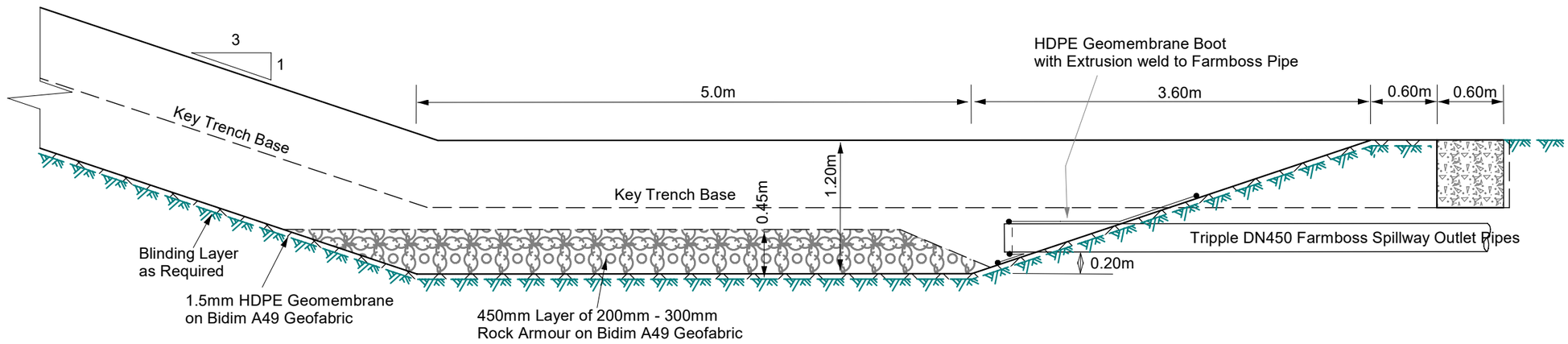
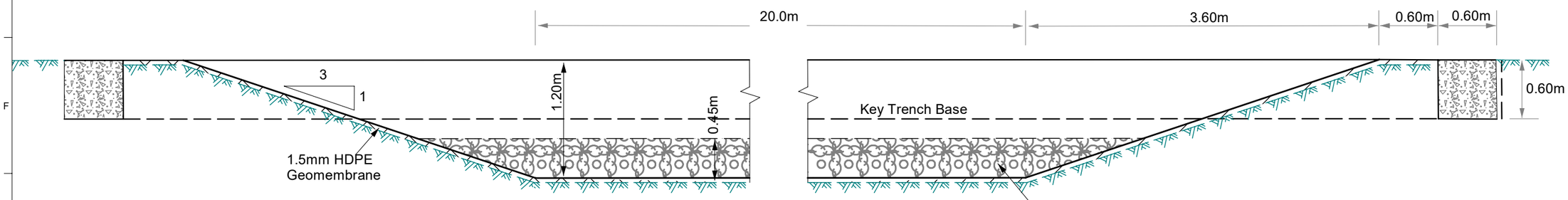


Section F - F
Scale 1:40



Section G - G
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REV | DATE | DESCRIPTION

Waingawa Water Storage Reservoir

CLIENT: Carterton District Council
247 Norfolk Road

DRAWING TITLE: Cross Sections

DRAWING NUMBER
SHEET 8 OF 12 | REVISION R0
SCALE: As Above | Date 18/11/2025 | DRG SIZE: A3
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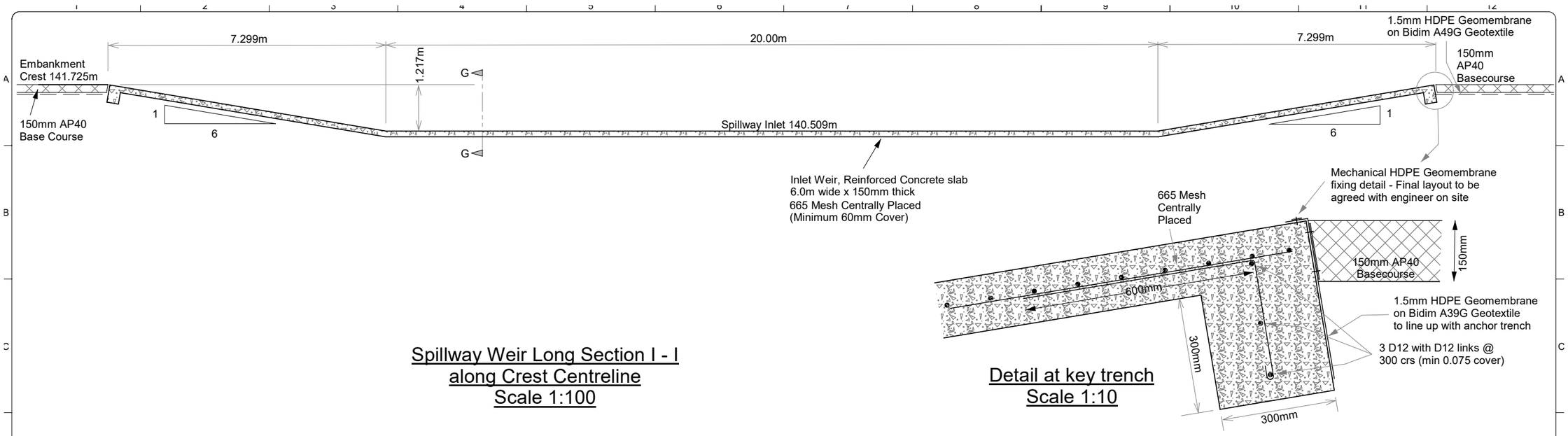
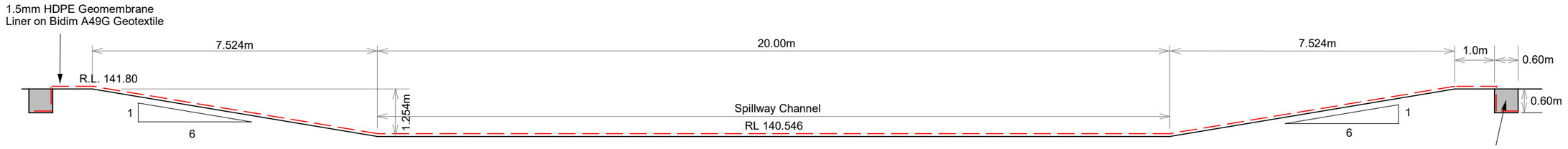
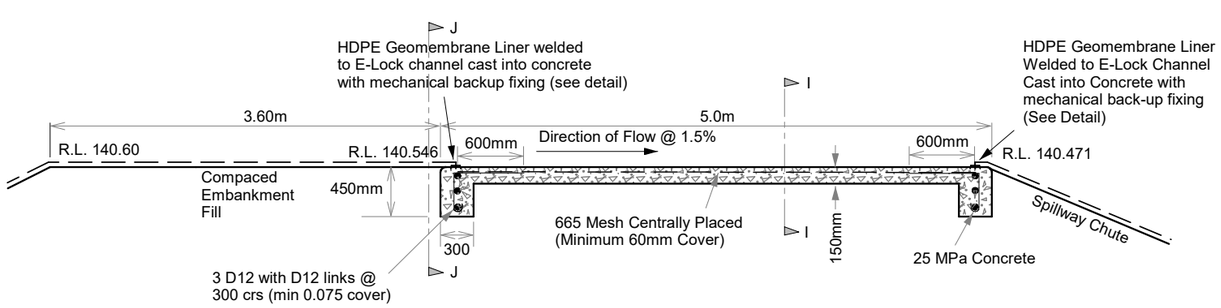


Spillway Weir Long Section I - I along Crest Centreline
Scale 1:100

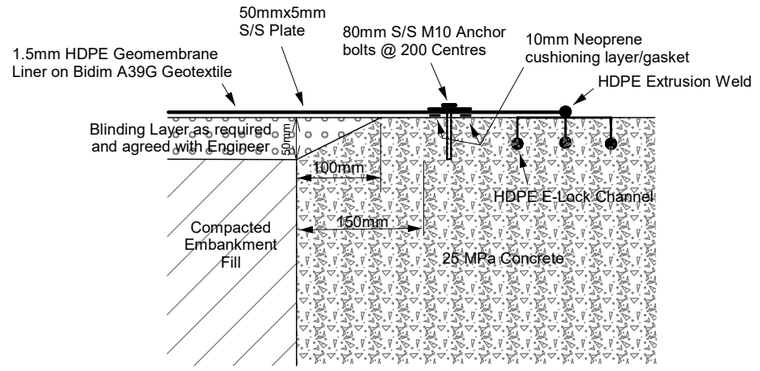
Detail at key trench
Scale 1:10



Spillway Cross Section J - J upstream of Weir
Scale 1:100



Spillway - Weir Cross Section H - H
Scale 1:50



Detail
Not to Scale

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REV | DATE | DESCRIPTION

Waingawa Water Storage Resaervoir

CLIENT: Carterton District Council
247 Norfolk Road

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DRAWING NUMBER
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REVISION R0
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Date 18/11/2025
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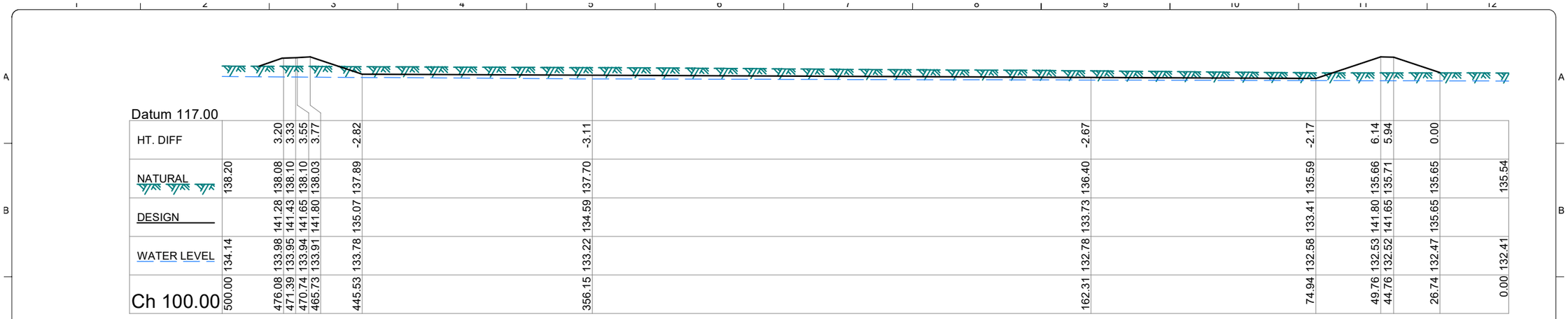

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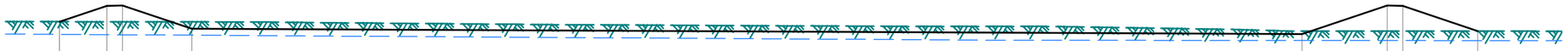

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DESIGN		136.57	141.65	141.80	134.36	132.67	141.80	141.65	133.64		
WATER LEVEL	132.68	132.57	132.47	132.44	132.29	130.60	130.58	130.57	130.56	130.54	
Ch 250.00	500.00	482.70	467.45	462.45	440.14	83.47	56.06	51.05	26.99	0.00	



Datum 116.00

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Datum 116.00

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Scale Horizontal 1:1500 Vertical 1:1500

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REV	DATE	DESCRIPTION

Waingawa Water Storage Reservoir

CLIENT: Carterton District Council
247 Norfolk Road

DRAWING TITLE: Cross Sections

DRAWING NUMBER

SHEET 11 OF 12

REVISION R0

SCALE: As Above Date 18/11/2025 DRG SIZE: A3

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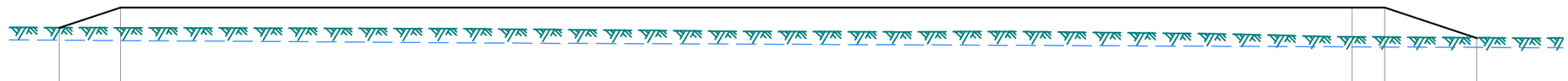

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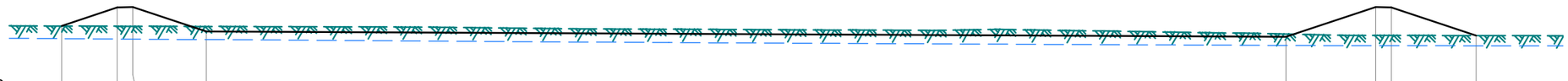

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WATER LEVEL	131.71	131.60	131.49	131.45	131.30	129.40	129.34	129.34	129.31	129.29
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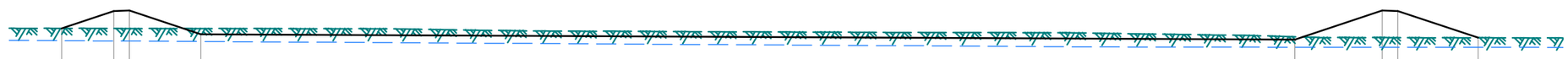

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WATER LEVEL	132.20	132.09	131.98	131.94	131.79	129.98	129.96	129.95	129.94	129.91
Ch 300.00	500.00	483.11	466.36	461.36	438.34	86.31	58.16	53.15	27.30	0.00

Scale Horizontal 1:1500 Vertical 1:1500

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REV	DATE	DESCRIPTION

Waingawa Water Storage Reservoir

CLIENT: Carterton District Council
247 Norfolk Road

DRAWING TITLE: Cross Sections

DRAWING NUMBER
SHEET 12 OF 12
REVISION R0
SCALE: As Above Date 18/11/2025 DRG SIZE: A3
CAD FILE NAME: Sheet 12 of 12.PDF

Geotechnical Factual Report
Waingawa Water Storage Project
247 Norfolk Road, Waingawa

RILEY

Geotechnical Factual Report
Waingawa Water Storage Project
247 Norfolk Road, Waingawa

Report prepared for: Carterton District Council

Report prepared by: Andrei van Dusschoten, Engineering Geologist
Reuben Simmons, Geotechnical Engineer

Report reviewed by: Titus Smith, Technical Director, CPEng



.....

Report approved for issue by: Don Tate, Project Director, FEngNZ, CPEng



.....

Report reference: 250338-B

Date: 26 November 2025

Copies to: Carterton District Council Electronic copy

Riley Consultants Ltd Electronic copy

Issue	Details	Date
1.0	Geotechnical Factual Report FINAL	26 November 2025

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4.0 Limitation 7

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Table 4: Bulk Samples and Soil Lab (WSP) Test Results 6

Appendices

Appendix A: NZGS and Riley Material Logging Guides
Appendix B: Machine Borehole Logs and Core Photographs
Appendix C: SPT Hammer Efficiency Certificates (Griffiths)
Appendix D: Machine Test Pits Logs and Photographs
Appendix E: Laboratory Soil Testing Reports (WSP)
Appendix F: Geotechnical Investigation Sketch Site Plan

Geotechnical Factual Report
Waingawa Water Storage Project
247 Norfolk Road, Waingawa

1.0 Introduction

Carterton District Council (CDC) is proposing to construct a water storage reservoir at 247 Norfolk Road, Waingawa. Riley Consultants Ltd (Riley) has been engaged by CDC to undertake geotechnical site investigations at the proposed storage site and produce a geotechnical factual report (GFR) to support geotechnical assessment and design. This GFR presents findings of the investigation and factual information related to geotechnical conditions (i.e. soil, and groundwater) at the site.

1.1 Site Description

The water storage reservoir is proposed to be located on the south side of 247 Norfolk Road, Waingawa, south-west of Masterton (Figure 1). The site forms a roughly 600m wide by 680m long square, approximately 400m off Norfolk Road. The site is currently occupied by an active deer farm. Several farming sheds are present in the central part of the site.

This site and surrounds form an historic alluvial floodplain on the south side of the Waingawa River. The ground surface at the site falls gently southwards from 139m to 130m elevation. An active gravel quarry is present on the south-east side of the property. Surrounding land is used for various sheep and beef, dairy and arable farming purposes.

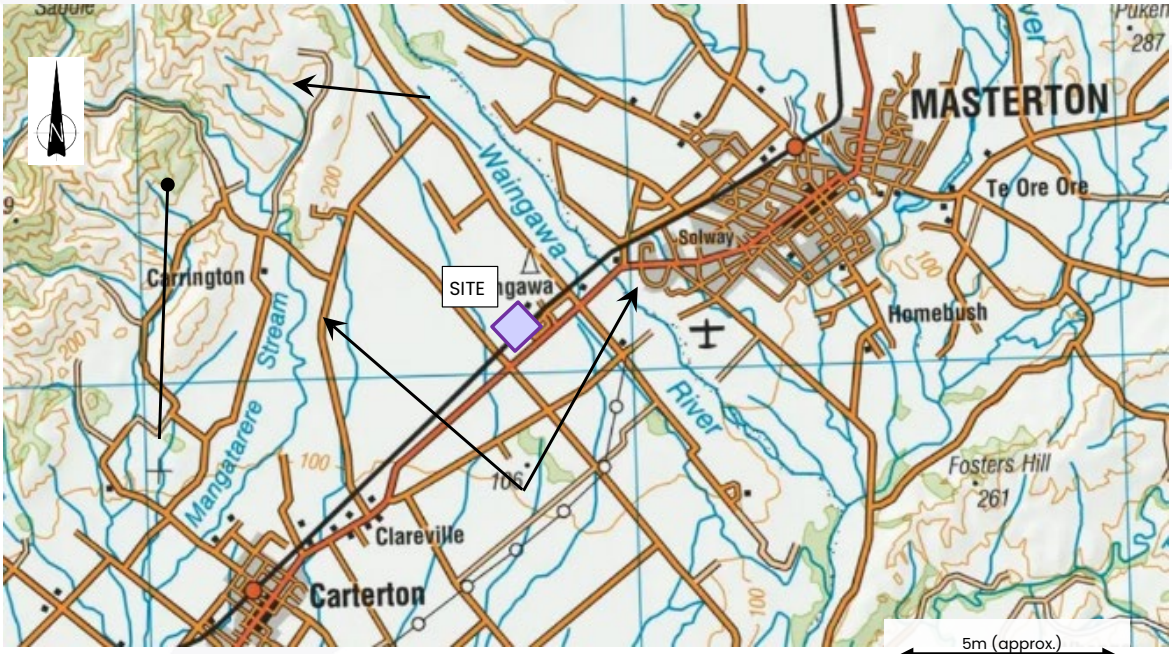

Figure 1: Regional location plan (extract from Topo250 – LINZ). Approximate site envelope indicated by purple polygon.

2.0 Scope of Works

The GFR collates geotechnical investigation and test results completed for the development. The scope of works is outlined below, with further details and reference to appendices provided Table 1.

- Limited site-walkover inspection.
- Five machine boreholes (MH), totalling maximum 100m of drilling.
- Up to 25 no. machine excavated test pits (TP).
- In-situ strength tests comprising standard penetration test (SPT) in boreholes, and hand shear vanes in test pits.
- Groundwater observations in MH and TP during the investigation, including manual measuring of water level in installed piezometers, and installation of water level loggers in piezometers for longer-term recording of water levels.
- Sampling of soils from test pits.
- Laboratory testing of selected samples.

3.0 Geotechnical Site Investigations

3.1 Project Nomenclature and Abbreviations

Encountered materials were logged in general accordance with New Zealand Geotechnical Society (NZGS) soil and rock field description guidelines (2005). A Geotechnical and Geological Information Sheet, and the NZGS 'field guide sheets' for rock and soil description, are provided in Appendix A.

Test location coordinates are in NZTM (2000), and the elevation datum is NZD2016. Elevations were approximated from elevation contours generated from 1m DEM imagery available from LINZ.

3.2 Completed Site Investigations

Completed geotechnical site investigations are summarised in Table 1. Investigation locations are presented on the appended sketch site plan, and summarised in tables, as referenced in Table 1.

Table 1: Waingawa Storage Pond Completed Site Investigations

Method	Summary of Works Completed	Tables/Appendices
Site Walkover	A limited site walkover inspection was undertaken during the site investigation (13 to 17 October 2025) by a Riley engineer and geologist. Land features of interest were observed, noted and photographed. Observed features included stockpiles of boulders, a watercourse, denuded channel-like undulations in the ground surface, and an area with pooled water.	Mapped features are indicated on the sketch site plan in Appendix F.

Method	Summary of Works Completed	Tables/Appendices
Machine boreholes (MH)	5 no. machine boreholes (MH01 to MH05) were completed between 13 and 17 October 2025, by Griffiths Drilling Ltd with two FRASTE CRSXL rigs using the Sonic method. One MH was located in each corner of the site, and one in the middle of the site (MH03). Depths ranged from 12m to 22.5m. At the time of reporting, 'core' sample (approximately 30 boxes) is stored on-site in a farm shed. Approximately 80mm diameter 'core' sample is produced by the Sonic method. Average recovery typically exceeded 80% but was less than this for some runs. Sample disturbance varied from minor to significant, and some 'baking' was evident, typically towards the end of each run. Drilling of boreholes typically required upwards of 15m^3 of water per hole, and use of biodegradable drilling mud. **Piezometer Installations** Single 50mm ID PVC piezometer standpipes were installed in each borehole following air-flushing. Response zones typically comprised 3m machine-slotted pipe, and 5m to 15m of filter sand. Bentonite clay was used as sealant above and below the response zones. Protective headworks comprised ground-flush flip-lid casings (lids secured with 8mm hex-head bolts), cemented into the ground. **Standard Penetration Tests (SPT)** SPT tests were undertaken in all boreholes, typically every 1.5m to 10.5m depth, and every 3m below this depth. SPT hammer details for each rig are as follows: • "FRASTE XL Duo" hammer; ETR = 88.2%; calibrated 17 June 2025 • "FRASTE XL Max" hammer; ETR = 83.5%; calibrated 17 June 2025	A summary of MHs including groundwater depths and installations is presented in Table 2. MH logs and core photographs are presented in Appendix B. Uncorrected SPT test values are presented on MH logs in Appendix B. SPT hammer efficiency certificates are in Appendix C.
Machine Test Pits (TP) and Samples	25 no. test pits (TP) were completed between 13 and 17 October 2025 (TP01 to TP25). TPs were undertaken with a 20t excavator, equipped with a toothed bucket, provided and operated by Scott's Ag Ltd. TPs were distributed in a grid pattern to achieve relatively even coverage across the site. TP depths ranged from 2.90m to 4.80m. TP target depths were 5m for sampling pits, and 3m to 4m for other pits, to meet project aims, and the site investigation time allowance. Sampling pits and a couple of non-sampling pits were terminated prior to reaching target depths due to flooding/wall collapse. TPs were backfilled in layers, tamped with the excavator bucket. Topsoil was sprinkled across the disturbed area, and track rolled. **Hand Shear Vane Tests** Shear vane tests were undertaken where a cohesive soil layer encountered in test pits. Peak and remoulded undrained shear strength (Su) were tested using 19mm diameter vane blades.	A summary of TP including groundwater inflow depth and termination reasons is presented in Table 3. TP logs and photos are presented in Appendix D. Peak and remoulded *Su* values are presented on test pit logs in Appendix D.
Samples	Bulk soil samples were collected from selected test pits, covering the range of materials encountered (silt 'capping' and several gravel types), and to achieve a reasonable spread across the site. Gravel samples comprised two bags, totalling 60kg to 80kg in weight. Material exceeding approximately 80mm in diameter ('oversize-fraction') was separated, measured, weighed (74kg to 151kg), photographed, and discarded (not bagged). Silt samples comprised 25kg (single large bag).	Bulk sample locations and depths are presented on Table 3. Samples with soil lab test results are presented on Table 4.

Method	Summary of Works Completed	Tables/Appendices
Laboratory Tests	Laboratory soil tests were completed on selected test pit samples by WSP Laboratory (IANZ accredited lab) in Wellington. Tests included wet sieve gradings, hydrometers, compaction (Standard Proctor), solid density, Atterberg limits, and one dispersivity test.	Lab test results are summarised on Table 4. WSP soil lab test reports are in Appendix E.
Groundwater Monitoring	At least one groundwater depth measurement was obtained from each borehole after piezometer installation. Water level loggers have been installed near the base of each borehole and are set to record water depths at 15 min intervals. Groundwater inflows encountered in test pits was also recorded. Where encountered, inflows were typically slow to steady (i.e. not rapid). Pits were left open for a minimum of five minutes before backfilling to allow inflows to 'reveal themselves' (develop).	Manual groundwater measurements from MHs are presented on Table 2. Groundwater inflow levels for TPs are presented in Table 3.

Table 2: Machine Borehole Summary Schedule

Machine Borehole ID	Completion Date (including installation)	Coordinates (NZTM) (1)		Collar Elevation (RLm) (1)	Hole Depth (mbgl)	Piezometer Response Zone From-To (mbgl) (2)	Groundwater Depth Post—Piezo-Install (mbgl)
		Easting	Northing				
MH01	17 October 2017	1817010	5463047	139	12.00	5.00-12.00	4.50
MH02	17 October 2025	1817371	5462596	134	15.29	10.00-15.29	3.93
MH03	16 October 2025	1816943	5462625	136	22.50	5.00-21.00	4.50
MH04	16 October 2025	1816493	5462627	138	15.00	10.00-15.00	4.10
MH05	15 October 2025	1816854	5462178	130	19.50	11.00-19.50	3.50

Notes: 1. Coordinates from handheld GPS; elevations based on contours generated in QGIS software from 1m DEM (from LINZ)
2. Refer to MH logs in Appendix B for schematic representation of piezometer installations.

Table 3: Test Pit Summary Including Groundwater Inflow Depths and Samples

Pit ID	Excavation Date	Coordinates (NZTM) (1)		Elevation (RLm) (1)	TP Depth (mbgl)	Ground-water Inflow (mbgl)	Termination Reason (3)	Bulk Sample (4)
		Easting	Northing					
TP01	13 October 2025	1817012	5463031	139	4.30	Not struck	Target Depth	1
TP02	16 October 2025	1817135	5462868	137	4.50	4.30	Flooding/ collapse	1
TP03	16 October 2025	1817234	5462742	136	3.40	Not struck	Target Depth	
TP04	16 October 2025	1817358	5462603	134	4.20	3.90	Flooding/ collapse	1
TP05	13 October 2025	1816979	5462899	138	3.20	Not struck	Target Depth	
TP06	16 October 2025	1817123	5462745	136	3.00	Not struck	Target Depth	
TP07	16 October 2025	1817234	5462597	135	3.20	Not struck	Target Depth	
TP08	13 October 2025	1816848	5462902	139	3.10	Not struck	Collapse	1
TP09	17 October 2025	1816994	5462758	137	3.65	Not struck	Target Depth	1
TP10	15 October 2025	1817112	5462600	135	4.40	Not struck	Target Depth	1
TP11	16 October 2025	1817227	5462492	134	3.00	Not struck	Target Depth	1
TP12	14 October 2025	1816843	5462775	137	3.80	3.80	Target Depth	
TP13	17 October 2025	1816959	5462647	135	3.15	Not struck	Target Depth	
TP14	16 October 2025	1817087	5462463	133	2.90	Not struck	Target Depth	
TP15	14 October 2025	1816683	5462775	138	4.10	Not struck	Target Depth	2
TP16	14 October 2025	1816818	5462611	135	3.00	Not struck	Target Depth	
TP17	15 October 2025	1816943	5462471	133	3.40	3.30	Target Depth	
TP18	15 October 2025	1817047	5462357	133	4.80	4.50	Target Depth	1
TP19	14 October 2025	1816668	5462638	136	2.80	Not struck	Target Depth	
TP20	14 October 2025	1816804	5462508	133	4.30	3.40	Flooding/ collapse	1
TP21	15 October 2025	1816938	5462352	131	3.20	3.00	Collapse	
TP22	15 October 2025	1816499	5462615	138	4.00	Not struck	Target Depth	1
TP23	15 October 2025	1816667	5462491	134	3.30	Not struck	Target Depth	
TP24	15 October 2025	1816795	5462357	132	3.80	3.60	Target Depth	
TP25	15 October 2025	1816863	5462183	130	4.50	4.00	Flooding/ collapse	1

Notes:
1. Coordinates from handheld GPS (+/-3m); elevations based on contours generated from public 1m DEM in QGIS (+/- 1m).
2. "mbgl" = metres below ground level; "RLm" = reduced level / elevation in metres
3. Termination rationale is discussed in Table 1.
4. Sample depths are provided in Table 4.

Table 4: Bulk Samples and Soil Lab (WSP) Test Results

Test Pit ID	Sample Depth From-To (mbgl)	Sample Weight (kg) [4]	Oversize Weight (kg) [4]	Maximum Particle Size (mm)	Lab Test Report Reference	Particle Size Distribution [5]					Atterberg Limits			Compaction			Other		
						Clay % (hydrometer)	Silt % (hydrometer)	Silt & Clay % [3]	Sand %	Gravel %	Liquid Limit	Plastic Limit	Plasticity Index	NMC (%)	MDD (t/m³)	OMC (%)	Solid Density (t/m³)	Emerson Class Number	Pinhole Dispersion
TP01	2.40 - 2.60	71	81	220															
TP02	3.60 - 3.90	78	97	220	OR4998/02			4	14	82				6.5	2.12	10			
TP04	2.10 - 2.30	73	74	200	OR4998/03			4	12	84									
TP08	1.50 - 1.70	72	89	250	OR4998/04			2	27	71									
TP09	0.50 - 0.90	71	50	180	QR4998/05			4	19	77				11.5	1.75	17	2.63		
TP10	2.60 - 2.90	78	96	290															
TP11	0.30 - 0.60	25	NA	NA	OR4998/07	25	46	71	27	2				24.0	1.65	22			
TP15	0.60 - 0.80	25	NA	NA	QR4998/08						39	13	26	25.8	1.61	22		1	ND1
TP15	2.20 - 2.40	72	151	210															
TP18	0.30 - 0.70	60	78	170	QR4998/10			15	27	58									
TP20	1.10 - 1.50	71	83	200	QR4998/11			3	25	72									
TP22	3.60 - 3.80	63	82	220				3	17	78									
TP25	2.80 - 3.00	71	76	230	QR4998/13									5.3	2.07	9	2.70		

1. WSP = WSP Laboratory; refer to Appendix E for laboratory reports.
2. mbgl = metres below ground level; MDD = maximum dry density; OMC = optimum moisture content; NMC = natural moisture content (as received, prior to compaction/grading testing)
3. "silt & clay" indicates proportion that passed 75-micron sieve.
4. Sample and oversize weights are as measured on-site with hand scale. Refer to Table 1 for details of 'oversize' faction processing.
5. Presented PSD values are as received from the lab (i.e. not corrected for removal on-site of particles greater than 80mm diameter)

3.3 Particle Size Distribution

Particle size distribution (PSD) plots are presented in Figure 2. These have not been corrected for the removed 'oversize-fraction'.

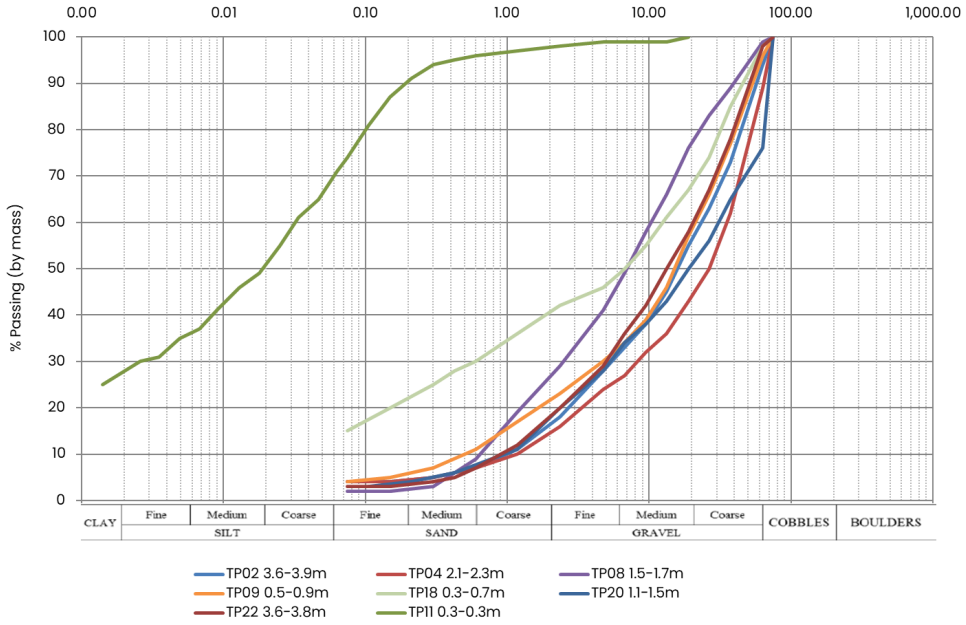

Figure 2: Uncorrected PSD plots

4.0 Limitation

This report has been prepared solely for the benefit of Carterton District Council as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this report are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

During excavation and construction, the site should be examined by an engineer or engineering geologist competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. It is possible that the nature of the exposed subsoils may require further investigation and the modification of the design based upon this report.

Riley Consultants Ltd would be pleased to provide this service and believes the project would benefit from such continuity. In any event, it is essential Riley Consultants Ltd is contacted if there is any variation in subsoil conditions from those described in the report as it may affect the design parameters recommended in the report.

Appendix A

NZGS and Riley Material Logging Guides

RILEY

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GEOTECHNICAL AND GEOLOGICAL INFORMATION

SOIL TYPES AND SYMBOLS

- FILL
- TOPSOIL
- SILT
- SAND
- GRAVEL
- CLAY
- PEAT
- GROUNDWATER LEVEL
- SCALA PENETROMETER — 10,11,10 — LAST 3 NUMBER OF BLOWS PER 50mm INCREMENT

ROCK TYPES AND SYMBOLS

- SANDSTONE
- SILTSTONE
- MUDSTONE
- LIMESTONE
- BASALT
- TUFF
- IGNIMBRITE
- GREYWACKE

SOIL STRENGTH CLASSIFICATION

FINE GRAINED COHESIVE SOILS

TERM	FIELD IDENTIFICATION	UNDRAINED SHEAR STRENGTH (KPa)
Very Soft (Vs)	Exudes between fingers when squeezed.	<12
Soft (S)	Easily indented by fingers.	12 – 25
Firm (F)	Indented only by strong finger pressure.	25 – 50
Stiff (St)	Indented by thumb pressure.	50 – 100
Very Stiff (VSt)	Indented by thumbnail.	100 – 200
Hard (H)	Difficult to indent by thumbnail.	200+

SPT & SCALA PENETROMETER RESULTS

TERM	SPT VALUE No. of BLOWS/300mm	SCALA PENETROMETER No. of BLOWS/100mm
very dense	>50	17+
dense	30 – 50	7 – 17
medium dense	10 – 30	3 – 7
loose	4 – 10	1 – 3
very loose	0 – 4	0 – 2

ROCK STRENGTH CLASSIFICATION

TERM		FIELD IDENTIFICATION	UNCONFINED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
Extremely weak	(EW)	Indented by thumbnail.	< 1
Very weak	(VW)	Crumbles under firm blows with point of geological hammer. Can be peeled with pocket knife.	1 – 5
Weak	(W)	Difficult to peel with pocket knife.	5 – 20
Moderately strong	(MS)	Cannot be scraped or peeled with pocket knife.	20 – 50
Strong	(S)	More than one blow of geological hammer to fracture.	50 – 100
Very strong	(VS)	Many blows of geological hammer to break.	100 – 250
Extremely strong	(ES)	Can only be chipped with geological hammer.	250+

MOISTURE CONDITION

Dry (D)	Looks and feels dry; powdery and friable.
Moist (M)	Feels cool; darkened in colour; no free water when remoulded.
Wet (W)	Feels cool; darkened in colour; free water forms on hands.
Saturated (S)	Free water is present on sample.

SAMPLE TYPES

- UNDISTURBED
- MACHINE AUGER DISTURBED
- D — HAND AUGER DISTURBED
- STANDARD PENETRATION TEST (solid cone)
- STANDARD PENETRATION TEST (hollow cone)

DRILLING METHOD

OB	OPEN BARREL
TT	TRIPLE TUBE
WB	WASH BORE
SH	UNDISTURBED SHELBY TUBE
RC	ROCK CORE
SPT	STANDARD PENETRATION TEST

FIELD TESTS

V	SHEAR VANE (corrected to BS:1377)
R	REMOULDED STRENGTH
P	POCKET PENETROMETER
CH	CLEGG HAMMER

INFORMATION BASED ON THE NZ GEOTECHNICAL SOCIETY INC. GUIDELINES FOR THE CLASSIFICATION AND DESCRIPTION OF SOIL AND ROCK FOR ENGINEERING PURPOSES

GEOLOGICALINFO.DWG REV. 3

Appendix B

Machine Borehole Logs and Core Photographs

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Ph: 03.379.4402
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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH01

Client:	Start Date: 16 Oct 2025	Hole Location:
Carterton District Council	End Date: 17 Oct 2017	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1817010, N 5463047	139 m	12.00 m	-90°	N/A	1 of 2

Elevation (m NZVD2016)	Depth (m)	Method	Run	Box No.	Core Recovery (%)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
138.75	0.25	Sonic core drilling	0.00		73	TOP SOIL	TS	TOPSOIL with some fine to coarse sand and gravel; dark grey.					
138.50	0.50							Fine to Coarse GRAVEL with minor fine to coarse sand, and silt; yellowish brown. Medium dense: moist: poorly graded: subangular to angular, slightly weathered sandstone gravel: sand, fine; silt and clay, slightly plastic (Late Pleistocene river deposits).					
138	1							Fine to Coarse GRAVEL with some fine to coarse sand and cobbles; yellowish grey. Dense to very dense: moist to wet: moderately graded: subrounded to rounded, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits).					
		S P	1.50		80						SPT 1.50 m 19, 31 N=50 for 15mm		
		Sonic core drilling	1.65		86			0.60m - 1.50m: Poor recovery, fines washed out.					
137	2							1.80m: Cobble (70x50mm), rounded.					
								1.90m: Cobble (90x45mm), subrounded.	DM				
								2.20m - 2.50m: Baked.					
								2.80m - 3.00m: Baked.					
136	3	In situ SPT test	3.00		65						SPT 3.00 m 5, 9 / 16, 34 for 28mm N=50 for 103mm		
		Sonic core drilling	3.29		80			3.20m: Cobble (70x40mm), angular.					
								3.30m - 3.50m: Fines washed out.					
135	4												
		S P	4.50		73						SPT 4.50 m 15, 35 N=50 for 14mm		
		Sonic core drilling	4.65		100	Q2A ALLUVIUM		5.20m: Cobble (80x50mm), rounded.					
134	5							5.30m: Cobble (90x70mm), rounded.					
133	6	situ SPT	6.00		79						SPT 6.00 m 9, 12 / 33, 17 for 23mm N=50 for 98mm		
132.70	6.30	Sonic core drilling	6.24		83			Fine to Coarse GRAVEL with some fine to coarse sand and cobbles; grey. Dense to very dense: wet: moderately graded: subrounded to rounded, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits).					
132	7							7.30m: Cobble (95x70mm), rounded to subrounded.					
		S P	7.50		73						SPT 7.50 m 50 N=50 for 0mm		
		Sonic core drilling	7.65		80								
131	8							8.20m: Cobble (80x50mm), rounded.					
								8.40m: Cobble (90x60mm), subrounded to angular.					
130	9	situ SPT	9.00		53						SPT 9.00 m 8, 18 / 32, 18 for 27mm N=50 for 102mm		
129.40	9.60	Sonic core drilling	9.28		86			Fine to Coarse GRAVEL with minor fine to coarse sand and cobbles; yellowish grey. Dense to very dense: wet: moderately					

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- **Moisture:** M = moist; W = wet; S = saturated
- Standard Penetration Test (SPT) — Hatched = Solid cone (C); No hatch = Split spoon (S)
- Vane Shear Strength (kPa) — V=Peak, R=Residual; UTP=Unable to penetrate; PP = Pocket Penetrometer
- Topsoil, Peat, Fill, Core Loss
- Clay, Silt, Sand, Gravel
- **Backfill:** Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.Hole collapsed to 11m
4.WL - 17/10/2025 - ~11.45

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Niko	RTS	TLS

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RILEY CONSULTANTS LTD. REPORT: RILEY MH-S (soil) - generated with CORE-GS by Geroc

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E: rileychch.co.nz

MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH01

Client:	Start Date: 16 Oct 2025	Hole Location:
Carterton District Council	End Date: 17 Oct 2017	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1817010, N 5463047	139 m	12.00 m	-90°	N/A	2 of 2

Elevation (m NZVD2016)	Depth (m)	Method	Run Box No.	Core Recovery (%)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
128.50	10.50	Sonic core drilling	10.50	86	Q2A ALLUVIUM		graded: subangular to subrounded, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits). 9.70m: Cobble (75x60mm), rounded. 10.40m: Cobble (80x70mm), rounded. 10.50m - 10.70m: Fines washed out.	WS				
128	11			83			Fine to Coarse GRAVEL with some fine to coarse sand and cobbles; grey. Dense to very dense: wet: moderately graded: subrounded to rounded, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits). 11.00m: Cobble (85x80mm), subrounded. 11.60m: Cobble (70x60mm), subrounded to subangular. 11.80m - 12.00m: Partially baked.					
127.00	12.00						END OF HOLE: 12.00m					
126	13											
125	14											
124	15											
123	16											
122	17											
121	18											
120	19											

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- **Moisture:** M = moist; W = wet; S = saturated
- Standard Penetration Test (SPT): Hatched = Solid cone (C); No hatch = Split spoon (S)
- Vane Shear Strength (kPa): V=Peak, R=Residual; UTP=Unable to penetrate; PP = Pocket Penetrometer
- Topsoil, Peat, Fill, Core Loss
- Clay, Silt, Sand, Gravel
- **Backfill:** Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.Hole collapsed to 11m
4.WL - 17/10/2025 - ~11.45

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Niko	RTS	TLS

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RILEY CONSULTANTS LTD. REPORT: RILEY MH-S (soil) - generated with CORE-GS by Geroc

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Ph: 03.379.4402
E: rileychch.co.nz

MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH02

Client:	Start Date: 16 Oct 2025	Hole Location:
Carterton District Council	End Date: 17 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1817371, N 5462596	134 m	15.29 m	N/A	N/A	1 of 2

Elevation (m NZVD2016)	Depth (m)	Method	Run (Box No.)	Core Recovery (%)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
133.90	0.10		0.00		TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black. Medium dense; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone, [Driller induced]; [TOPSOIL].					
133.60	0.40	Sonic core drilling		100			Sandy SILT, with some gravel, with minor cobbles; brown. Stiff; moist; sand, fine to coarse; gravel, coarse; cobbles, up to 70mm, Siltstone/fine sandstone, Moderately strong to strong; [Q2 Alluvium].					
	1						Silty fine to coarse GRAVEL; grey. Very dense; moist to wet; non-plastic; subangular to angular.					
		In situ SPT test	1.50	95			0.60m: Some fine to coarse sand.			SPT 1.50 m 10, 21 / 29, 21 N=50 for 150mm		
132.20	1.80						1.00m: Grades to brown.					
		Sonic core drilling	1.80	95			1.30m: Grades to include grey minor cobbles [Driller induced].					
	2						Sandy fine to coarse GRAVEL; grey. Very dense; wet; subangular to angular; sand, fine to coarse; poorly gap graded.					
							2.80m: Grades to subrounded to angular [Driller induced] gravel.					
	3	In situ SPT test	3.00	100						SPT 3.00 m 6, 10 / 11, 12, 13, 13 N=49		
		Sonic core drilling	3.45	100			3.50m: Grades to include some brown silt.					
	4											
		In situ SPT test	4.50	100						SPT 4.50 m 3, 10 / 11, 21, 13, 5 for 10mm N=50 for 235mm		
	5	Sonic core drilling	4.89	100	Q2A ALLUVIUM							
		S P	6.00	100						SPT 6.00 m 14, 36 for 55mm N=50 for 0mm		
	6		6.13									
		Sonic core drilling		100			6.63m: Grades to include minor cobbles [60x65mm]; moderately strong to strong; siltstone/fine sandstone. [Driller induced].					
	7											
126.50	7.50	In situ SPT test	7.50	100			Gravelly fine to coarse SAND, with minor silt; grey. Very dense; saturated; gravel, fine to coarse, subangular to angular.			SPT 7.50 m 5, 11 / 17, 23, 10 for 20mm N=50 for 170mm		
		Sonic core drilling	7.82	100			8.02m: Grades to include minor cobbles (70 x 40mm); moderately strong to strong; siltstone/fine sandstone.					
	8											
125.13	8.85						Sandy fine to coarse GRAVEL, with minor silt; grey. Very dense; saturated; subrounded to subangular; sand, fine to coarse.					
	9	S P	9.00	100						SPT 9.00 m 10, 40 N=50 for 0mm		
		Sonic core drilling	9.15	100			9.50m: Grades to some silt.					
							9.60m: Grades to include minor cobbles (75mm); moderately					

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- Standard Penetration Test (SPT) Hatched = Solid cone (C) No hatch = Split spoon (S)
- Vane Shear Strength (kPa) V=Peak, R=Residual UTP=Unable to penetrate PP = Pocket Penetrometer

Moisture: M = moist; W = wet; S = saturated

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel

Backfill: Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.WL - 17/10/2025 - ~12.00

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Ethan	ADT	TLS

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH02

Client:	Start Date: 16 Oct 2025	Hole Location:
Carterton District Council	End Date: 17 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1817371, N 5462596	134 m	15.29 m	N/A	N/A	2 of 2

Elevation (m NZVD2016)	Depth (m)	Method	Run (Box No.)	Core Recovery (%)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
		Sonic core drilling		100	Q2A ALLUVIUM		strong to strong. 10.60m: Cobbles; 65 x 65mm; strong; siltstone/fine sandstone.					
118.71	15.29	situ SPT	15.00	100			13.50m: Cobbles; 75 x 70mm; moderately strong to strong; siltstone to fine sandstone. END OF HOLE: 15.29m			SPT 15.00 m 7, 11 / 20, 30 for 65mm N=50 for 140mm		

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- Standard Penetration Test (SPT) Hatched = Solid cone (C) No hatch = Split spoon (S)
- Vane Shear Strength (kPa) V=Peak, R=Residual UTP=Unable to penetrate PP = Pocket Penetrometer

Moisture: M = moist; W = wet; S = saturated

- Topsoil
- Peat
- Fill
- Core Loss
- Clay
- Silt
- Sand
- Gravel

Backfill:

- Bentonite
- Grout/concrete
- Drill arisings
- Filter sand

Remarks

1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.WL - 17/10/2025 - ~12.00

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Ethan	ADT	TLS

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH03

Client:	Start Date: 13 Oct 2025	Hole Location:
Carterton District Council	End Date: 16 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1816943, N 5462625	136 m	22.50 m	-90°	N/A	1 of 3

Elevation (m NZVD2016)	Depth (m)	Method	Run (Box No.)	Core Recovery (%)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
135.80	0.20	Sonic core drilling	0.00	64	PS OI	TS	TOPSOIL with some fine to coarse sand and gravel; dark grey.					
135.60	0.40						Fine to Coarse GRAVEL with minor fine to coarse sand, and silt; yellowish brown. Medium dense: moist: moderately graded: subrounded to rounded, slightly weathered sandstone gravel: sand, fine; silt and clay, slightly plastic (Late Pleistocene river deposits).					
135	1						Fine to Coarse GRAVEL with some fine to coarse sand and cobbles; grey. Dense to very dense: moist to wet: moderately graded: subrounded to rounded, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits). 1.50m: Driller noted waterloss.			SPT 1.50 m 7, 9 / 9, 9, 18, 18 for 60mm N=50 for 285mm		
		In situ SPT test	1.50	70								
134	2	Sonic core drilling	1.94	72				DM				
133	3	In situ SPT test	3.00	60						SPT 3.00 m 3, 10 / 34, 16 for 20mm N=50 for 95mm		
		Sonic core drilling	3.33	87			3.30m: Cobble (95x60mm), rounded.					
132.50	4.10											
131.70	4.30						Sandy GRAVEL (fine to coarse) with some cobbles; grey. Dense to very dense: wet: poorly graded: subrounded to rounded, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits).	▼				
		SPT	4.50	53						SPT 4.50 m 10, 50 N=50 for 0mm		
131	5	Sonic core drilling	4.65	73	Q2A ALLUVIUM		Fine to Coarse GRAVEL with some fine to coarse sand and cobbles; grey. Dense to very dense: wet: poorly graded: subrounded to subangular, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits). 4.50m: Becomes brownish grey. 5.65m - 6.00m: Core bound. 5.80m: Cobble (60x50mm), rounded.					
		SPT	6.00	42						SPT 6.00 m 16, 34 for 65mm N=50 for 0mm		
129.40	6.60	Sonic core drilling	6.14	77			Fine to Coarse GRAVEL with minor fine to coarse sand and cobbles; grey. Dense to very dense: wet: poorly graded: subrounded to subangular, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits).					
128.30	7.70	SPT	7.50	70						SPT 7.50 m 39, 11 N=50 for 85mm		
128	8	Sonic core drilling	7.74	87			Fine to Coarse GRAVEL with some cobbles and minor fine to coarse sand; brownish grey. Dense to very dense: wet: poorly graded: subrounded to subangular, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposi.					
127	9	In situ SPT test	9.00	79						SPT 9.00 m 9, 13 / 22, 28 for 60mm N=50 for 135mm		
		Sonic core drilling	9.29	80			9.70m: Cobble (90x80mm), rounded.					

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- **Moisture:** M = moist; W = wet; S = saturated
- Standard Penetration Test (SPT) — Hatched = Solid cone (C); No hatch = Split spoon (S)
- Vane Shear Strength (kPa) — V=Peak, R=Residual; UTP=Unable to penetrate; PP = Pocket Penetrometer
- Topsoil, Peat, Fill, Core Loss
- Clay, Silt, Sand, Gravel
- **Backfill:** Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.Hole collapsed to 21m
4.WL - 17/10/2025 - 09:00

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Niko	RTS	TLS

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH03

Client:	Start Date: 13 Oct 2025	Hole Location:
Carterton District Council	End Date: 16 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1816943, N 5462625	136 m	22.50 m	-90°	N/A	2 of 3

Elevation (m NZVD2016)	Depth (m)	Method	Run	Box No.	Core Recovery (%)	Geological Unit	Legend	Geological Description	Groundwater	Field Strength	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
125.40	10.60	Sonic core drilling	10.50		80			10.00m: Cobble (90x50mm), subrounded to rounded. 10.30m: Cobble (80x40mm), angular (machine induced).					
		S P	10.65		60			Fine to Coarse GRAVEL with some fine to coarse sand and cobbles; grey. Dense to very dense: wet: poorly graded: subrounded to subangular, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits). 11.20m - 12.00m: Baked.			SPT 10.50 m 16, 34 for 70mm N=50 for 0mm		
125	11	Sonic core drilling	12.00		80			11.90m: Cobble (80x50mm), angular (machine induced).					
		S P	12.15		40			12.50m: Cobble (80x40mm), rounded.			SPT 12.00 m 18, 32 for 70mm Nc=50 for 0mm		
123.20	12.80	Sonic core drilling	13.80		92			Fine to Coarse GRAVEL with some fine to coarse sand and minor cobbles; grey. Dense to very dense: wet: poorly graded: subrounded to rounded, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits). 13.50m: Cobble (90x60mm), subrounded. 13.80m: Corebound.					
122.20	13.80	In-situ SPT test						Core loss.					
122	14	Sonic core drilling	15.00		30	Q2A ALLUVIUM							
121.00	15.00	S P	15.14		89			Fine to Coarse GRAVEL with some fine to coarse sand and cobbles; grey. Dense to very dense: wet: moderately graded: subrounded to angular, slightly weathered sandstone gravel and cobble: sand, fine (Late Pleistocene river deposits). 15.13m: Cobble (90x50 and 75x50mm), rounded. 16.20m - 16.50m: Baked.			SPT 15.00 m 16, 34 for 60mm Nc=50 for 0mm		
120	16	Sonic core drilling	16.50		90			17.80m: Fines washed out.					
118	18	SPT	18.00		78						SPT 18.00 m 8, 16 / 40, 10 for 5mm Nc=50 for 80mm		
		Sonic core drilling	18.23		89								
117	19	Sonic core d	19.50		100			19.60m: Cobble (80x60mm), rounded.					

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- **Moisture:** M = moist; W = wet; S = saturated
- Standard Penetration Test (SPT): Hatched = Solid cone (C); No hatch = Split spoon (S)
- Vane Shear Strength (kPa): V=Peak, R=Residual; UTP=Unable to penetrate; PP = Pocket Penetrometer
- Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel

Backfill: Bentonite; Grout/concrete; Drill arisings; Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.Hole collapsed to 21m
4.WL - 17/10/2025 - 09:00

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Niko	RTS	TLS

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH03

Client:	Start Date: 13 Oct 2025	Hole Location:
Carterton District Council	End Date: 16 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1816943, N 5462625	136 m	22.50 m	-90°	N/A	3 of 3

Elevation (m NZVD2016)	Depth (m)	Method	Run / Box No.	Core Recovery (%)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005). Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
115	21	Sonic core drilling		100	Q2A ALLUVIUM		19.84m: Cobble (80x50mm), angular (machine induced). 20.20m: Cobble (75x50mm), subrounded to subangular. 20.80m: Cobble (80x80mm), subrounded.	WS				
114	22	Cable percussion (shell and auger)	21.00	73								
113.50	22.50						END OF HOLE: 22.50m					
113	23											
112	24											
111	25											
110	26											
109	27											
108	28											
107	29											

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- **Moisture:** M = moist; W = wet; S = saturated
- Standard Penetration Test (SPT): Hatched = Solid cone (C); No hatch = Split spoon (S)
- Vane Shear Strength (kPa): V=Peak, R=Residual; UTP=Unable to penetrate; PP = Pocket Penetrometer
- Topsoil, Peat, Fill, Core Loss
- Clay, Silt, Sand, Gravel
- **Backfill:** Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.Hole collapsed to 21m
4.WL - 17/10/2025 - 09:00

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Niko	RTS	TLS

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH04

Client:	Start Date: 15 Oct 2025	Hole Location:
Carterton District Council	End Date: 16 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1816493, N 5462627	138 m	15.00 m	-90°	N/A	1 of 2

Elevation (m NZVD2016)	Depth (m)	Method	Run (Box No.)	Core Recovery (%)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
137.60	0.00	Sonic core drilling	0.00	80	TOPSOIL	TS	SILT, with some clay and gravel; dark brown. Stiff; moist; low plasticity; gravel, fine to coarse, subangular to angular; [TOPSOIL].					
137.60	0.40					TS	Gravelly SILT, with some clay; brown. Very dense; moist; low plasticity; gravel, subangular to angular; Poorly gap graded [Q2 Alluvium].					
137	1						0.70m: Grades to include some fine to medium sand; grey, and cobbles up to 50mm [Driller induced].					
		Std SPT	1.50	95						SPT 1.50 m 18, 24 / 50 N=50 for 75mm		
		Sonic core drilling	1.73	95								
136	2											
135.80	2.20						Sandy fine to coarse GRAVEL; grey. Very dense; wet; subangular to angular; sand, fine to coarse; Poorly gap graded.					
135	3	S P	3.00	90						SPT 3.00 m 21, 29 for 60mm N=50 for 0mm		
		Sonic core drilling	3.14	90			3.15m: Grades to include minor to some cobbles up to 80mm; moderately strong to strong, siltstone.					
134	4						4.20m: Some silt.	▼				
		Std SPT	4.50	90						SPT 4.50 m 20, 27 / 50 for 65mm N=50 for 65mm		
		Sonic core drilling	4.71	90	Q2A ALLUVIUM		5.50m: Alternate silt layers approximately 500mm thick, brown.					
133	5											
132	6	S P	6.00	95			6.13m: Grey, absence of silt layer.			SPT 6.00 m 15, 35 for 55mm N=50 for 0mm		
		Sonic core drilling	6.13	95			6.80m: Subrounded to angular [Driller induced].					
131	7											
		Std SPT	7.50	100						SPT 7.50 m 11, 23 / 47, 3 for 3mm N=50 for 78mm		
		Sonic core drilling	7.73	100			8.20m: Some cobbles up to 75mm [Driller induced].					
130	8											
129	9	situ SPT	9.00	100						SPT 9.00 m 10, 13 / 33, 17 for 40mm N=50 for 115mm		
128.80	9.20	Sonic core drilling	9.27	100			Gravelly fine to coarse SAND; grey with red streaks. Very dense; gravel, fine to coarse, subrounded to angular; Poorly gap graded, saturated [Driller induced].					

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- Standard Penetration Test (SPT) — Hatched = Solid cone (C); No hatch = Split spoon (S)
- Vane Shear Strength (kPa) — V=Peak, R=Residual; UTP=Unable to penetrate; PP = Pocket Penetrometer

Moisture: M = moist; W = wet; S = saturated

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel

Backfill: Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.WL - 17/10/2025 - 09:15

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Ethan	ADT	TLS

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH04

Client:	Start Date: 15 Oct 2025	Hole Location:
Carterton District Council	End Date: 16 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1816493, N 5462627	138 m	15.00 m	-90°	N/A	2 of 2

Elevation (m NZVD2016)	Depth (m)	Method	Run / Box No.	Core Recovery (%)	Geological Unit	Legend	Geological Description	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
127.60	10.40	Sonic core drilling		100	Q2A ALLUVIUM		[CONT] Gravelly fine to coarse SAND; grey with red streaks. Very dense; gravel, fine to coarse, subrounded to angular; Poorly gap graded, saturated [Driller induced].					
							Sandy GRAVEL; grey. Very dense; saturated; subrounded to angular; sand, fine to coarse.					
127	11						10.60m: Grades to iniclude minor to some cobbles; [Driller induced]; moderately strong to strong.					
							11.50m: Gley.					
							11.80m: Gley.					
126	12	S P.	12.00	100						SPT 12.00 m 18, 32 for 65mm N=50 for 0mm		
			12.14									
		Sonic core drilling										
125	13			100								
124	14											
123.00	15.00						14.80m: Grades to include minor to some silt.					
123	15	S P.	15.00	100			END OF HOLE: 15.00m			SPT 15.00 m 24, 26 for 35mm N=50 for 0mm		
122	16											
121	17											
120	18											
119	19											

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- **Moisture:** M = moist; W = wet; S = saturated
- Standard Penetration Test (SPT) — Hatched = Solid cone (C); No hatch = Split spoon (S)
- Vane Shear Strength (kPa) — V=Peak, R=Residual; UTP=Unable to penetrate; PP = Pocket Penetrometer
- Topsoil, Peat, Fill, Core Loss
- Clay, Silt, Sand, Gravel
- **Backfill:** Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.WL - 17/10/2025 - 09:15

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Ethan	ADT	TLS

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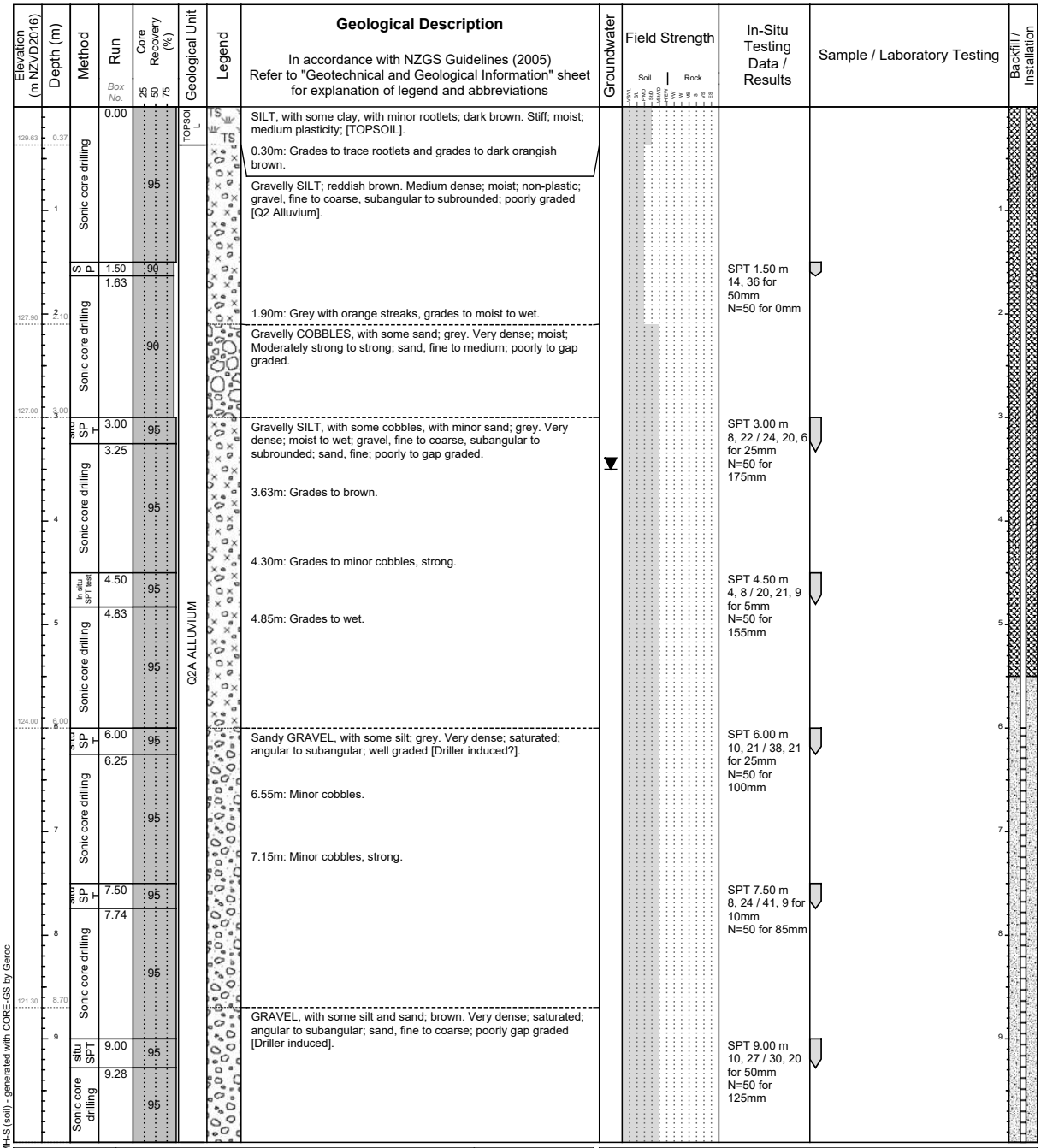
MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH05

Client:	Start Date: 13 Oct 2025	Hole Location:
Carterton District Council	End Date: 15 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1816854, N 5462178	130 m	19.50 m	N/A	N/A	1 of 2



Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.WL - 17/10/2025 - 09:30

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Ethan	ADT	TLS

Printed: 26/11/2025 11:16:04 am

RILEY CONSULTANTS LTD. REPORT: RILEY MH-S (soil) - generated with CORE-GS by Geroc

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MACHINE HOLE LOG

Project No.:	Project Name:	Project Location:	No.:
250338	Waingawa Water Storage Project	247 Norfolk Road, Waingawa	MH05

Client:	Start Date: 13 Oct 2025	Hole Location:
Carterton District Council	End Date: 15 Oct 2025	Refer to site plan

Co-ordinates (NZTM):	Ground Level (NZVD2016):	Hole Depth:	Inclination:	Azimuth:	Sheet:
E 1816854, N 5462178	130 m	19.50 m	N/A	N/A	2 of 2

Elevation (m NZVD2016)	Depth (m)	Method	Run (Box No.)	Core Recovery (%)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" sheet for explanation of legend and abbreviations)	Groundwater	Field Strength (Soil | Rock)	In-Situ Testing Data / Results	Sample / Laboratory Testing	Backfill / Installation
119.60	10.40	Sonic core drilling		95	Q2A ALLUVIUM		[CONT] GRAVEL, with some silt and sand; brown. Very dense; saturated; angular to subangular; sand, fine to coarse; poorly gap graded [Driller induced].					
		In situ SPT test	10.50	90			10.10m: Grades to include minor cobbles and sand, strong.			SPT 10.50 m 5, 10 / 20, 30 for 50mm N=50 for 125mm		
118.40	11.60	Sonic core drilling	10.85				Sandy GRAVEL, with some silt; grey. Very dense; saturated; angular to subrounded; poorly gap graded [Driller induced?]. 10.80m: Well graded. 11.10m: Some cobbles, strong.					
117.90	12.10			90			Gravelly SAND; grey. Very dense; saturated; gravel, fine to coarse; poorly gap graded. 11.70m: 100mm fine to coarse sand lense. 11.80m: Grades to include minor to some cobbles, strong.					
							Sandy fine to coarse GRAVEL; sand, fine to coarse. 12.20m: Cobbles, moderately strong. 13.25m: Some cobbles, moderately strong.					
		situ SPT	13.50	95						SPT 13.50 m 8, 14 / 22, 28 for 40mm N=50 for 115mm		
		Sonic core drilling	13.77	95			14.00m: Minor cobbles up to 80mm, moderately strong to strong. 16.20m: Some silt.					
		S P	16.50	95						SPT 16.50 m 13, 37 N=50 for 0mm		
		Sonic core drilling	16.65	95			16.65m: Driller induced sand layers (saturated). 17.00m: Minor to some cobbles, moderately strong. 19.20m: Cobbles, subrounded to subangular.					
110.50	19.50	S P	19.50	95			END OF HOLE: 19.50m			SPT 19.50 m 22, 28 N=50 for 0mm		

Explanations: *Refer to "Geological and Geotechnical Information" sheet for further details.*

- Standing Water Level
- Out flow
- In flow
- Standard Penetration Test (SPT) Hatched = Solid cone (C) No hatch = Split spoon (S)
- Vane Shear Strength (kPa) V=Peak, R=Residual UTP=Unable to penetrate PP = Pocket Penetrometer

Moisture: M = moist; W = wet; S = saturated

Topsoil, Peat, Fill, Core Loss, Clay, Silt, Sand, Gravel

Backfill: Bentonite, Grout/concrete, Drill arisings, Filter sand

Remarks
1.Descriptions are based on material as recovered, and moderate to significant drilling disturbance is likely to be present, including 'baked' zones.
2. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
3.WL - 17/10/2025 - 09:30

All dimensions in metres NOT TO SCALE	Drilling Contractor:	Drilling Rig ID:	Driller:	Logged By:	Checked By:
	Griffiths Drilling	FRASTE CRSXL (SONIC)	Ethan	ADT	TLS

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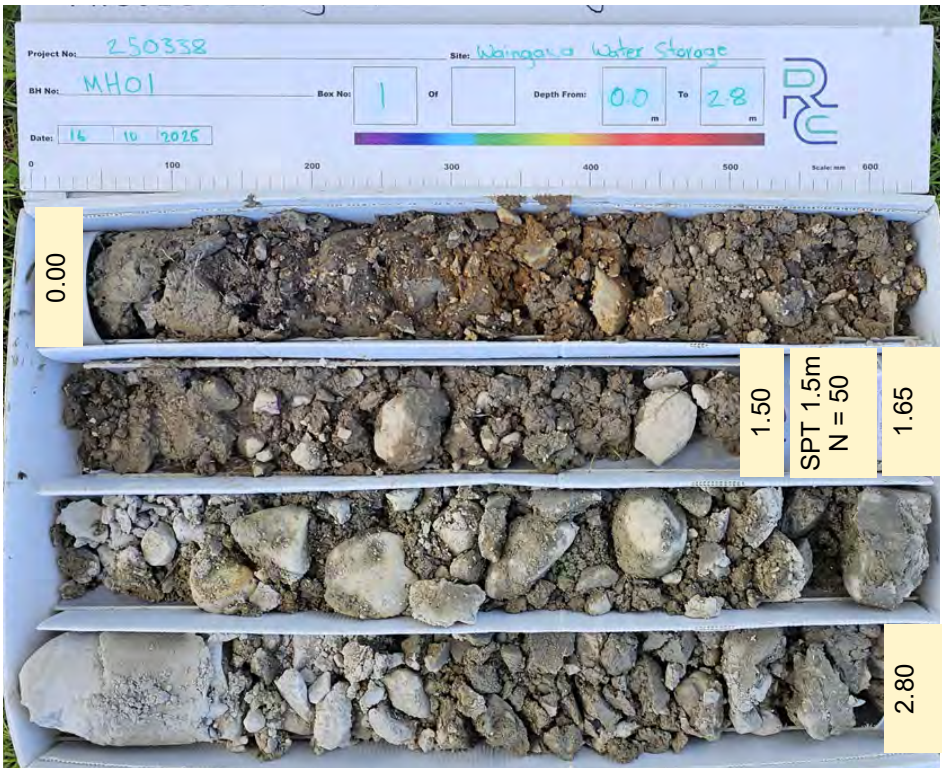

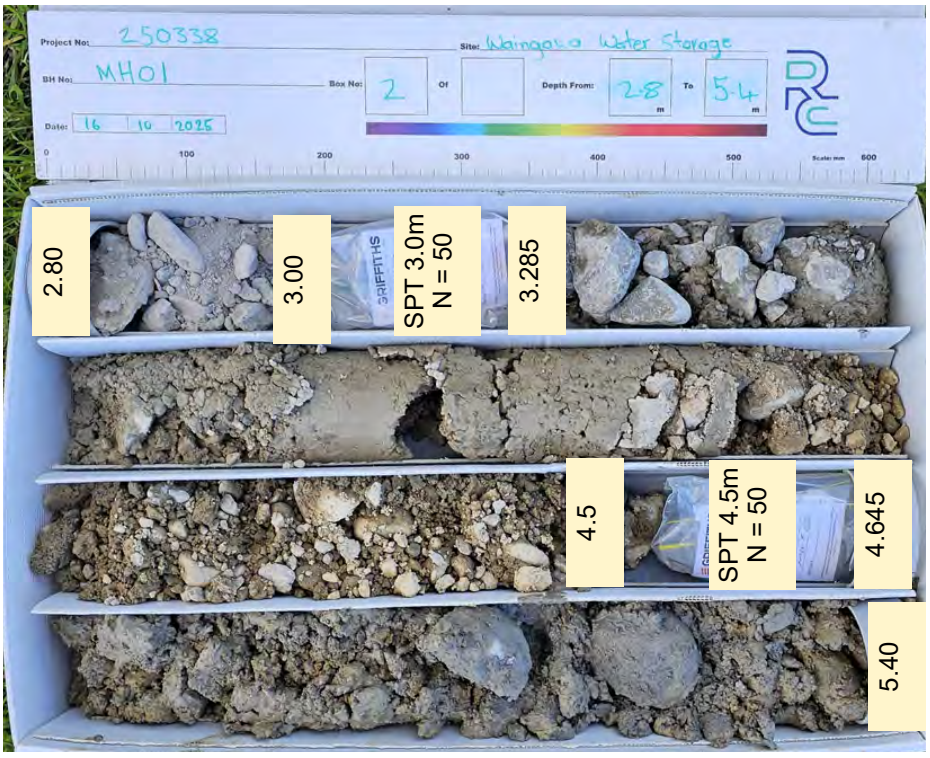

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH01	RILEY
		Date:	October 2025	
		Box No(s).	1 and 2 of 5	
Notes:	1. Drill method = Sonic core drilling 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	0.00	
		Depth To (m):	5.40	
Project No.	250338	**Interval (m):**	5.40	

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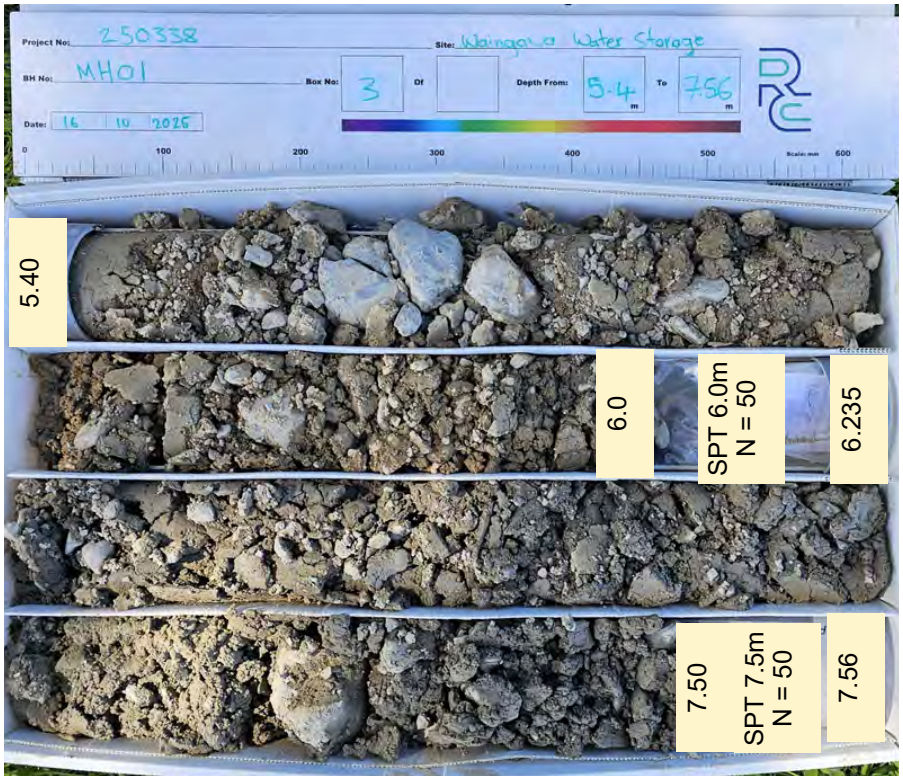

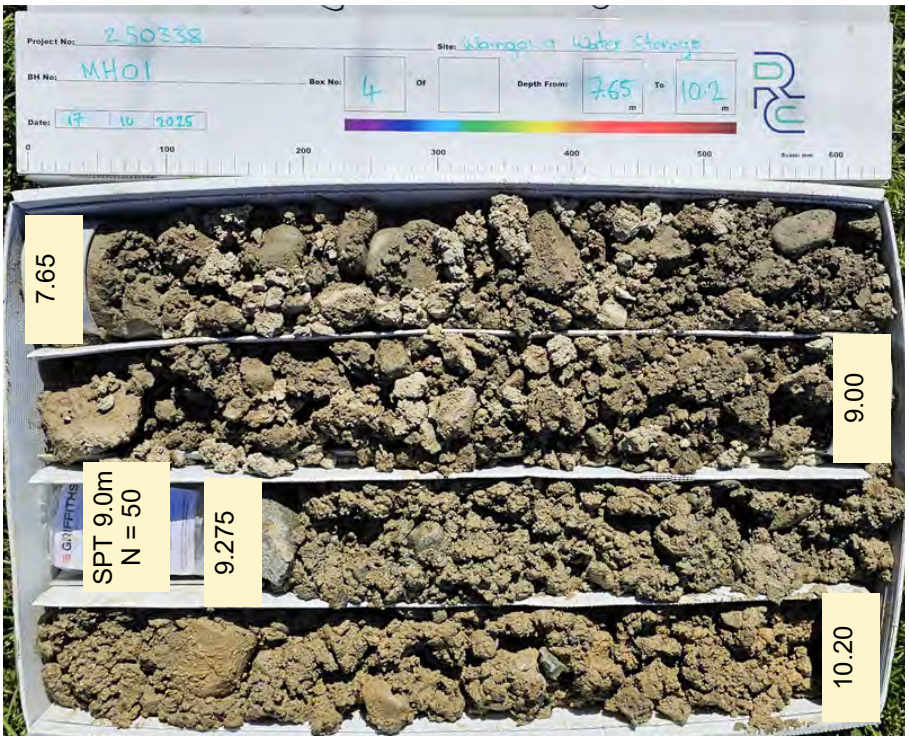

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH01
		Date:	October 2025
		Box No(s).	3 and 4 of 5
Notes:	1. Drill method = Sonic core drilling 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	5.40
		Depth To (m):	10.20
Project No.	250338	**Interval (m):**	4.80

RILEY

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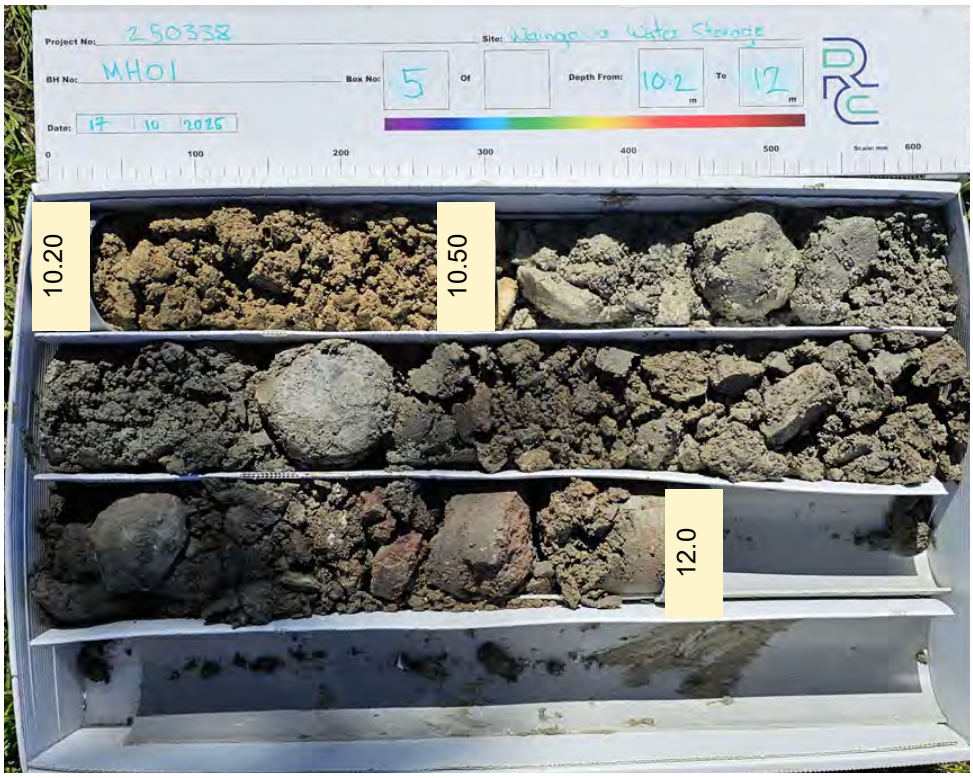

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH01	RILEY
		Date:	October 2025	
		Box No(s).	5 of 5	
Notes:	1. Drill method = Sonic core drilling 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	10.20	
		Depth To (m):	12.00	
Project No.	250338	**Interval (m):**	1.80	

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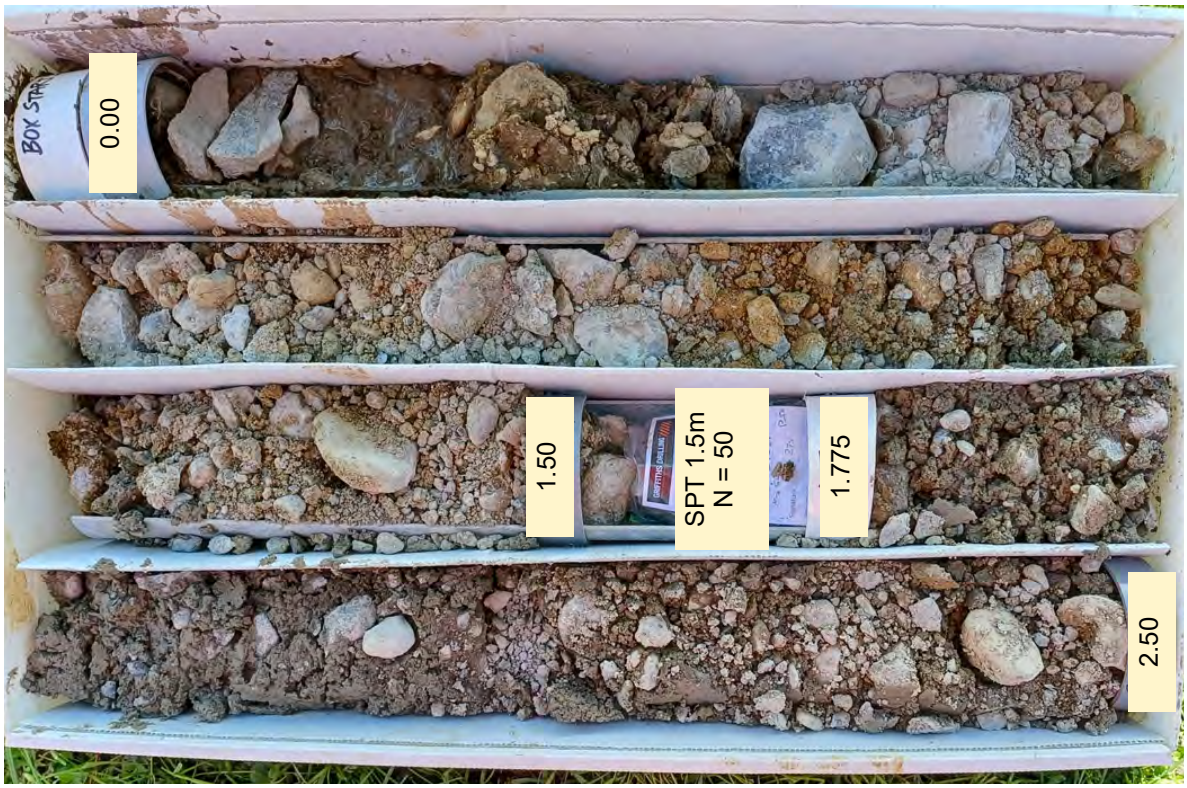

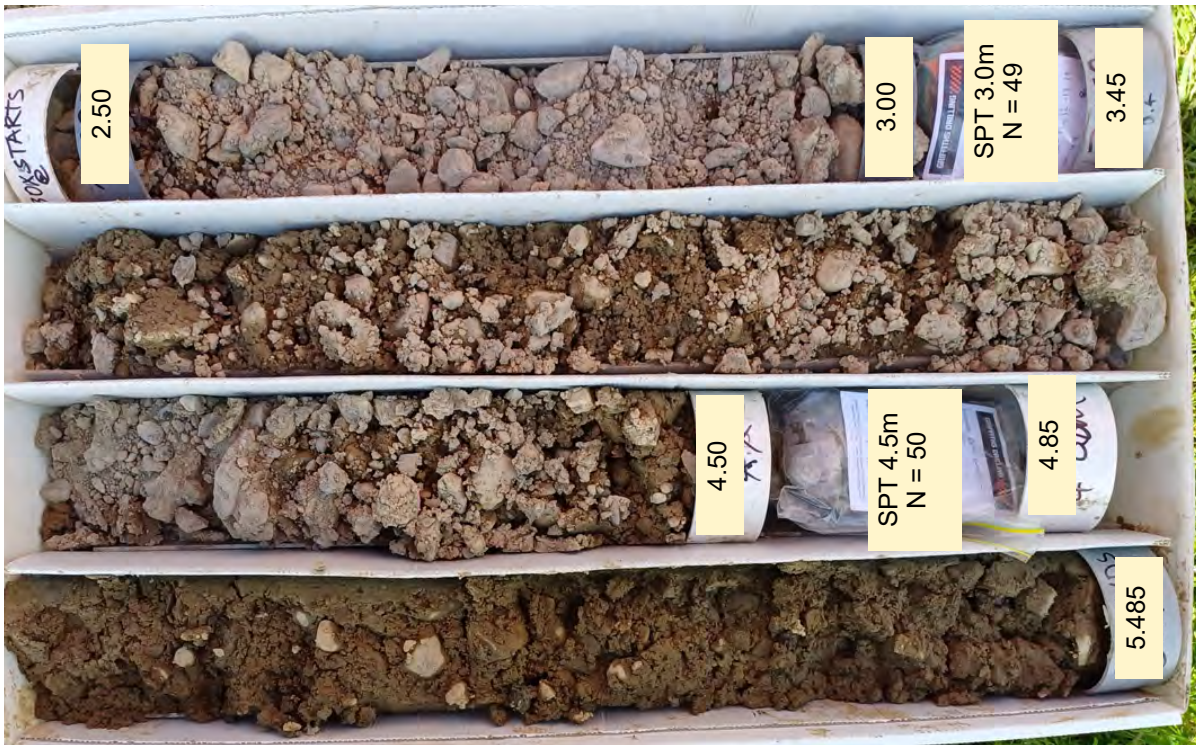

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH02
		Date:	October 2025
		Box No(s).	1 and 2 of 7
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	0.00
		Depth To (m):	5.485
Project No.	250338	**Interval (m):**	5.485

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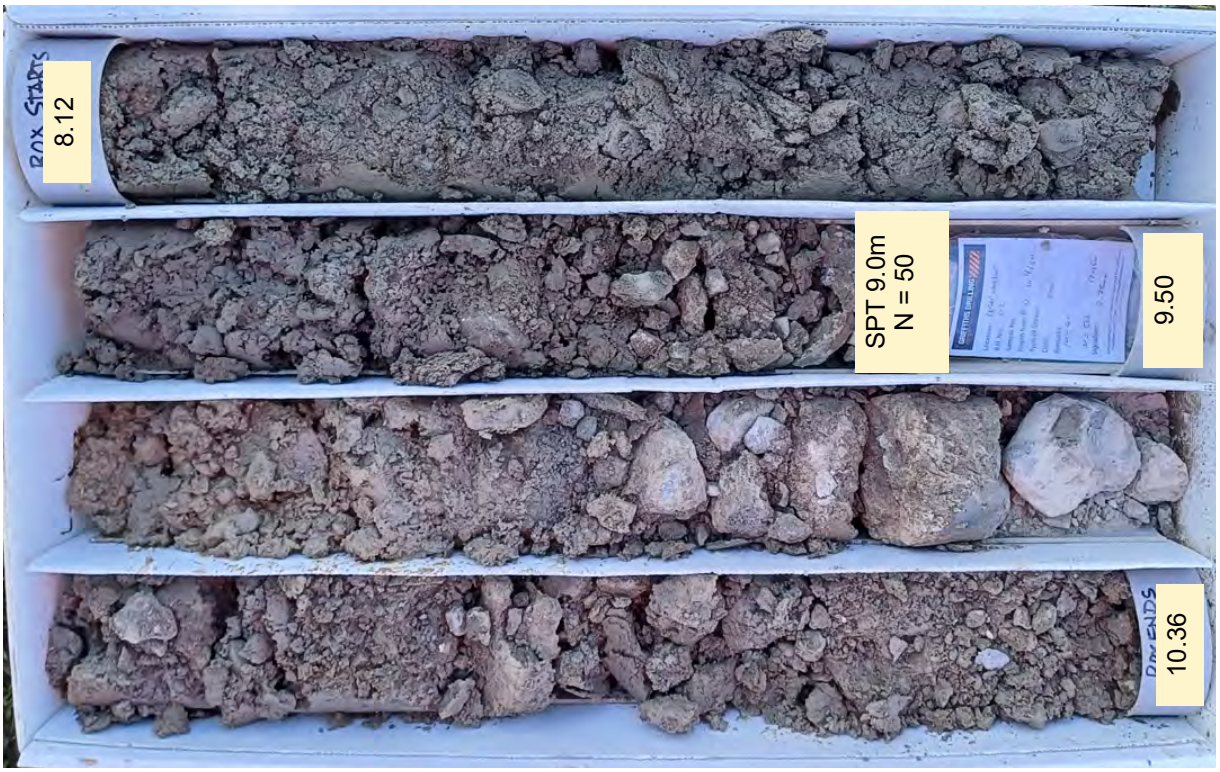
RILEY





Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH02
		Date:	October 2025
		Box No(s).	3 and 4 of 7
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	5.485
		Depth To (m):	10.35
Project No.	250338	**Interval (m):**	4.865

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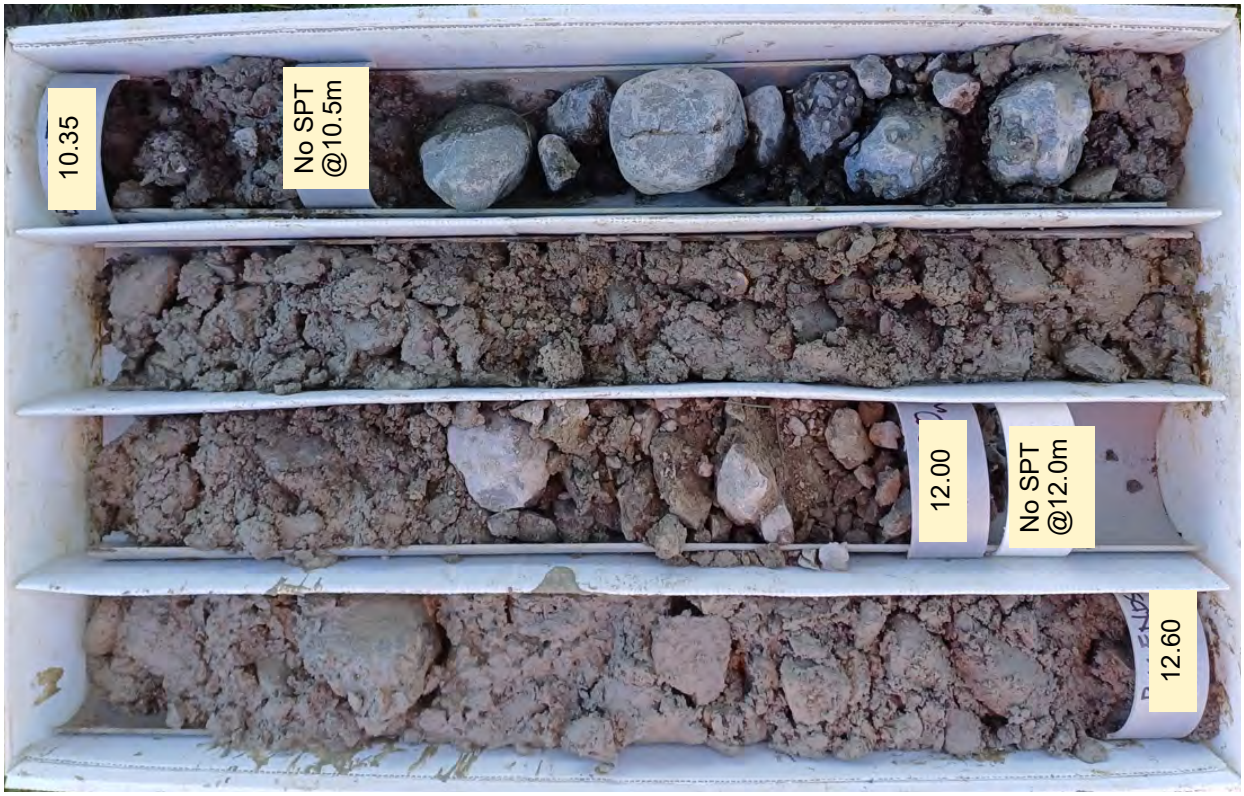

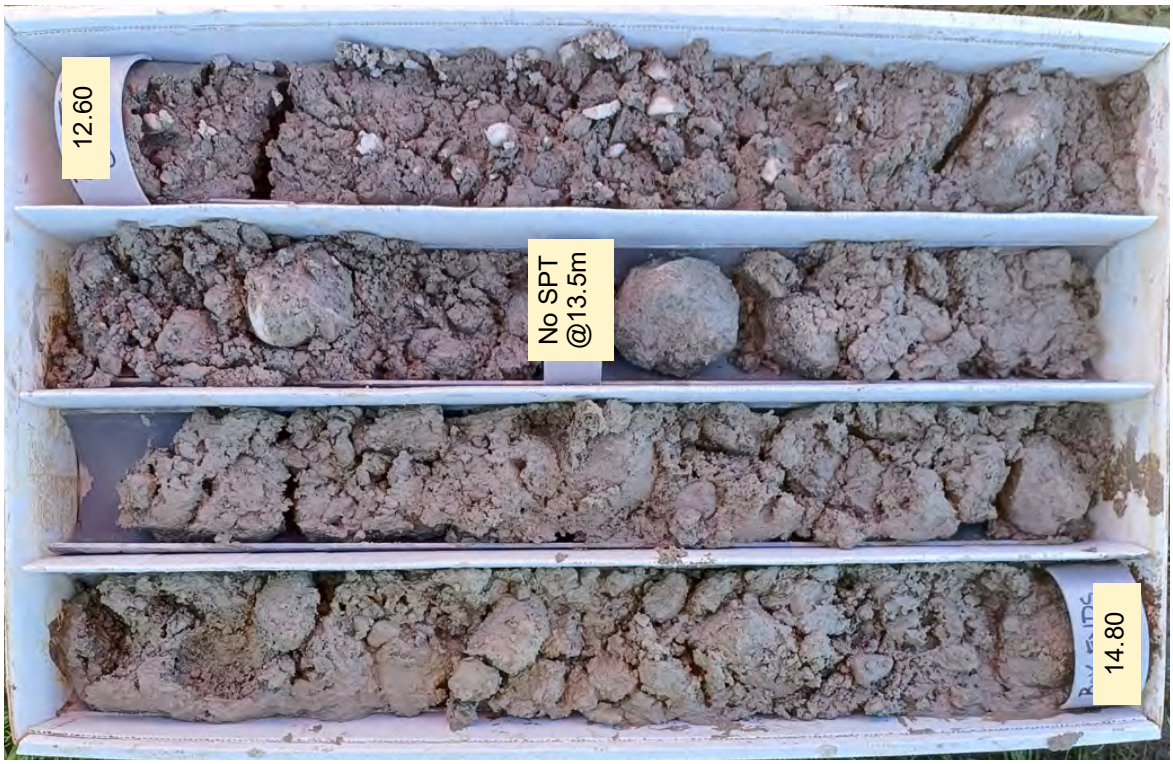

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH02
		Date:	October 2025
		Box No(s).	5 and 6 of 7
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	10.35
		Depth To (m):	14.80
Project No.	250338	**Interval (m):**	4.45

RILEY

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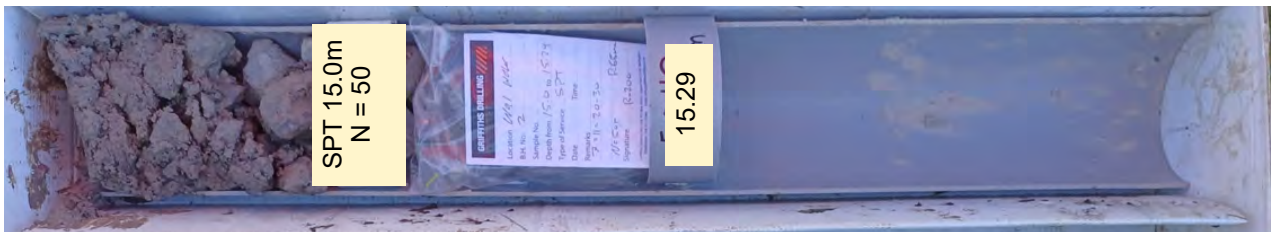

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH02	RILEY
		Date:	October 2025	
		Box No(s).	7 of 7	
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	14.80	
		Depth To (m):	15.29	
Project No.	250338	**Interval (m):**	0.49	

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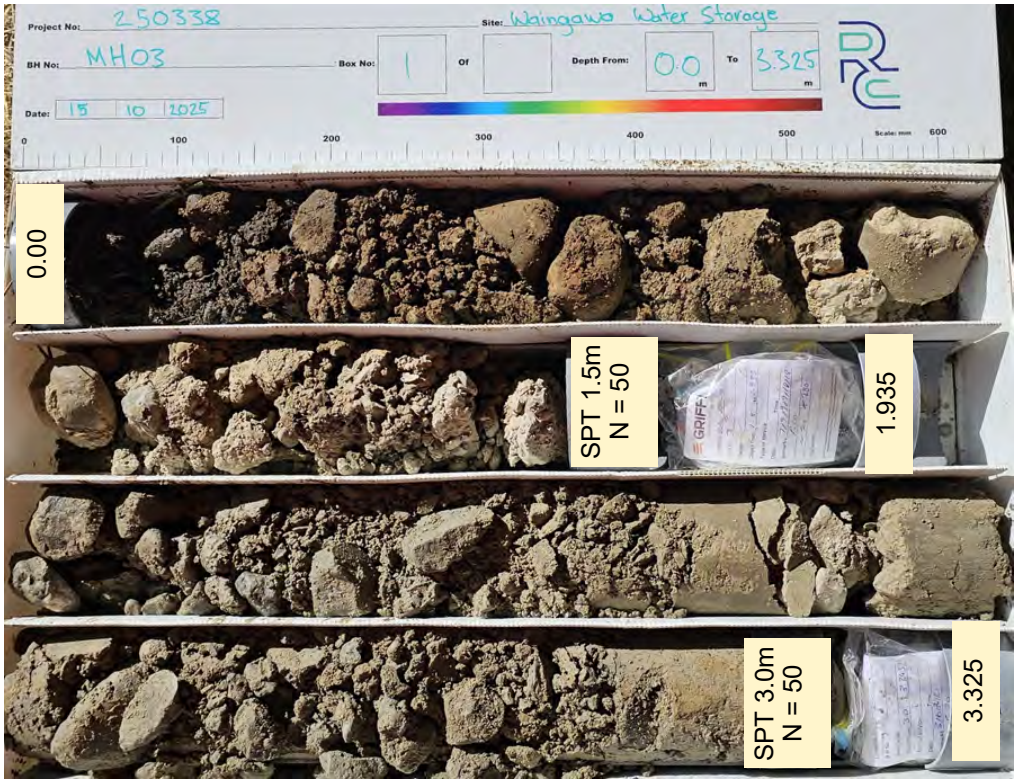



Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH03
		Date:	October 2025
		Box No(s).	1 and 2 of 8
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	0.00
		Depth To (m):	6.00
Project No.	250338	**Interval (m):**	6.00

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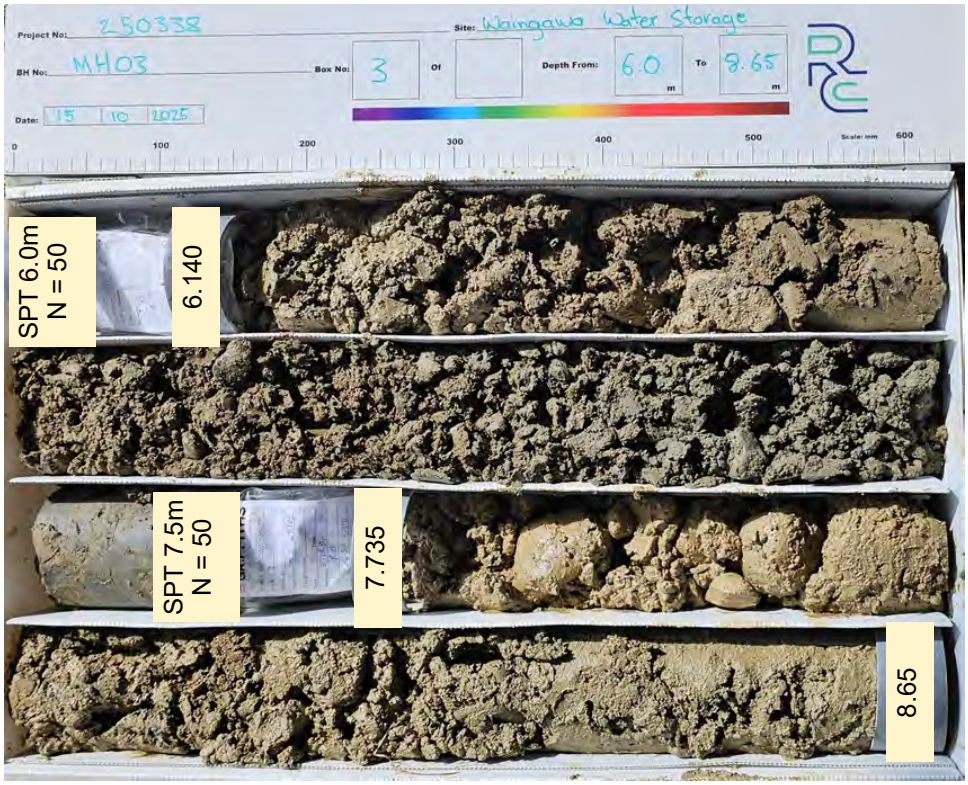

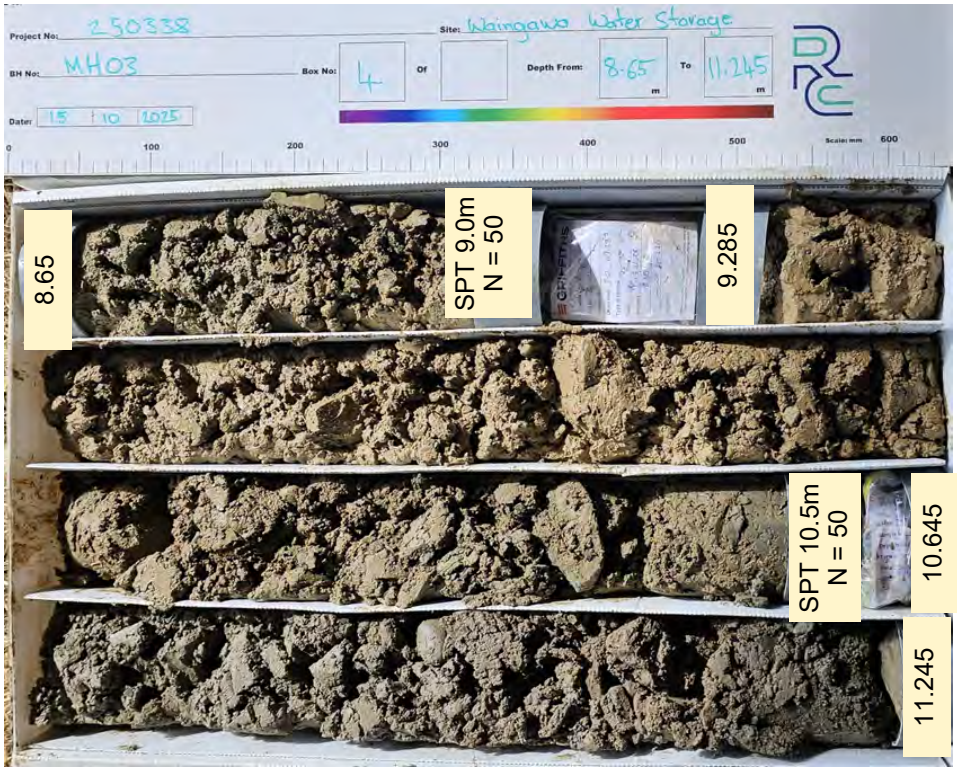

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH03	RILEY
		Date:	October 2025	
		Box No(s).	3 and 4 of 8	
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	6.00	
		Depth To (m):	11.245	
Project No.	250338	**Interval (m):**	5.245	

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Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH03
		Date:	October 2025
		Box No(s).	5 and 6 of 8
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	11.245
		Depth To (m):	17.40
Project No.	250338	**Interval (m):**	6.155

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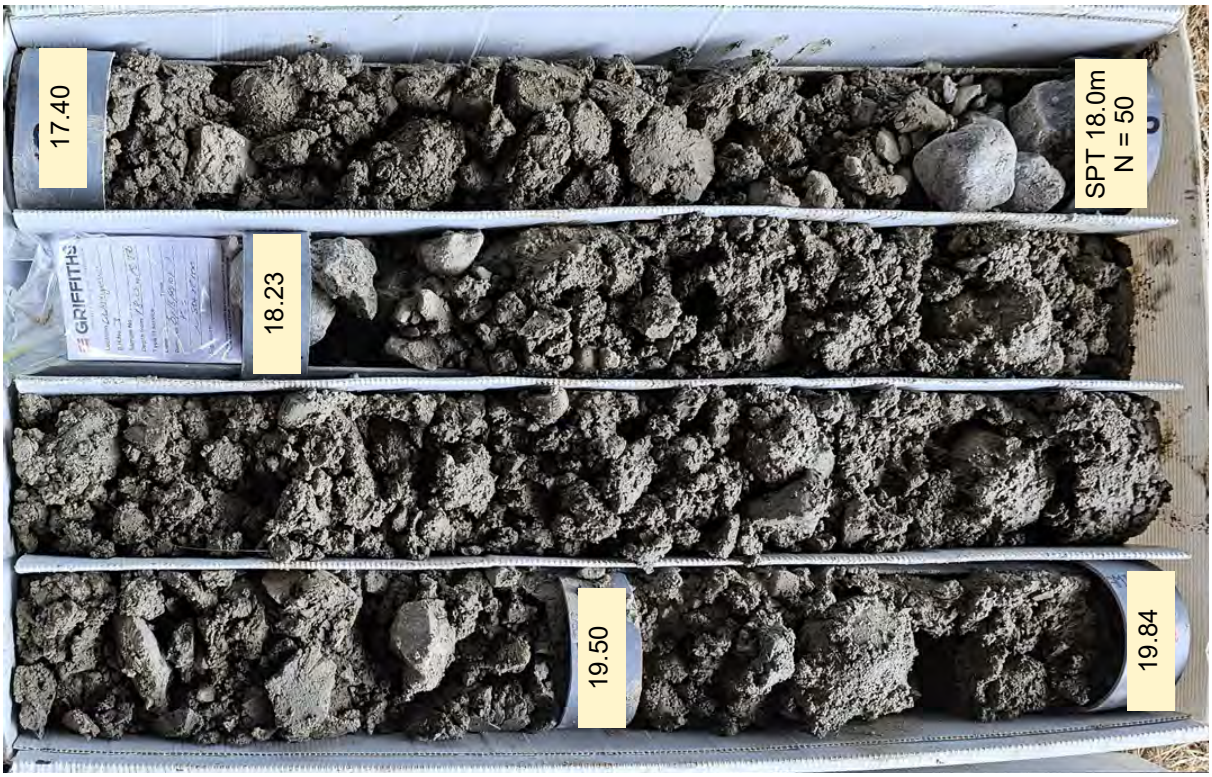



Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH03
		Date:	October 2025
		Box No(s).	7 and 8 of 8
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	17.40
		Depth To (m):	22.5
Project No.	250338	**Interval (m):**	5.10

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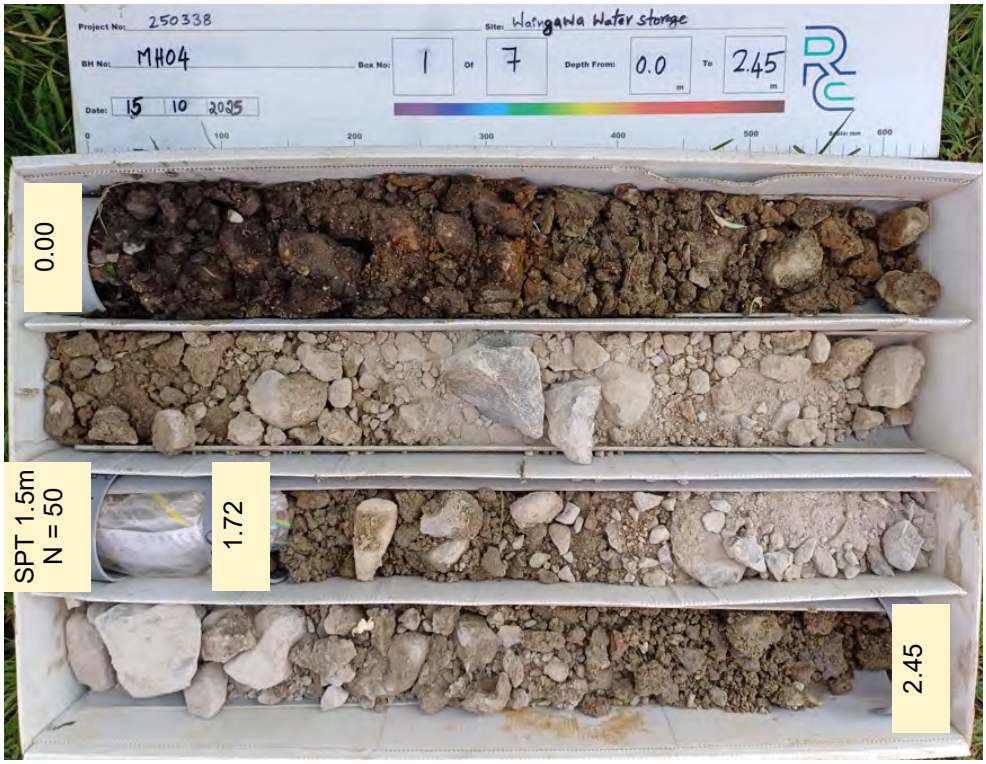

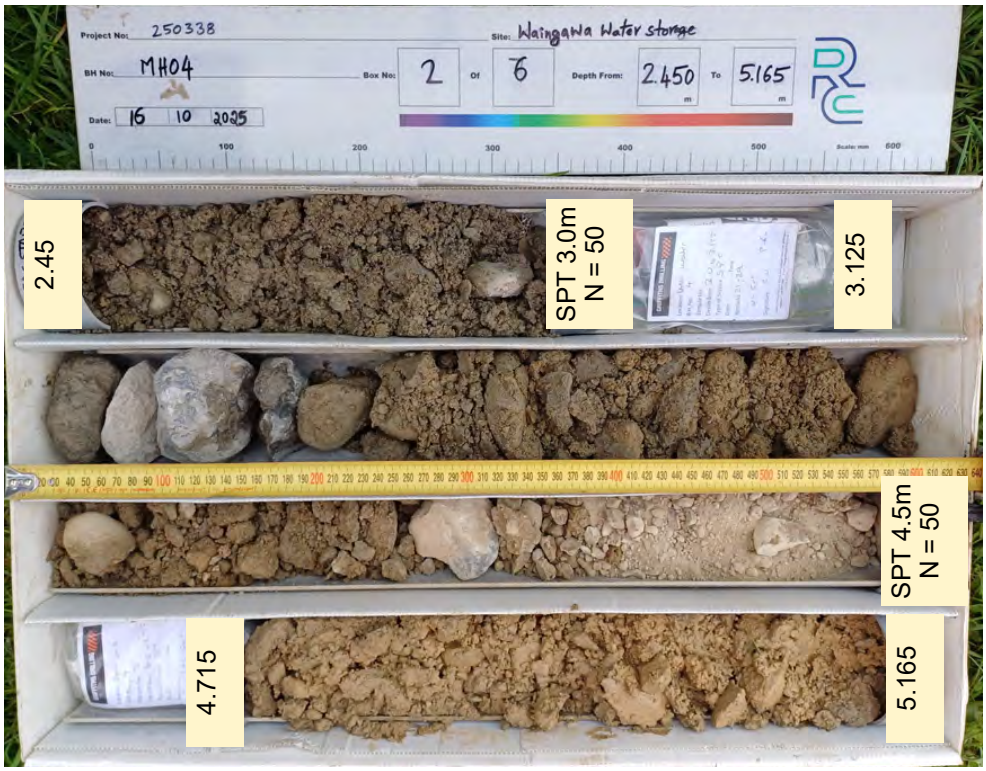

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH04
		Date:	October 2025
		Box No(s).	1 and 2 of 7
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	0.00
		Depth To (m):	5.165
Project No.	250338	**Interval (m):**	5.165

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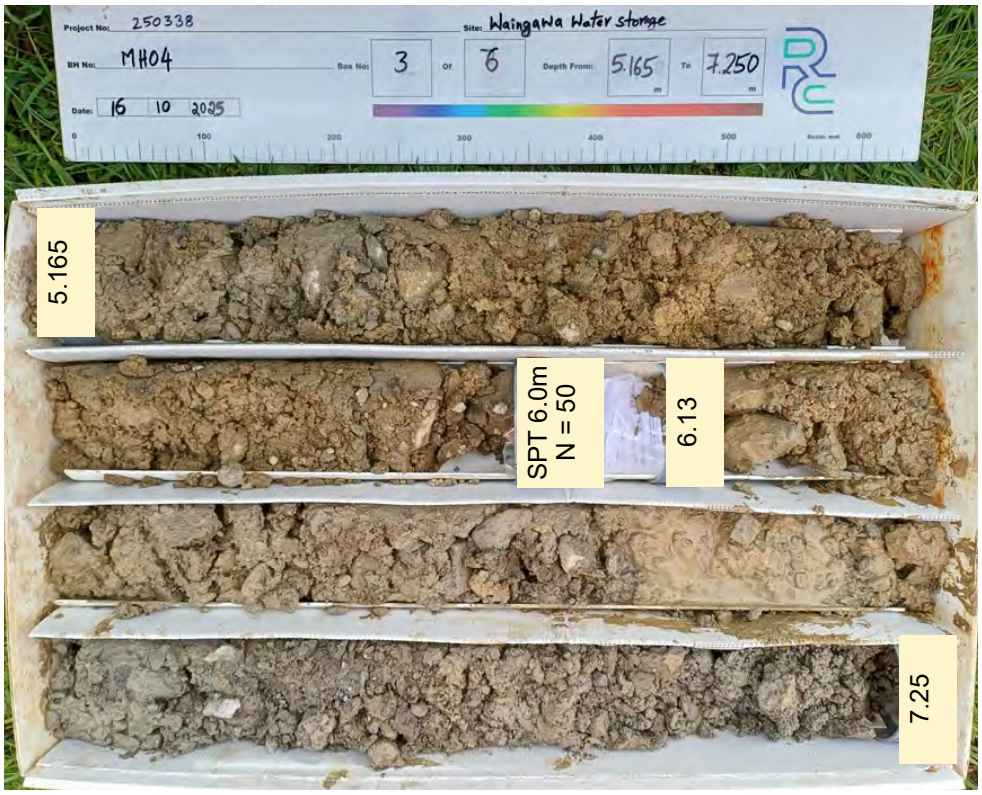
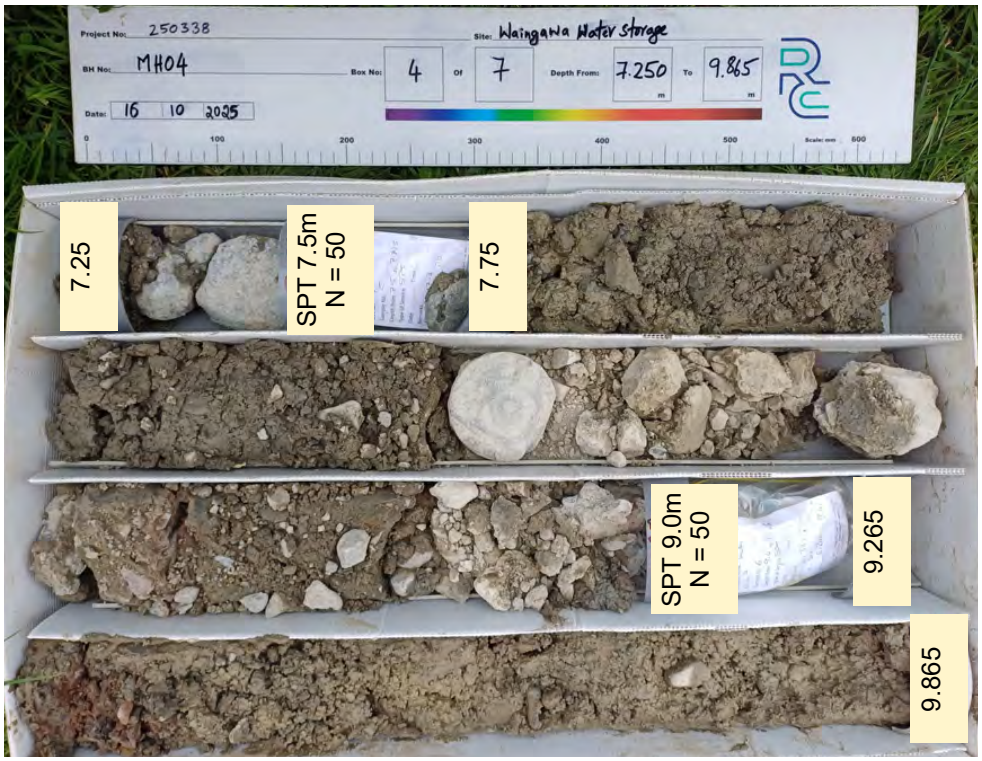
RILEY





Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH04
		Date:	October 2025
		Box No(s).	3 and 4 of 7
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	5.165
		Depth To (m):	9.865
Project No.	250338	**Interval (m):**	4.70

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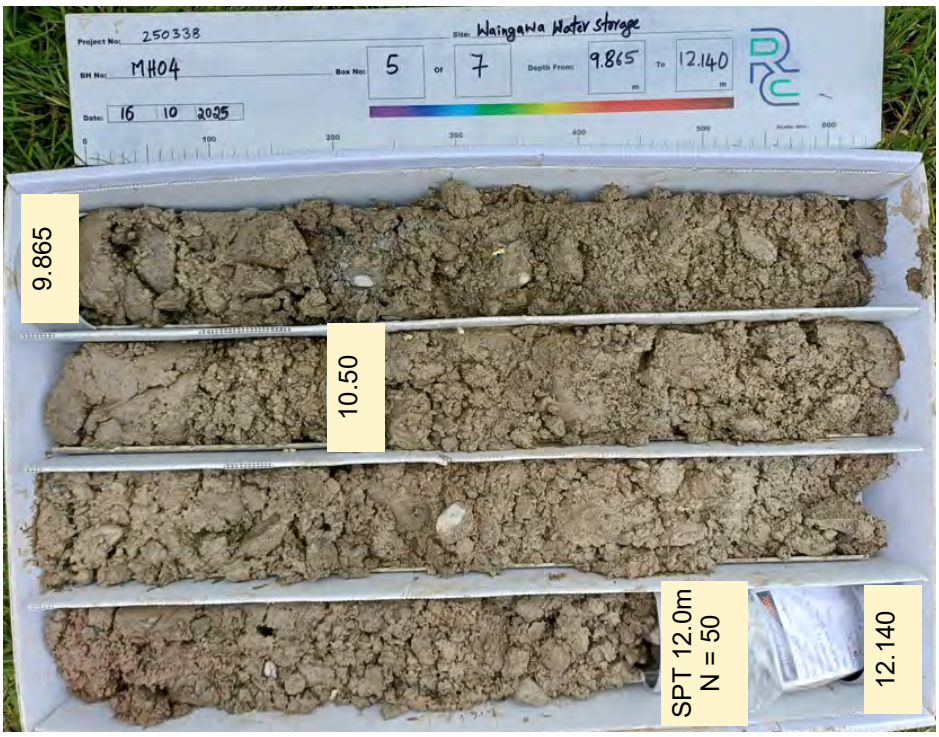
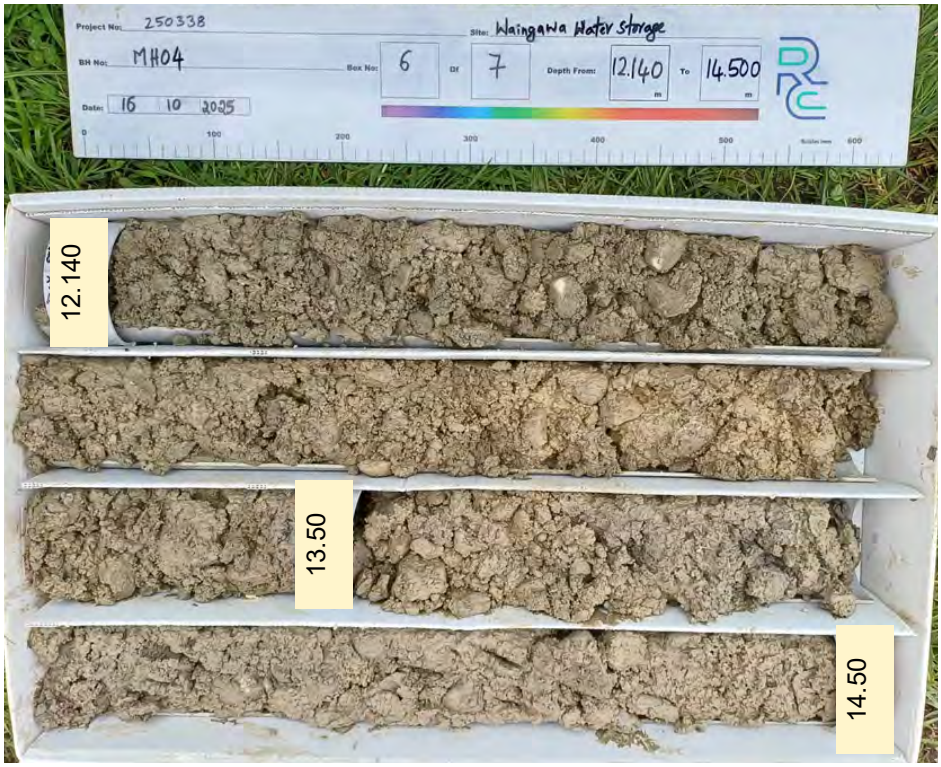
RILEY





Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH04
		Date:	October 2025
		Box No(s).	5 and 6 of 7
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	9.865
		Depth To (m):	14.50
Project No.	250338	**Interval (m):**	4.635

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Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH04	RILEY
		Date:	October 2025	
		Box No(s).	7 of 7	
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	14.50	
		Depth To (m):	15.11	
Project No.	250338	**Interval (m):**	0.61	

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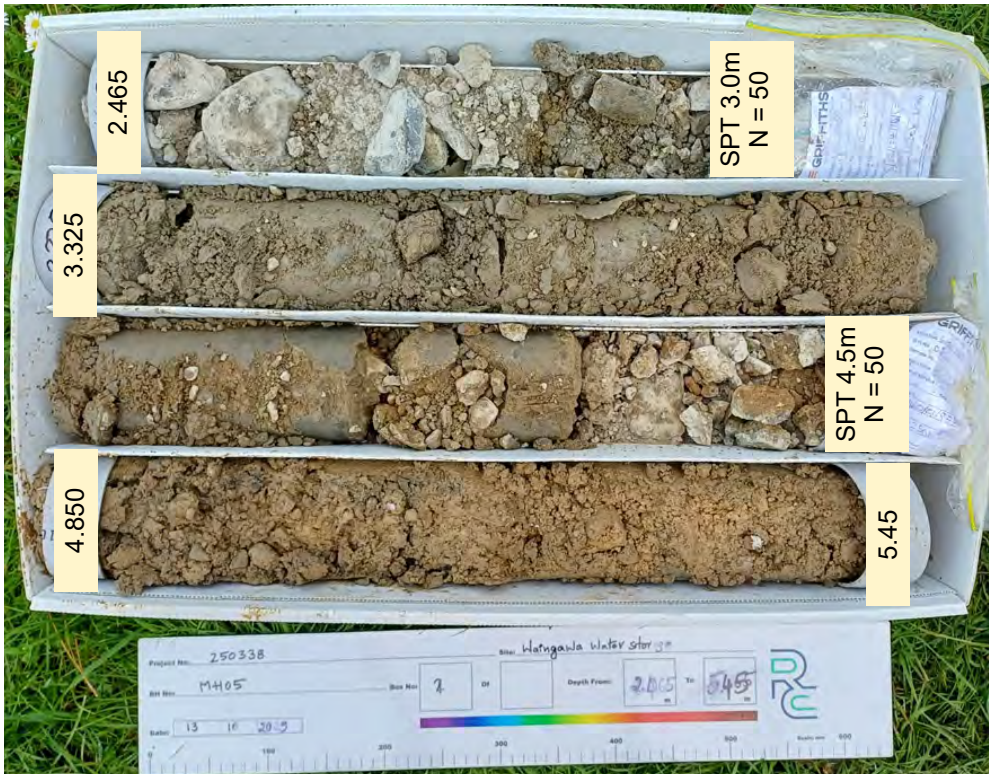

Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH05
		Date:	October 2025
		Box No(s).	1 and 2 of 8
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	0.00
		Depth To (m):	5.45
Project No.	250338	**Interval (m):**	5.45

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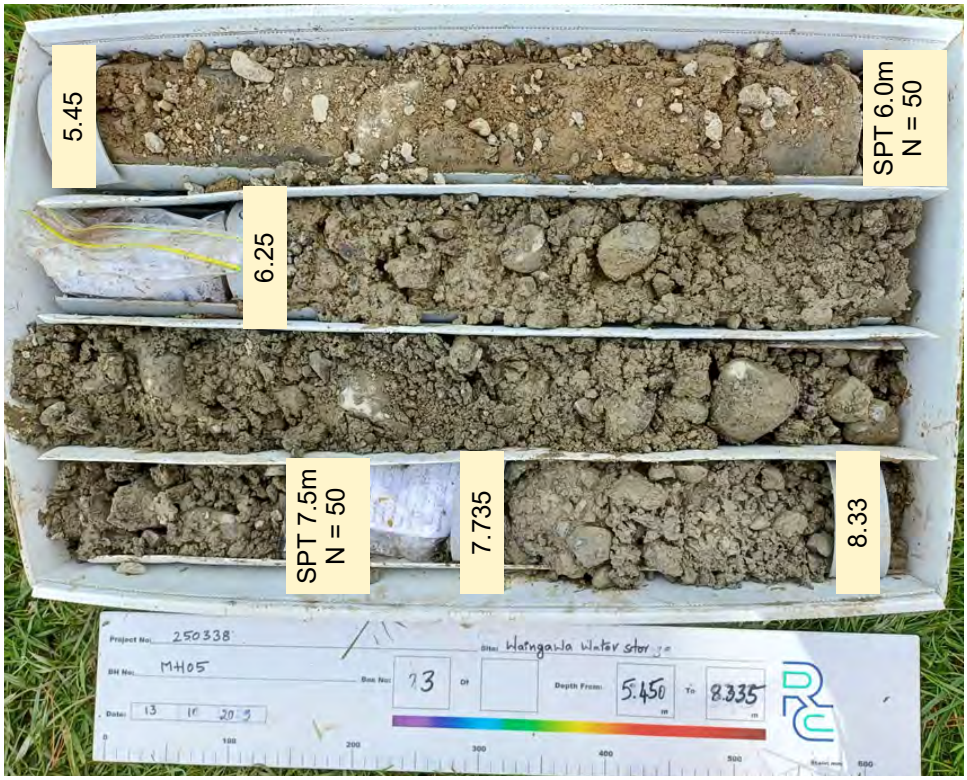
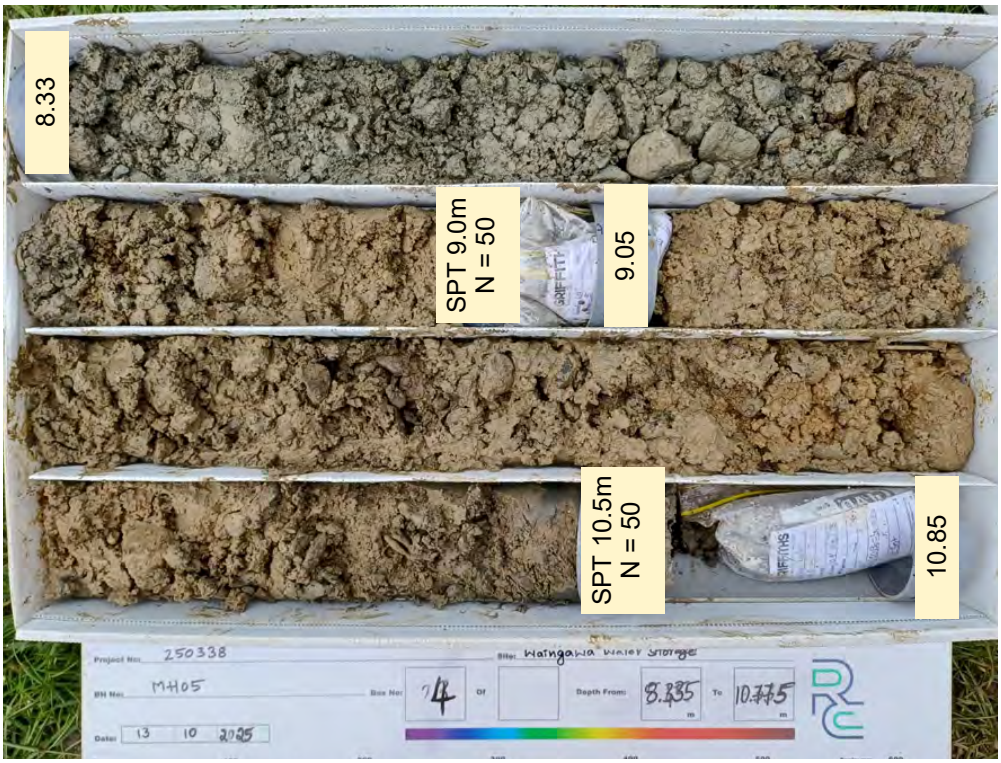
RILEY





Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH05	RILEY
		Date:	October 2025	
		Box No(s).	3 and 4 of 8	
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	5.45	
		Depth To (m):	10.775	
Project No.	250338	**Interval (m):**	5.325	

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Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH05
		Date:	October 2025
		Box No(s).	5 and 6 of 8
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Depth from (m):**	10.775
		Depth To (m):	15.60
Project No.	250338	**Interval (m):**	4.825

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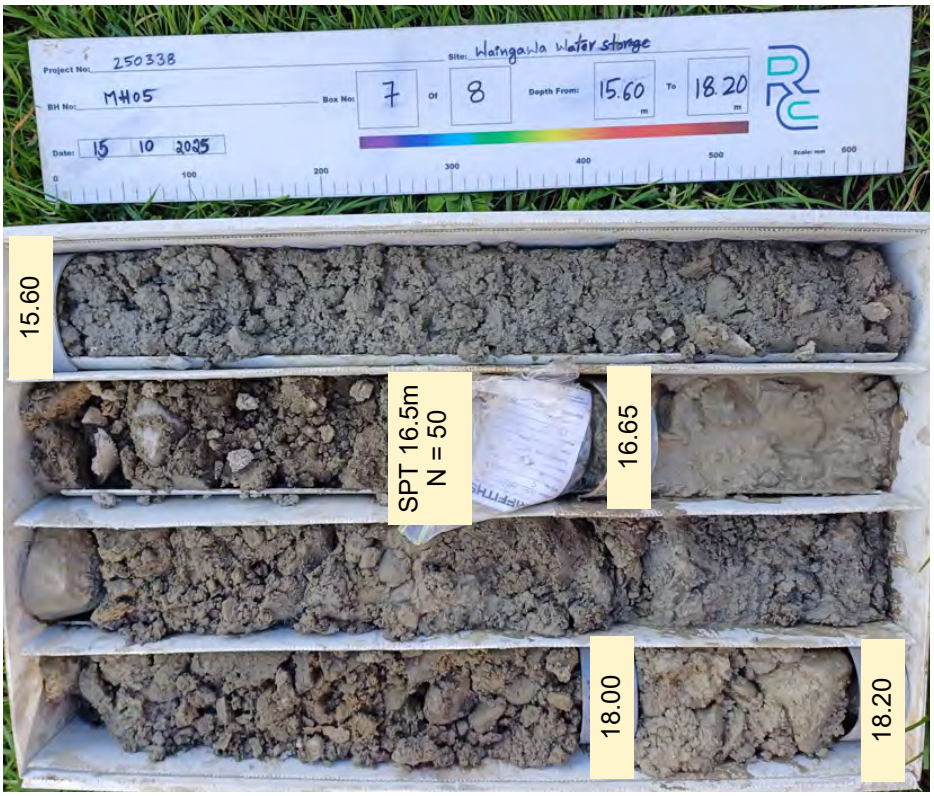
RILEY





Client / Project:	CARTERTON DISTRICT COUNCIL WAINGAWA WATER STORAGE MACHINE BOREHOLE PHOTOS	**Hole ID:**	MH05	RILEY
		Date:	October 2025	
Notes:	1. Drill method = xxx 2. All dimensions in metres; to nearest 0.05m. 3. Depths in parentheses (e.g. at start / end of core boxes) are within a drilling-run 4. C/L = core loss; SPT = standard penetration test (split spoon); SPT-SC = solid cone.	**Box No(s).**	7 and 8 of 8	
		Depth from (m):	15.60	
		Depth To (m):	19.65	
Project No.	250338	**Interval (m):**	4.05	

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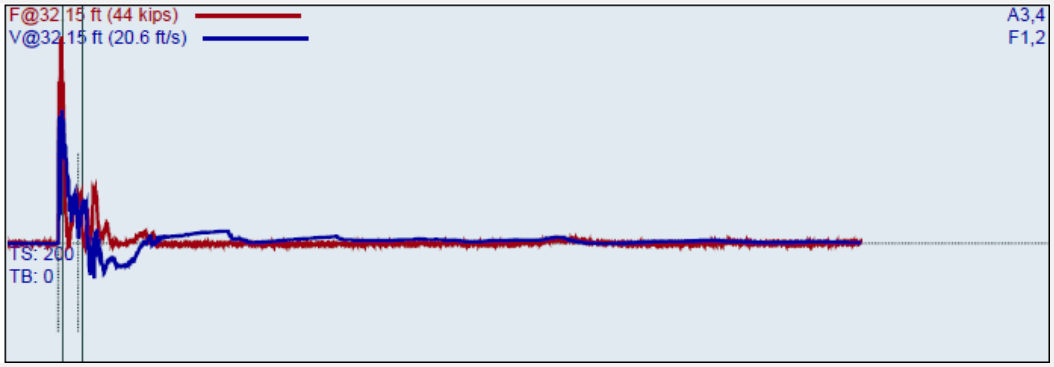
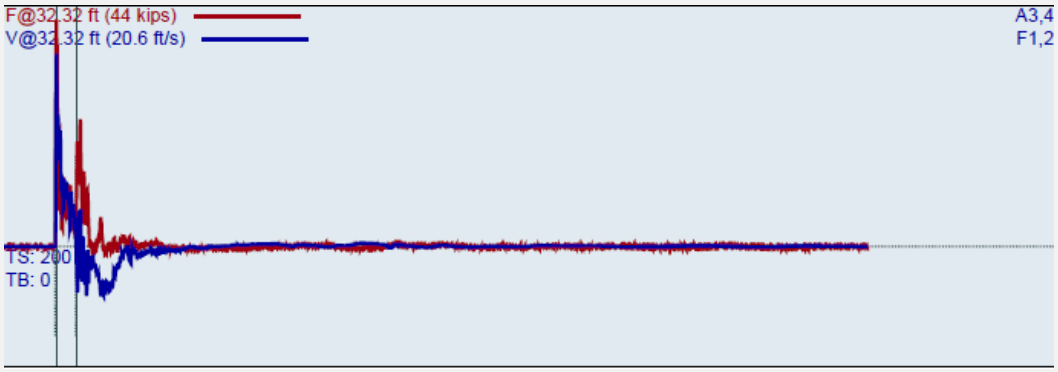
Appendix C

SPT Hammer Efficiency Certificates (Griffiths)

Griffiths Drilling (NZ) Ltd SPT Hammer Calibration Report			
SPT Hammer:	Fraste XL Duo Auto	**Date Tested:**	17/6/25
Location:	GD Yard	**Calibration Equipment:**	Pile Dynamics Inc. SPT Analyzer
Average ETR %	88.2	**Standard Deviation:**	3.3
Test Completed by:	N Abbott	**Test Reviewed by:**	N Abbott
Signed:		**Signed:**	



Griffiths Drilling (NZ) Ltd SPT Hammer Calibration Report			
SPT Hammer:	Fraste XL Max	**Date Tested:**	17/6/25
Location:	GD Yard	**Calibration Equipment:**	Pile Dynamics Inc. SPT Analyzer
Average ETR %	83.5	**Standard Deviation:**	3.7
Test Completed by:	N Abbott	**Test Reviewed by:**	N Abbott
Signed:		**Signed:**	



Appendix D

Machine Test Pits Logs and Photographs

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP01

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	13 Oct 2025	139 m	E 1817012, N 5463031

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.30 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results	Backfill / Install
138.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M			
138.40	0.60	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orange brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].							
				GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 280mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls).							
136.60	2.40			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 280mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts- minor spalling only of side walls. 2.80m: Grades to light orangish brown.		2.40 - 2.60m, 71kg (4)		M W			
134.70	4.30			END OF HOLE: 4.30m - Target Depth							

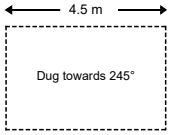
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

RILEY CONSULTANTS LTD. REPORT: RILEY TP-S (soil) - generated with CORE-GS by Geroc

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP02

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	16 Oct 2025	137 m	E 1817135, N 5462868

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.50 m	Flooding/collapse	1 of 1	FINAL

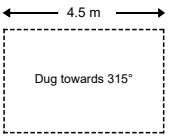
Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil / Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results	Backfill / Install
136.73	0.27	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].				M			
136.35	0.65			Sandy SILT, with trace clay; light yellowish brown to light orange brown with grey mottles. Very stiff to hard; moist; low plasticity; sand, fine; [Q2a ALLUVIUM].						V=111 R=35 V=105 R=41 V=146 R=44 V=198 R=55	
				GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls). 0.70m - 0.90m: Discontinuous lens with trace to minor reddish-brown silt/clay in matrix, cementing clasts - several scraps with toothed bucket to break up [IRON PAN].							
134.80	2.20	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 320mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls. 2.60m: Grades to wet.		3.60 - 3.90m, 78kg (4)		M W			
132.50	4.50			4.30m: Steady groundwater inflow.							
				END OF HOLE: 4.50m - Flooding/collapse							

SKETCHES / PHOTOS

LOCATION PLAN



Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- ☐ None
- ☑ Slow Seep (@4.30m)
- ☐ Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator	GEO1247	AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP03

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	16 Oct 2025	136 m	E 1817234, N 5462742

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.40 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
135.72	0.28	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M	5 10 15			0.5	
135.30	0.70	Q2A ALLUVIUM		SILT, with some sand, with trace clay; light yellowish brown to light orangish brown. Very stiff to hard; moist.								1.0	
134.30	1.70			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 250mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/caving side walls).				M W				1.5	
132.60	3.40			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 280mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls. 2.20m: Grades to wet. 2.70m: Maximum boulder diameter 280mm.				W				2.0 2.5 3.0	
				END OF HOLE: 3.40m - Target Depth								3.5 4.0 4.5	

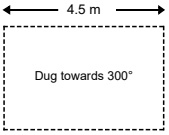
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP04

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	16 Oct 2025	134 m	E 1817358, N 5462603

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.20 m	Flooding/collapse	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results	Backfill / Install
133.70	0.30	TOPSOIL	TS	Sandy medium to coarse GRAVEL, with some silt, with trace rootlets; dark brown to black; moist; non-plastic; sand, fine; [TOPSOIL].				M			
	0.5			Sandy gravelly SILT, with trace rootlets; orange brown; moist; gravel, medium to coarse; loosely-packed [Q2a ALLUVIUM].							
133.30	0.70			0.45m: Grades to light yellowish brown.							
	1.0	Q2A ALLUVIUM		GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 220mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/caving side walls).							
	1.5										
	2.0										
131.90	2.10			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 250mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.		2.10 - 2.30m, 73kg (4)		M W			
	2.5										
	3.0										
	3.5										
	4.0			3.90m: Groundwater inflow.							
129.80	4.20							W			
	4.5			END OF HOLE: 4.20m - Flooding/collapse							

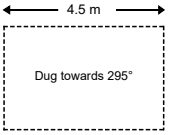
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- ☑ Slow Seep (@3.90m)
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP05

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	13 Oct 2025	138 m	E 1816979, N 5462899

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.20 m	Target Depth	1 of 1	FINAL

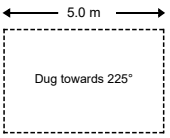
Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
137.80	0.20	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M	5 10 15			0.5 1.0 1.5 2.0 2.5 3.0	
137.30	0.70	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orange brown; moist; subangular to rounded; boulders, up to 270mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].									
				GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; sand, fine to medium; loosely-packed.(major spalling/partial caving side walls).				M W					
				2.70m: Max boulder size 300mm.									
134.80	3.20			END OF HOLE: 3.20m - Target Depth								3.5 4.0 4.5	

SKETCHES / PHOTOS

LOCATION PLAN



Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- ☑ None
- ☐ Slow Seep
- ☐ Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

RILEY CONSULTANTS LTD. REPORT: RILEY TP-S (soil) - generated with CORE-GS by Geroc

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CHRISTCHURCH 8011
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E: rileychch.co.nz

TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP06

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	16 Oct 2025	136 m	E 1817123, N 5462745

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.00 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results
135.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			
135.30	0.70	Q2a ALLUVIUM		SILT, with some sand, with trace clay; light yellowish brown to light orangish brown. Very stiff to hard; moist; [Q2a ALLUVIUM].	M		V=160 R=39
				GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed (minor spalling/partial caving side walls).	M W		
				1.40m - 1.70m: Lens of sandy fine to coarse GRAVEL, trace light yellowish brown silt.			
				2.10m: Maximum boulder size 320mm.			
133.00	3.00			END OF HOLE: 3.00m - Target Depth			

Field Strength: Soil | Rock
Samples + Lab Tests
Groundwater: Not Encountered
Scala Penetrometer (blows / 50mm): 5, 10, 15
Scala Intervals
In-Situ Testing Data/Results
Backfill / Install

SKETCHES / PHOTOS

LOCATION PLAN



Stability:
4.5 m
Dug towards 320°
1.2 m

Explanations:
Scala Penetrometer Tests
Raw data in blows per 100mm
Vane Shear Strength (kPa)
V=Peak, R=Residual,
UTP=Unable to penetrate
Moisture: M = moist;
W = wet; S = saturated

Groundwater:
None
Slow Seep
Rapid Inflow
Standing Water Level
Inflow
Outflow

Backfill:
Bentonite
Grout/concrete
Spoil/arisings
Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator	GEO1247	AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP07

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	16 Oct 2025	135 m	E 1817234, N 5462597

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.20 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
134.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M	5 10 15			0.5 1.0 1.5 2.0 2.5 3.0	
134.40	0.60	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orange brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].				M W					
133.40	1.60			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 290mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls).				M					
131.80	3.20			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist; up to 290mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls. 1.90m: Grades to moist to wet, 'sheen' on clasts.				M W					
				END OF HOLE: 3.20m - Target Depth									

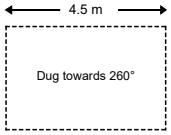
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow
- Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP08

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	13 Oct 2025	139 m	E 1816848, N 5462902

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.10 m	Collapse	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results	Backfill / Install
138.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].				M			
138.40	0.60	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orange brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].							
				Sandy GRAVEL & COBBLES & BOULDERS; brownish grey; moist; subangular to rounded, up to 280mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls).		1.50 - 1.70m, 72kg (4)	Not Encountered	M W			
135.90	3.10			END OF HOLE: 3.10m - Collapse							

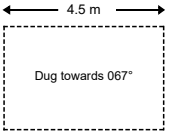
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow
- Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP09

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	17 Oct 2025	137 m	E 1816994, N 5462758

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.65 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results	Backfill / Install
136.72	0.28	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].							
136.10	0.90	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orange brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].		0.50 - 0.90m, 71kg (4)	Not Encountered	M			
135.60	1.40			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 320mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls).				M W			
133.35	3.65			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 330mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls. 2.50m: Grades to wet ('sheen' on clasts).				W			
				END OF HOLE: 3.65m - Target Depth							

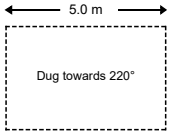
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP10

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	15 Oct 2025	135 m	E 1817112, N 5462600

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.40 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil / Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm) 5 10 15	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
134.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M					
134.50	0.50	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orange brown; moist; subangular to rounded; boulders, up to 280mm, predomiantly fine sandstone; loosely-packed [Q2a ALLUVIUM].				M W				0.5	
133.90	1.10			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed.(major spalling/caving side walls). 0.70m - 1.10m: Trace to minor reddish-brown silt/clay in matrix, cementing clasts - several scraps with toothed bucket to break up [IRON PAN].				M				1.0	
133.50	1.50			Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed.								1.5	
	2.0			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/caving side walls).								2.0	
	2.5			2.80m: Wet (sheen); maximum boulder diameter 330-350mm.		2.60 - 2.90m, 78kg (4)		M W				2.5	
	3.0											3.0	
	3.5											3.5	
	4.0											4.0	
130.60	4.40			END OF HOLE: 4.40m - Target Depth								4.5	

SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:
5.0 m
Dug towards 250°
1.2 m

Explanations:
Scala Penetrometer Tests
Raw data in blows per 100mm
Vane Shear Strength (kPa)
V=Peak, R=Residual,
UTP=Unable to penetrate
Moisture: M = moist;
W = wet; S = saturated

Groundwater:
None
Slow Seep
Rapid Inflow
Standing Water Level
Inflow
Outflow

Backfill:
Bentonite
Grout/concrete
Spoil/arisings
Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP11

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	16 Oct 2025	134 m	E 1817227, N 5462492

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.00 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results	Backfill / Install
133.72	0.28	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].							
133.40	0.60	Q2A ALLUVIUM		SILT, with some sand and gravel, with trace clay; light yellowish brown to light orangish brown. Very stiff; moist; gravel, medium to coarse, subangular to rounded.		0.30 - 0.60m, 25kg	Not Encountered	M		V=139 R=26	
132.20	1.80			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls). 0.85m: Grades to moist. Maximum boulder diameter 280mm.				M W			
131.00	3.00			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 280mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts- minor spalling only of side walls.							
				END OF HOLE: 3.00m - Target Depth							

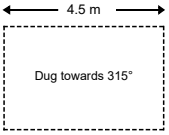
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator	GEO1247	AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP12

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	14 Oct 2025	137 m	E 1816843, N 5462775

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.80 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Soil Moisture
136.80	0.20	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].	M
136.30	0.70	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orange brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].	
				GRAVEL & COBBLES & BOULDERS, with minor sand; greyish brown; moist to wet; subangular to rounded, up to 250mm, predominantly fine sandstone, very strong; loosely-packed, 'sheen' (major spalling/caving side walls).	
				1.30m: Grades to brownish grey.	
135.00	2.00			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; subrounded to subangular, up to 280mm, predominantly fine sandstone; loosely packed; wet 'sheen', light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.	M W
				3.60m: Grades to wet.	
133.20	3.80			END OF HOLE: 3.80m - Target Depth	W

Field Strength: Soil | Rock (VSt, St, F, St, MSO, StSO, StVSt, W, S, ES)

Samples + Lab Tests

Groundwater

Scala Penetrometer (blows / 50mm): 5, 10, 15

In-Situ Testing Data/Results (Scala Intervals; Depth (m))

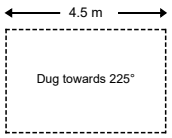
Backfill / Install

SKETCHES / PHOTOS

LOCATION PLAN



Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep (@3.80m)
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP13

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	17 Oct 2025	135 m	E 1816959, N 5462647

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.15 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
134.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M	5 10 15			0.5	
134.30	0.70	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orange brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].								1.0	
				GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls).				M W				1.5	
133.30	1.70			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 330mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.								2.0	
				2.40m: Grades to wet ('sheen').				W				2.5	
131.85	3.15			END OF HOLE: 3.15m - Target Depth								3.0	
												3.5	
												4.0	
												4.5	

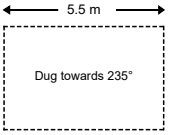
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP14

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	16 Oct 2025	133 m	E 1817087, N 5462463

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	2.90 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
132.76	0.24	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M	5 10 15			0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5	
132.40	0.60	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some sand, with minor silt, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].									
				GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 250mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls). 0.65m - 0.90m: Discontinuous lens with trace to minor reddish-brown silt/clay in matrix, cementing clasts - several scraps with toothed bucket to break up [IRON PAN].				M W				
131.30	1.70			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 250mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts- minor spalling only of side walls.									
130.10	2.90			END OF HOLE: 2.90m - Target Depth									

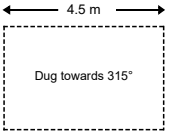
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

RILEY CONSULTANTS LTD. REPORT: RILEY TP-S (soil) - generated with CORE-GS by Geroc

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP15

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	14 Oct 2025	138 m	E 1816683, N 5462775

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.10 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results	Backfill / Install
137.70	0.30	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered				
137.40	0.60	Q2A ALLUVIUM		SILT, with some sand, with minor gravel; light orange brown. Very stiff to hard; moist; non-plastic; sand, fine; gravel, fine to medium; loosely-packed [Q2a ALLUVIUM].		0.60 - 0.80m, 25kg		M		UTP	
136.90	1.10			SILT, with some sand, with minor gravel; light yellowish brown to light orangish brown. Very stiff to hard; moist; gravel, medium to coarse.							
133.90	4.10			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls).		2.20 - 2.40m, 72kg (4)		M W			
				END OF HOLE: 4.10m - Target Depth							

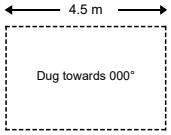
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator	GEO1247	AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP16

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	14 Oct 2025	135 m	E 1816818, N 5462611

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.00 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
134.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M	5 10 15			0.5	
134.40	0.60	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].								1.0	
				GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 370mm, predominantly fine sandstone, very strong; loosely-packed, some caving of side walls. Interbedded layers with/without silt coating.				M W				1.5	
												2.0	
												2.5	
132.00	3.00			END OF HOLE: 3.00m - Target Depth								3.0	
												3.5	
												4.0	
												4.5	

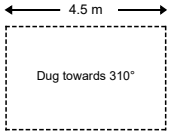
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

RILEY CONSULTANTS LTD. REPORT: RILEY TP-S (soil) - generated with CORE-GS by Geroc

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP17

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	15 Oct 2025	133 m	E 1816943, N 5462471

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.40 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
132.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].				M	5 10 15			0.5	
132.20	0.80	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM]. 0.35m - 0.80m: Trace to minor reddish-brown silt/clay in matrix, cementing clasts - several scraps with toothed bucket to break up [IRON PAN].				M W				1.0	
	1.5			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 270mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls). 1.50m: Grades to wet ("sheen" on clasts).								1.5	
	2.0											2.0	
130.50	2.50							W				2.5	
	3.0			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; wet; up to 330mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts- minor spalling only of side walls.								3.0	
129.60	3.40			3.30m: Steady groundwater inflow.			▽						
	3.5			END OF HOLE: 3.40m - Target Depth								3.5	
	4.0											4.0	
	4.5											4.5	

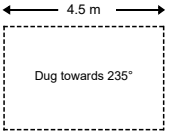
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- ☑ Slow Seep (@3.30m)
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP18

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	15 Oct 2025	133 m	E 1817047, N 5462357

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.80 m	Target Depth	1 of 1	FINAL

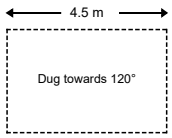
Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
132.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].				M	5 10 15				
132.30	0.70	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets; light orangish brown; moist; subangular to rounded, up to 170mm; loosely-packed [Q2a ALLUVIUM].		0.30 - 0.70m, 60kg (4)							
				GRAVEL & COBBLES, with minor sand; brownish grey; moist to wet; up to 150mm; loosely-packed (moderate spalling/caving side walls).									
				1.50m: Grades to include boulders, max 270mm. Grades to wet 'sheen'.									
131.10	1.90			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 350mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.				M W					
				4.45m: Grades to include boulders up to 420mm.									
				4.50m: Steady groundwater inflow.			▽	W					
128.20	4.80			END OF HOLE: 4.80m - Target Depth									

SKETCHES / PHOTOS

LOCATION PLAN



Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- ☑ Slow Seep (@4.50m)
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP19

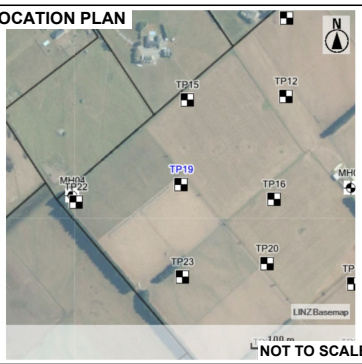
Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	14 Oct 2025	136 m	E 1816668, N 5462638

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	2.80 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
135.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M	5 10 15			0.5	
135.50	0.50	Q2A ALLUVIUM	TS	Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].								1.0	
	1.0			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 380mm, predominantly fine sandstone, very strong; loosely-packed.(major spalling/caving side walls).								1.5	
134.30	1.70			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 350mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.				M W				2.0	
133.20	2.80			END OF HOLE: 2.80m - Target Depth								2.5	
	3.0											3.0	
	3.5											3.5	
	4.0											4.0	
	4.5											4.5	

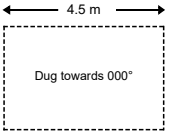
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

RILEY CONSULTANTS LTD. REPORT: RILEY TP-S (soil) - generated with CORE-GS by Geroc

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP20

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	14 Oct 2025	133 m	E 1816804, N 5462508

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.30 m	Flooding/collapse	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Samples + Lab Tests	Soil Moisture
132.78	0.22	TOPSOIL	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].		M
132.55	0.45	Q2A ALLUVIUM	Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].		
			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed.(major spalling/caving side walls).	1.10 - 1.50m, 83kg (4)	M W
130.90	2.10		Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 350mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.		
			3.40m: Steady groundwater inflow.		W
128.70	4.30		END OF HOLE: 4.30m - Flooding/collapse		

Groundwater: Slow Seep (@3.40m)

Scala Penetrometer (blows / 50mm): 5, 10, 15

In-Situ Testing Data/Results

Backfill / Install

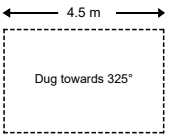
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- ☐ None
- ☑ Slow Seep (@3.40m)
- ☐ Rapid Inflow
- ▼ Standing Water Level
- ◁ Inflow ▷ Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP21

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	15 Oct 2025	131 m	E 1816938, N 5462352

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.20 m	Collapse	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil / Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm) 5 10 15	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
130.70	0.30	TOPS OIL	TS TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].									
130.00	1.00	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predomiantly fine sandstone; loosely-packed [Q2a ALLUVIUM].				M				0.5	
129.80	1.20			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; Variable. Loosely-packed.(major spalling/caving side walls). 1.00m - 1.20m: Lens light yellowish-brown, fine sandy SILT, trace clay - lateral extent 1.5m+ (pit length 4.5m).								1.0	
				Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 350mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.				M W				1.5 2.0 2.5	
127.80	3.20			3.00m: Steady groundwater inflow.			◁	W				3.0	
				END OF HOLE: 3.20m - Collapse								3.5 4.0 4.5	

SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:
5.0 m
Dug towards 330°
1.2 m

Explanations:
Scala Penetrometer Tests Raw data in blows per 100mm
Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
Moisture: M = moist; W = wet; S = saturated

Groundwater:
None
Slow Seep (@3.00m)
Rapid Inflow
Standing Water Level
Inflow
Outflow

Backfill:
Bentonite
Grout/concrete
Spoil/arisings
Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP22

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	15 Oct 2025	138 m	E 1816499, N 5462615

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.00 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results	Backfill / Install
137.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M			
137.40	0.60	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].							
	1.0			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed.(major spalling/caving side walls).				M W			
135.20	2.80			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; non-plastic; up to 350mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.		3.60 - 3.80m, 63kg (4)					
134.00	4.00			END OF HOLE: 4.00m - Target Depth							

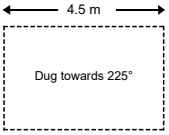
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep
- Rapid Inflow
- Standing Water Level
- Inflow
- Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP23

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	15 Oct 2025	134 m	E 1816667, N 5462491

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.30 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
133.75	0.25	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].			Not Encountered	M	5 10 15			0.5	
133.40	0.60	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].								1.0	
				0.40m: Grades to yellowish brown.								1.5	
				GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls).				M W				2.0	
				1.80m: Lens of yellowish brown, less coarse, higher silt. Minor to moderate caving. Loosely packed.								2.5	
				2.60m: Grades to wet 'sheen'.								3.0	
131.20	2.80			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 350mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.								3.5	
130.70	3.30			END OF HOLE: 3.30m - Target Depth								4.0	
	4.5											4.5	

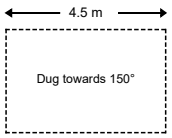
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- ☑ None
- ☐ Slow Seep
- ☐ Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP24

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	15 Oct 2025	132 m	E 1816795, N 5462357

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	3.80 m	Target Depth	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	Scala Intervals	In-Situ Testing Data/Results	Depth (m)	Backfill / Install
131.70	0.30	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].									
				Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].				M					
130.90	1.10			0.70m - 1.10m: Trace to minor reddish-brown silt/clay in matrix, cementing clasts - several scraps with toothed bucket to break up [IRON PAN].									
		Q2A ALLUVIUM		GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed. 'sheen'. (major spalling/caving side walls).									
129.80	2.20			Medium to coarse GRAVEL & COBBLES & BOULDERS, with minor sand, with trace silt; light yellowish brown (matrix) to brownish grey; moist to wet; up to 300mm, predominantly fine sandstone; loosely packed; light yellowish-brown silt coating and weakly cementing clasts - minor spalling only of side walls.				M W					
128.20	3.80			3.60m: Steady groundwater inflow.				W					
				END OF HOLE: 3.80m - Target Depth									

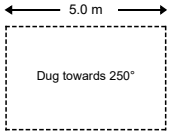
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- ☐ None
- ☑ Slow Seep (@3.60m)
- ☐ Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

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TEST PIT LOG

Project:	Location:	Pit Position:	No.:
Waingawa Water Storage Project	247 Norfolk Road, Waingawa	Refer to site plan	TP25

Project No.:	Date Excavated:	Ground Level (m NZVD2016):	Co-ordinates (NZTM):
250338	15 Oct 2025	130 m	E 1816863, N 5462183

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Carterton District Council	4.50 m	Flooding/collapse	1 of 1	FINAL

Elevation m NZVD2016	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to "Geotechnical and Geological Information" for explanation of material legend and abbreviations)	Field Strength (Soil | Rock)	Samples + Lab Tests	Groundwater	Soil Moisture	Scala Penetrometer (blows / 50mm)	In-Situ Testing Data/Results (Depth (m))	Backfill / Install
129.72	0.28	TOPSOIL	TS	Silty fine SAND, with some gravel and cobbles, with trace rootlets; dark brown, locally black; moist; non-plastic; gravel, medium to coarse, cobbles, subangular to rounded, Sandstone; [TOPSOIL].				M			
129.40	0.60	Q2A ALLUVIUM		Medium to coarse GRAVEL & COBBLES, with some silt and sand, with trace rootlets and boulders; light orangish brown; moist; subangular to rounded; boulders, up to 280mm, predominantly fine sandstone; loosely-packed [Q2a ALLUVIUM].							
	1.0			GRAVEL & COBBLES & BOULDERS, with minor sand; brownish grey; moist to wet; subangular to rounded, up to 300mm, predominantly fine sandstone, very strong; loosely-packed (major spalling/partial caving side walls).				M W			
	3.0			3.00m: Grades to wet to saturated. Minor spalling/caving.		2.80 - 3.00m, 71kg (4)		WS			
	3.5			3.70m: Slow seep groundwater inflow.							
	4.0			4.00m: Rapid inflow of groundwater.				S			
125.50	4.50			END OF HOLE: 4.50m - Flooding/collapse							

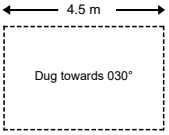
SKETCHES / PHOTOS

LOCATION PLAN



NOT TO SCALE

Stability:



Explanations:
- Scala Penetrometer Tests Raw data in blows per 100mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- ☐ None
- ☑ Slow Seep (@4.00m)
- ☐ Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Coordinates based on hand-held GPS (+/-3m); elevations based on LiDAR DEM (+/-1m)
2. Excavator equipped with 1.2m wide toothed bucket; base weight 20t, appendage weight 8t
3. Backfilling completed in layers compacted with excavator bucket, topsoil reinstated, and surface track-rolled.
4. Weight of sample is post-removal of material exceeding ~80mm diameter Refer to report for further details.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	Scott's Ag Contracting	20t Excavator		AVD	TLS

RILEY CONSULTANTS LTD. REPORT: RILEY TP-S (soil) - generated with CORE-GS by Geroc

Printed: 26/11/2025 11:11:41 am





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP01	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	13-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	4.30	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP02
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	16-10-2025
Notes:		**Plant:**	20t exc. tooth bucket
		Pit Toe Depth (m):	4.50
Project No.	250338	**Terminated Due To:**	Collapse

RILEY





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP03	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	16-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.40	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP04	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	16-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	4.20	
Project No.	250338	**Terminated Due To:**	Collapse	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP05	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	13-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.20	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP06	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	16-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.00	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP07	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	16-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.20	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP08	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	13-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.10	
Project No.	250338	**Terminated Due To:**	Collapse	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP09	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	17-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.65	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP10	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	15-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	4.40	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP11	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	16-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.00	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP12	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	14-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.80	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP13	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	17-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.15	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP14	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	16-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	2.90	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP15	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	14-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	4.10	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP16	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	14-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.00	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP17	RILEY
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	15-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.40	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP18	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	15-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	4.80	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP19	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	14-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	2.80	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP20	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	14-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	4.30	
Project No.	250338	**Terminated Due To:**	Caving	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP21	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	15-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.20	
Project No.	250338	**Terminated Due To:**	Collapse	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP22	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	14-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	4.00	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP23	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	15-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.30	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP24	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	15-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	3.80	
Project No.	250338	**Terminated Due To:**	Target Depth	





Client	CARTERTON DISTRICT COUNCIL	**Pit ID:**	TP25	
Project Title	WAINGAWA WATER STORAGE MACHINE EXCAVATION PIT PHOTOS	**Date:**	15-10-2025	
Notes:		**Plant:**	20t exc. tooth bucket	
		Pit Toe Depth (m):	4.50	
Project No.	250338	**Terminated Due To:**	Collapse	

Appendix E

Laboratory Soil Testing Reports (WSP)

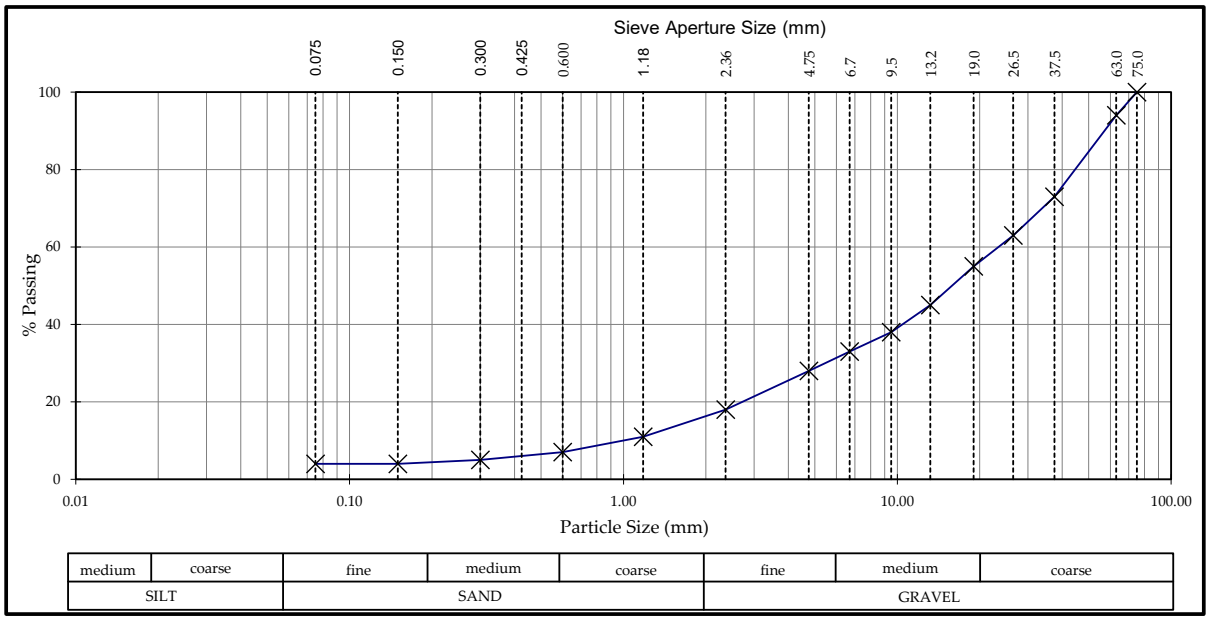
WET SIEVE ANALYSIS
TEST REPORT

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not stated
Sampling method :	Test Pit
Sample description :	GRAVEL with some Sand
Sample condition	Moist
Test Pit no :	TP02
Depth (m) :	3.60 -3.90

Project No :	5-22000.74
Lab Ref No :	OR4998/02
Client Ref No :	250338

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	100	19.00	55	4.75	28	0.425	-
63.00	94	13.20	45	2.36	18	0.300	5
37.50	73	9.50	38	1.18	11	0.150	4
26.50	63	6.70	33	0.600	7	0.075	4



Test Method	Notes
NZS 4402 : 1986 Test 2.8.1 (Wet sieve)	History: As received Fraction tested: Passing 80mm (supplied by client) Dispersant Used: n/a All information supplied by Client *Fraction passing finest sieve is by difference.*

Date tested : 20 - 23/10/2025
Date reported : 31/10/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 31/10/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-099 (11/07/2020)

WSP
Lower Hutt (The Esplanade)
Quality Management Systems Certified to ISO 9001

33 The Esplanade
PO Box 30 845, Lower Hutt, 5040, Lower Hutt, New Zealand

Telephone 04 587 0600
Website www.wsp.com/nz

DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

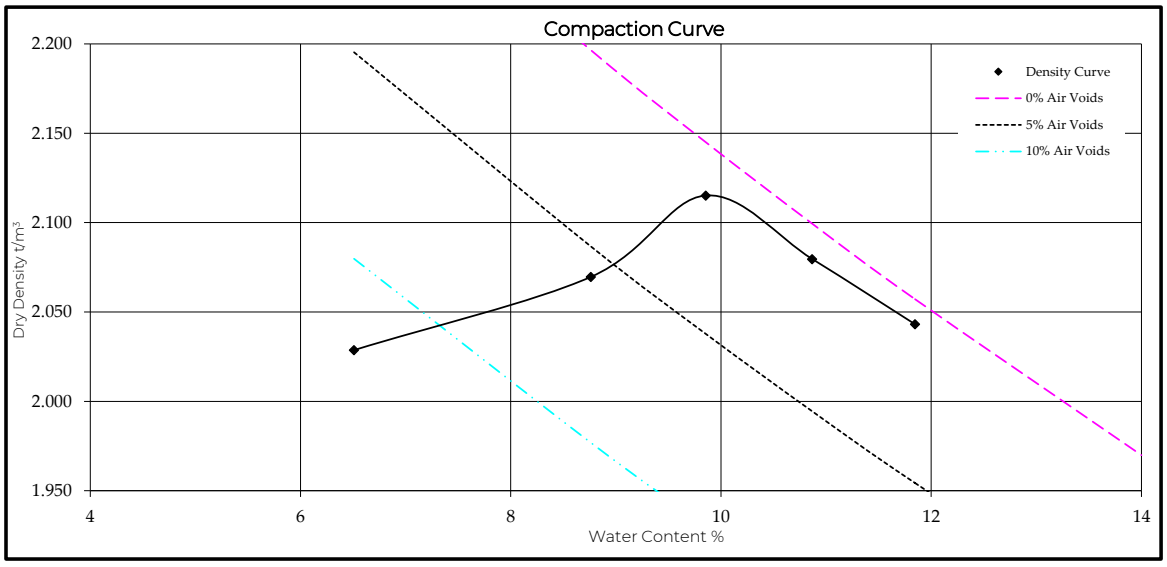
Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not Stated
Sampling method :	Test Pit
Sample description :	GRAVEL with some sand
Sample condition :	Moist
Solid density :	2.72 t/m³ (Assumed)
Source :	TP02 3.6m-3.9m

Project No :	5-22000.74
Lab Ref No :	OR4998/02
Client Ref No :	250338

Test Results

Maximum dry density	2.12	t/m³	Natural water content	6.5	%	
Optimum water content	10	%	Fraction tested	-19.0mm		

Sample ID								
Bulk density	t/m³	2.161	2.251	2.324	2.306	2.285		
Water content	%	6.5	8.8	9.9	10.9	11.8		
Dry density	t/m³	2.029	2.070	2.115	2.080	2.043		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	55% passing 19.0mm All information supplied by client.

Date tested : 22 - 29/10/2025
Date reported : 06/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 06/11/2025

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

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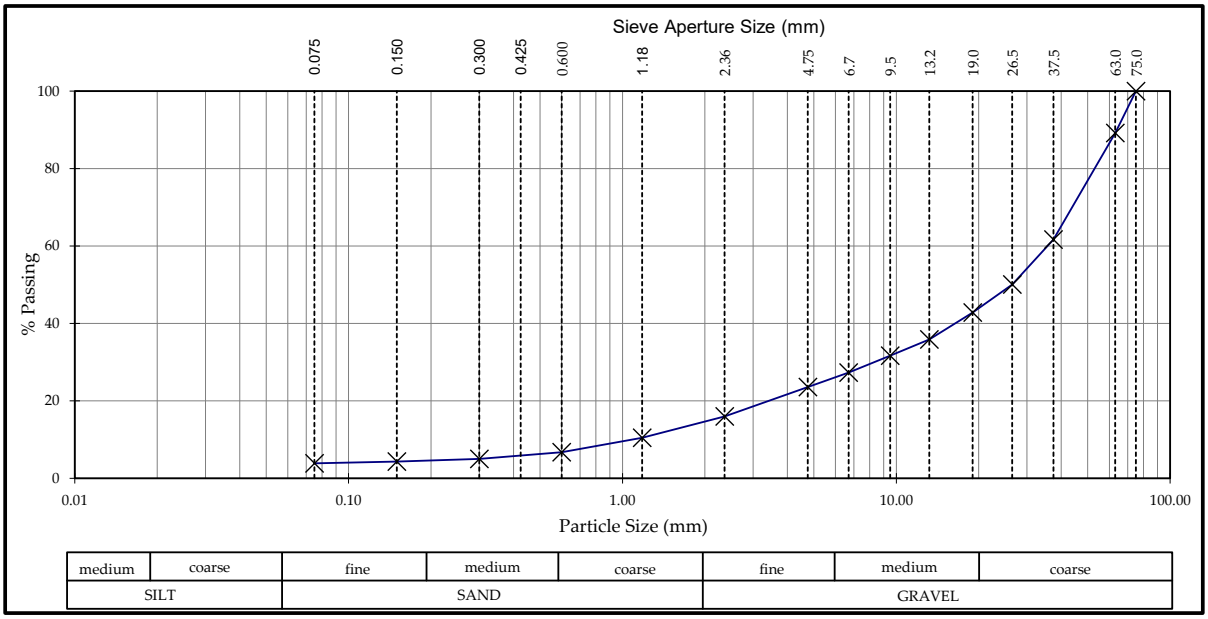
WET SIEVE ANALYSIS
TEST REPORT

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not stated
Sampling method :	Test Pit
Sample description :	GRAVEL with minor sand
Sample condition	Moist
Test Pit no :	TP04
Depth (m) :	2.1 - 2.3

Project No :	5-22000.74
Lab Ref No :	OR4998/03
Client Ref No :	250338

Sieve Analysis							
Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	100	19.00	43	4.75	24	0.425	-
63.00	89	13.20	36	2.36	16	0.300	5
37.50	62	9.50	32	1.18	10	0.150	4
26.50	50	6.70	27	0.600	7	0.075	4



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1 (Wet sieve)	History: As received Fraction tested: Passing 80mm (supplied by client) Dispersant Used: n/a All information supplied by Client *Fraction passing finest sieve is by difference.*

Date tested : 21 - 24/10/2025
Date reported : 31/10/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 31/10/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-099 (11/07/2020)

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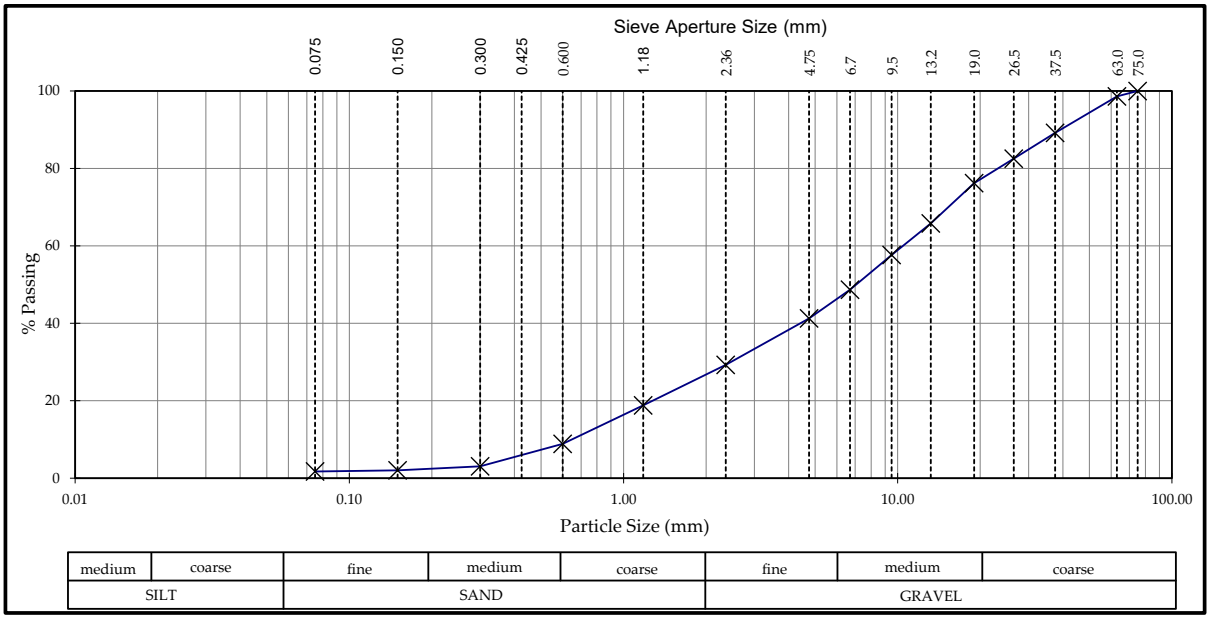
WET SIEVE ANALYSIS
TEST REPORT

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not stated
Sampling method :	Test Pit
Sample description :	Sandy GRAVEL
Sample condition	Moist
Test Pit no :	TP08
Depth (m) :	1.5 - 1.7

Project No :	5-22000.74
Lab Ref No :	OR4998/04
Client Ref No :	250338

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	100	19.00	76	4.75	41	0.425	-
63.00	99	13.20	66	2.36	29	0.300	3
37.50	89	9.50	58	1.18	19	0.150	2
26.50	83	6.70	49	0.600	9	0.075	2



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1 (Wet sieve)	History: As received Fraction tested: Passing 80mm (supplied by client) Dispersant Used: n/a All information supplied by Client *Fraction passing finest sieve is by difference.*

Date tested : 22 - 24/10/2025
Date reported : 31/10/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 31/10/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-099 (11/07/2020)

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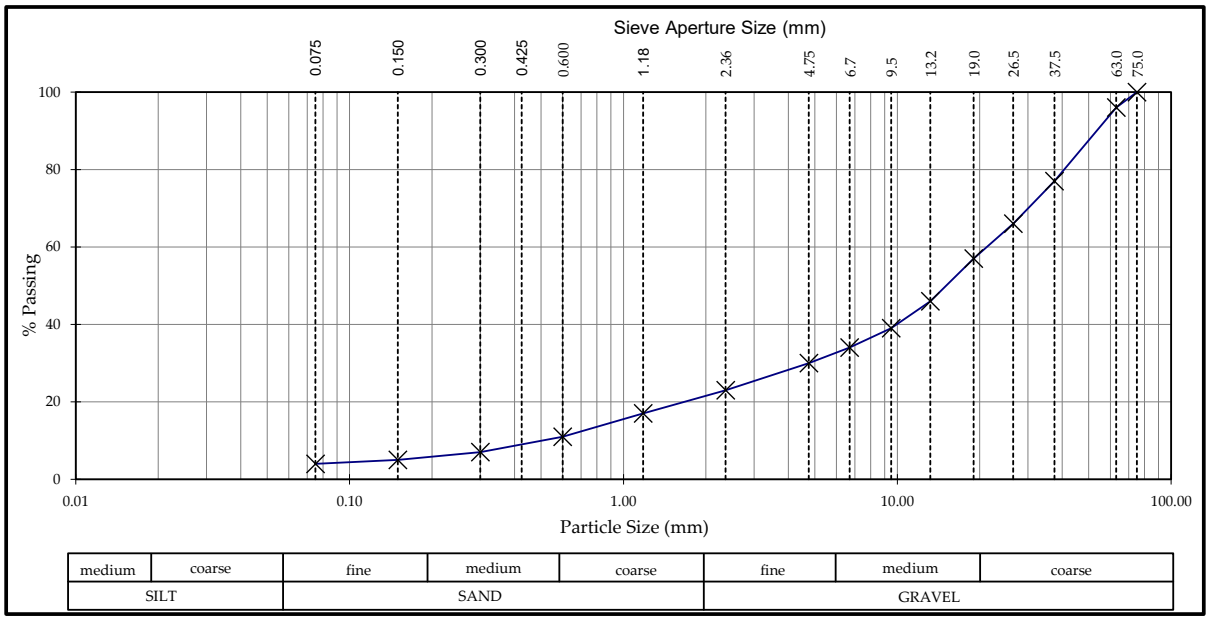
WET SIEVE ANALYSIS
TEST REPORT

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not stated
Sampling method :	Test Pit
Sample description :	Sandy GRAVEL
Sample condition	Moist
Test Pit no :	TP09
Depth (m) :	0.5 - 0.9

Project No :	5-22000.74
Lab Ref No :	OR4998/5
Client Ref No :	250338

Sieve Analysis							
Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	100	19.00	57	4.75	30	0.425	-
63.00	96	13.20	46	2.36	23	0.300	7
37.50	77	9.50	39	1.18	17	0.150	5
26.50	66	6.70	34	0.600	11	0.075	4



Test Method	Notes
NZS 4402 : 1986 Test 2.8.1 (Wet sieve)	History: As received Fraction tested: Passing 80mm (supplied by client) Dispersant Used: n/a All information supplied by Client *Fraction passing finest sieve is by difference.*

Date tested : 22/10 - 31/10/2025
Date reported : 05/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 05/11/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-099 (11/07/2020)

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Website www.wsp.com/nz

DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

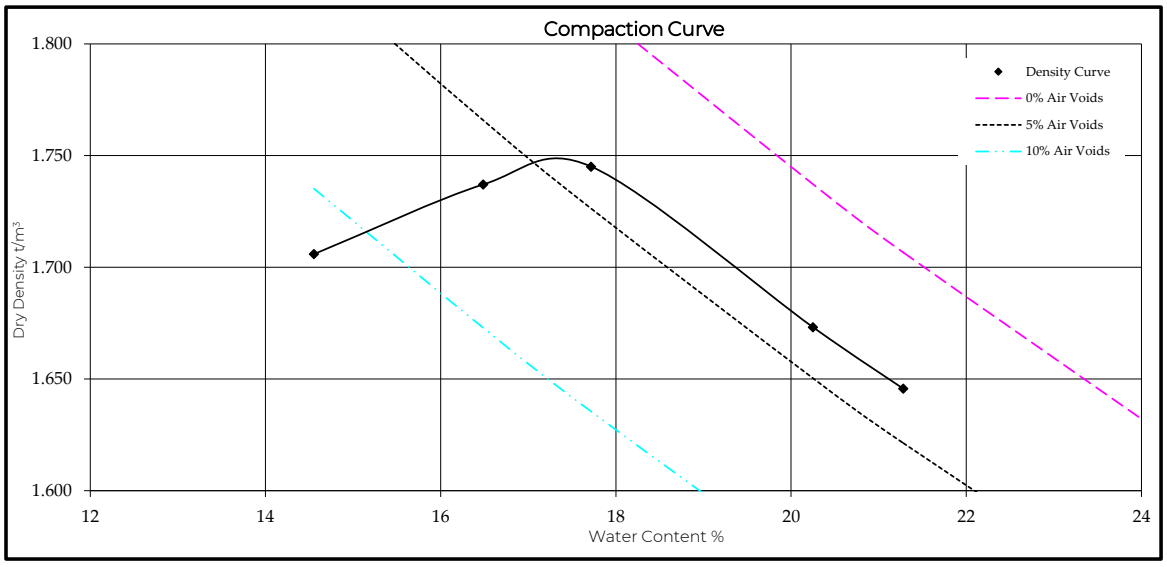
PRELIMINARY

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not Stated
Sampling method :	Test Pit
Sample description :	Sandy GRAVEL
Sample condition :	Moist
Solid density :	2.68 t/m³ (Tested)
Source :	TP09 0.5 - 0.9m

Project No :	5-22000.74
Lab Ref No :	OR4998/05
Client Ref No :	250338

Test Results

Maximum dry density	1.75 t/m³			Natural water content	11.5 %		
Optimum water content	17 %			Fraction tested	< 19mm		
Sample ID							
Bulk density t/m³	1.954	2.023	2.054	2.012	1.996		
Water content %	14.6	16.5	17.7	20.3	21.3		
Dry density t/m³	1.706	1.737	1.745	1.673	1.646		
Sample condition							



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	57% Passing 19.0mm All information supplied by client.

Date tested : 30/10 - 04/11/2025
Date reported : 06/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 06/11/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-026 (19/01/2020)

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PARTICLE SIZE ANALYSIS TEST REPORT

Project*	**Waingawa Water Storage - Lab testing**
Location*	**145 Norfolk Road, Waingawa**
Client*	**Riley Consultants Ltd**
Contractor*	**n/a**
Engineer :	**TLS**
Date sampled*	**Not Stated**
Sampling method*	**Test Pit**
Sample source*	**TP11 0.3m-0.6m**
Sample description:	**Sandy Clayey SILT with trace gravel**
Sample condition:	**Moist, as rec'd sealed in bag**
Solid density (fines)	**2.68** t/m^3 Assumed
Water content (as rec'd)	**25.0** % whole

Project No:	**5-22000.74**
Sample No:	**OR4998/07**
Client Ref:	**250338**

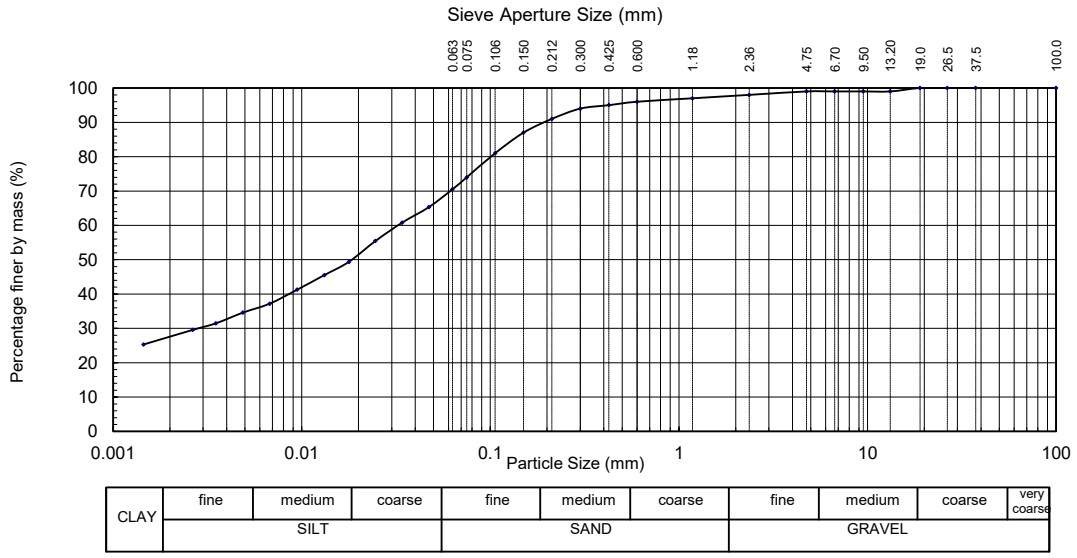
Sieve Analysis

Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)
100.0	**100**	6.70	**99**	0.300	**94**
37.5	**100**	4.75	**99**	0.212	**91**
26.5	**100**	2.36	**98**	0.150	**87**
19.0	**100**	1.18	**97**	0.106	**81**
13.20	**99**	0.600	**96**	0.075	**74**
9.50	**99**	0.425	**-**	0.063	**71**

Percent passing finest sieve obtained by difference

Hydrometer Analysis

Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
0.047	**65**	0.0068	**37**
0.034	**61**	0.0049	**35**
0.025	**55**	0.0035	**31**
0.018	**49**	0.0026	**30**
0.013	**46**	0.0014	**25**
0.009	**41**		



Test Methods (where used)	**Notes**
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve) Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	History: Natural * Project / sample details supplied.

Date Tested: 23/10-4/11/2025
Date Reported: 6/11/2025

Results only applied to sample tested
Sampling is not covered by IANZ Accreditation
This report may only be reproduced in full

Approved Signatory
Designation: *Senior Laboratory Technician - R. Steele*
Date: 6/11/2025

ACCREDITED IANZ TESTING LABORATORY
All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

PF-LAB-100 (20/03/2018) Page 1 of 1

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WSP Research & Innovation Centre
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Facsimile +64 4 587 0604
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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

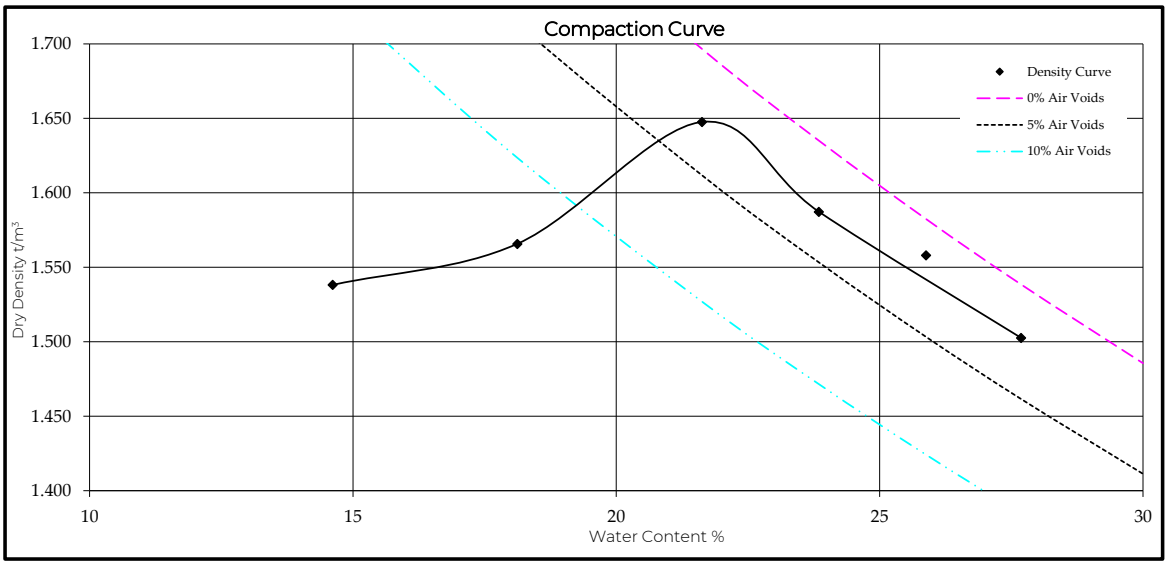
Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not Stated
Sampling method :	Test Pit
Sample description :	Silt
Sample condition :	Moist
Solid density :	2.68 t/m³ (Assumed)
Source :	TP11 0.3m-0.6m

Project No :	5-22000.74
Lab Ref No :	OR4998/07
Client Ref No :	250338

Test Results

Maximum dry density	1.65	t/m³	Natural water content	24.0	%	
Optimum water content	22	%	Fraction tested	Whole		

Sample ID					Nat			
Bulk density	t/m³	1.763	1.849	2.004	1.966	1.961	1.919	
Water content	%	14.6	18.1	21.6	23.8	25.9	27.7	
Dry density	t/m³	1.538	1.566	1.648	1.587	1.558	1.503	
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	All information supplied by client.

Date tested : 21 - 29/10/2025
Date reported : 31/10/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 31/10/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-026 (19/01/2020)

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

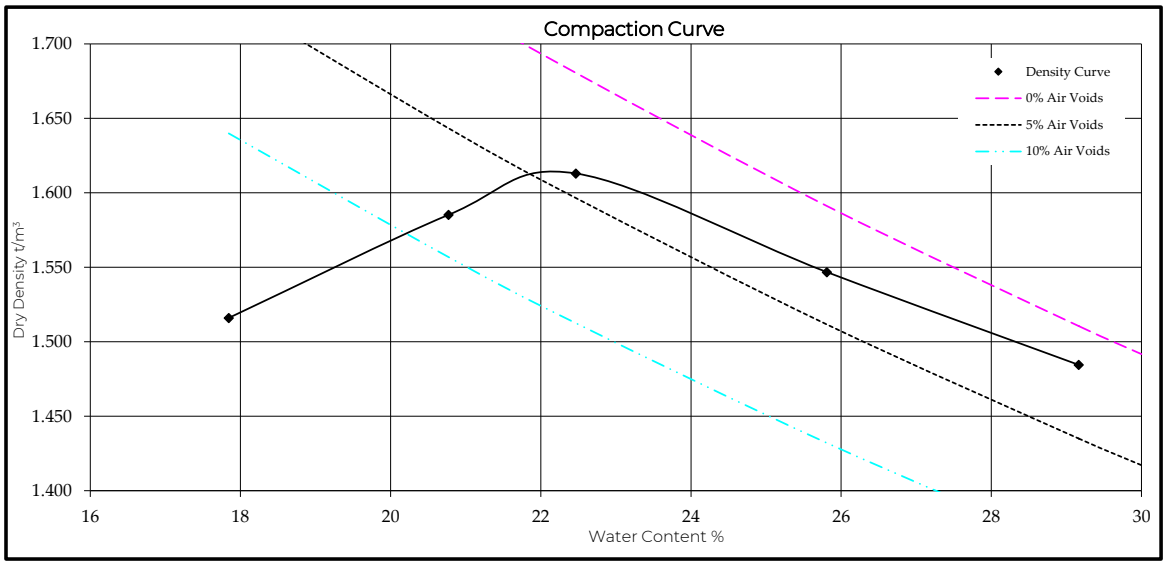
Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not Stated
Sampling method :	Test Pit
Sample description :	AP65 Silt/Clay with minor gravel
Sample condition :	Moist
Solid density :	2.70 t/m³ (Assumed)
Source :	TP15 0.6m-0.8m

Project No :	5-22000.74
Lab Ref No :	OR4998/08
Client Ref No :	250338

Test Results

Maximum dry density	1.61	t/m³	Natural water content	25.8	%		
Optimum water content	22	%	Fraction tested	-19.0mm			

Sample ID					Nat			
Bulk density	t/m³	1.787	1.915	1.975	1.946	1.917		
Water content	%	17.8	20.8	22.5	25.8	29.2		
Dry density	t/m³	1.516	1.585	1.613	1.547	1.484		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	97% passing 19.0mm All information supplied by client.

Date tested : 28 - 31/10/2025
Date reported : 04/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 04/11/2025

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Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-026 (19/01/2020)

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PLASTICITY INDEX FOR AGGREGATES TEST REPORT

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	N/A
Engineer:	TLS
Date sampled :	Not Stated
Sampling method :	Test Pit
Sample description :	AP65 Silt/Clay with minor gravel
Sample condition :	As Received
Source :	TP15 (0.6-0.8m)

Project No :	5-22000.74
Lab Ref No :	OR4998/08
Client Ref No :	250338

Test Results

Client Ref No :	250338
Cone penetration limit :	39
Plastic limit :	26
Plasticity index :	13
Sample fraction :	Fraction passing 425µm test sieve
As received water content :	25.1 %
Linear Shrinkage:	8

Test Methods			
Water Content	NZS 4407 : 2015 : Test 3.1		History: Natural
Cone Penetration	NZS 4407 : 2015 : Test 3.2		
Plastic Limit	NZS 4407 : 2015 : Test 3.3		
Plasticity Index	NZS 4407 : 2015 : Test 3.4		
Linear Shrinkage	NZS 4402 : 1986, Test 2.6	(not accreditated)	

Date tested : 5-10/11/2025
Date reported : 12/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

IANZ Approved Signatory

Designation : *Geomechanical Technician (DW Pollard)*
Date : 12/11/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-053 (09/06/2021)

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CRUMB TEST FOR DISPERSIBILITY OF SOILS TEST REPORT

Project :	Waingawa Water Storage - Lab Testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	-
Sampled by :	Client
Date sampled :	Not stated
Date received :	29/10/25
Sampling method :	Test Pit
Sample condition :	Dry to OWC

Project No :	5-22000.74
Lab Ref No :	HA15851_crm
Client Ref No :	"OR4998/8"

Test Results

Sample Lab Ref No :	HA15851_crm
Location ID :	TP15
Depth (m) :	0.6-0.8
Description :	Silt/Clay
Grade :	1
Water Content as rec'd (%) :	24.9
Water Content as tested (%) :	23.2

Grade 1 : Nondispersive : No reaction - no turbid water created by colloids
Grade 2 : Intermediate : Slight reaction - faint , barely visible colloidal suspension
Grade 3 : Dispersive : Moderate reaction - easily visible cloud of suspended clay colloids around crumb surface
Grade 4 : Highly Dispersive : Strong reaction - dense profuse cloud of suspended clay colloids around bottom of dish

Test Methods		Notes
Crumb Test :	ASTM D6572 - 13	1) Whole soil tested.
Water Content :	NZS 4402 : 1986 Test 2.1	2) Samples were tested at natural water content.
		3) Samples tested were natural crumbs.

Date tested : 17/11/25
Date reported : 18/11/25

This report may only be reproduced in full
All information supplied by Client

Approved

Designation : *Senior Civil Engineering Technician*
Date : 18/11/25

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PINHOLE DISPERSION TEST REPORT

Project :	Waingawa Water Storage - Lab testing		
Location :	145 Norfolk Road, Waingawa		
Client :	Riley Consultants Ltd		
Sample Location ID :	TP15	Depth :	0.6-0.8m
Sampled by :	Client		
Date sampled :	Not Stated		
Date received :	29/10/25		
Sample description :	Silt/Clay		
Sample condition :	Dry to OWC		
Sample compaction :	NZ Std Compaction		

Project No :	5-22000.74
Lab Ref No :	HA15851_PnH
Client Ref No :	"OR4998/8"

Test Results

Test Sample Condition at Test

Diameter of test specimen (mm)	33.08
Length of test specimen (mm)	37.34
Mass of compacted specimen (g)	60.91

	As Rec'd	Target	As Tested	Post Test
Wet Density (t/m^3)	-	-	1.90	-
Water Content (%)	24.9	22.0	23.2	26.2
Dry Density (t/m^3)	-	1.60	1.54	-

Pinhole Test Observations

Head (mm)	Flow rate (ml/s)	Colour of outflow (Cloudiness)	Falling Particles
50	0.50	Completely Clear/Clear From Top	None
180	0.69	Completely Clear/Clear From Top	None
380	0.97	Completely Clear/Clear From Top	None
1020	1.67	Completely Clear/Clear From Top	None

Pinhole dimensions

Hole Diameter at start of test (mm)	1.0
Hole Diameter at end of test (mm)	1.0

Note : The pinhole when observed at the end of the test showed NO CHANGE in diameter.

PINHOLE TEST RESULT

ND1

Test Method	Notes
ASTM D4647/D4647M-13 Method A: The Pinhole Test NZS 4402:1986, Test 2.1 Determination of the water content	Soil tested : Material Passing 2.36mm sieve Fluid used : distilled water Sample cured for : 24 hours

Date tested : 12/11/25
Date reported : 18/11/25

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All information supplied by Client

Approved

Designation : *Senior Civil Engineering Technician*
Date : 18/11/25

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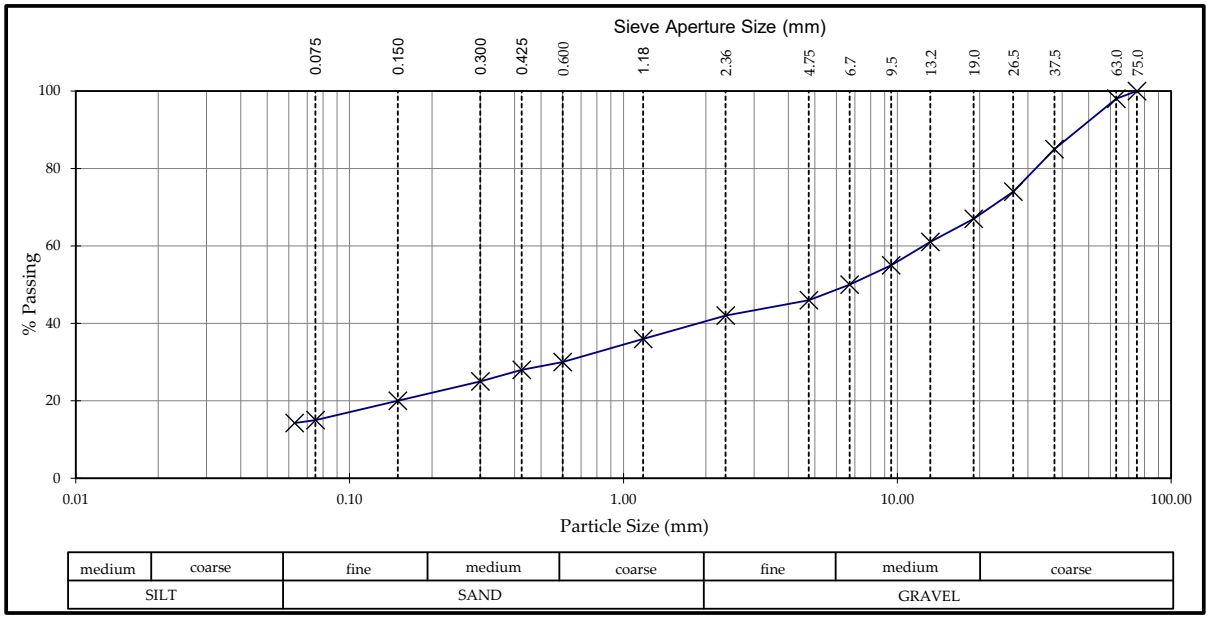
WET SIEVE ANALYSIS
TEST REPORT

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not stated
Sampling method :	Test Pit
Sample description :	sandy GRAVEL with some silt
Sample condition	Moist
Test Pit no :	TP18
Depth (m) :	0.3-0.7

Project No :	5-22000.74
Lab Ref No :	OR4998/10
Client Ref No :	250338

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	100	19.00	67	4.75	46	0.425	28
63.00	98	13.20	61	2.36	42	0.300	25
37.50	85	9.50	55	1.18	36	0.150	20
26.50	74	6.70	50	0.600	30	0.075	15



Test Method	Notes
NZS 4402 : 1986 Test 2.8.1 (wet sieve)	History: As received, whole WC = 15.5% Fraction tested: Passing 80mm (supplied by client) Dispersant Used: n/a All information supplied by Client *Fraction passing finest sieve is by difference.*

Date tested : 29/10 - 3/11/2025
Date reported : 06/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 06/11/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-099 (11/07/2020)

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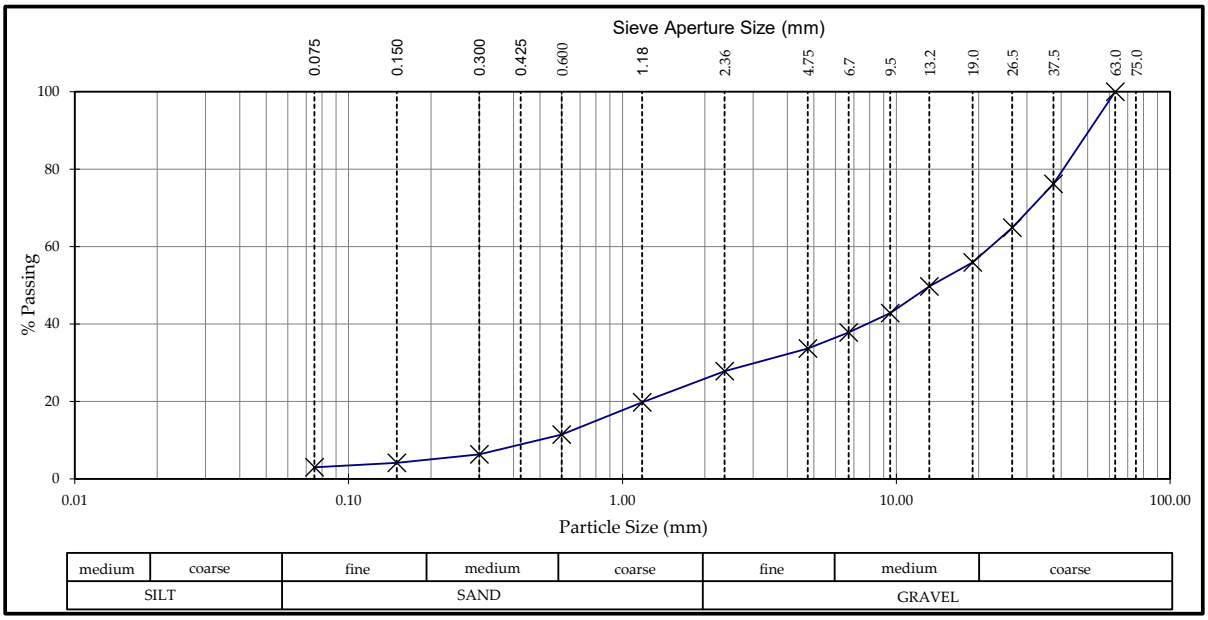
WET SIEVE ANALYSIS
TEST REPORT

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not stated
Sampling method :	Test Pit
Sample description :	Sandy GRAVEL
Sample condition	Moist
Bore hole no :	TP20
Depth (m) :	1.1 - 1.5

Project No :	5-22000.74
Lab Ref No :	OR4998/11
Client Ref No :	250338

Sieve Analysis							
Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	56	4.75	34	0.425	-
63.00	100	13.20	50	2.36	28	0.300	6
37.50	76	9.50	43	1.18	20	0.150	4
26.50	65	6.70	38	0.600	11	0.075	3



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1 (Wet Sieve)	History: As received Fraction tested: Passing 80mm (supplied by client) Dispersant Used: n/a All information supplied by Client *Fraction passing finest sieve is by difference.*

Date tested : 23 - 29/10/2025
Date reported : 06/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 06/11/2025

ACCREDITED IANZ TESTING LABORATORY

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PF-LAB-099 (11/07/2020)

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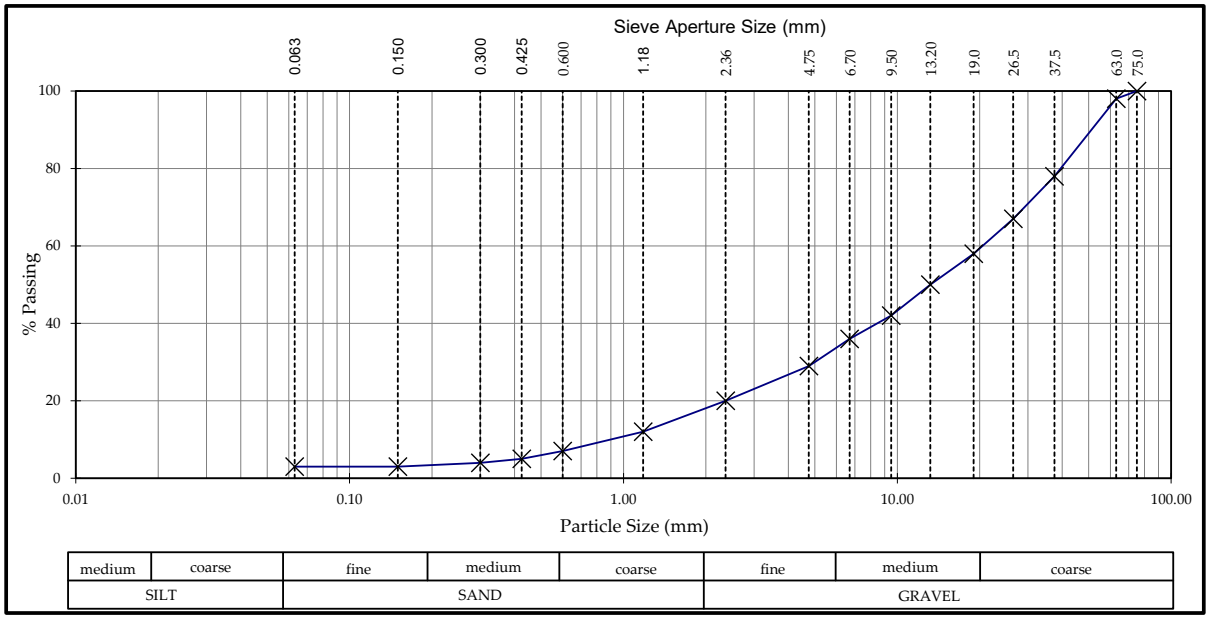
WET SIEVE ANALYSIS
TEST REPORT

Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Sampled by :	TLS
Date sampled :	Not stated
Sampling method :	Test Pit
Sample description :	GRAVEL with some sand and trace silt
Sample condition	Moist
Bore hole no :	TP22
Depth (m) :	3.6-3.8

Project No :	5-22000.74
Lab Ref No :	OR4998/12
Client Ref No :	250338

Sieve Analysis							
Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.0	100	19.0	58	4.75	29	0.425	5
63.0	98	13.20	50	2.36	20	0.300	4
37.5	78	9.50	42	1.18	12	0.150	3
26.5	67	6.70	36	0.600	7	0.063	3



Test Method	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve)	History: Air Dried Fraction tested: Passing 70mm (supplied by client) Dispersant Used: Sodium Hexametaphosphate & Sodium Bicarbonate All information supplied by Client *Fraction passing finest sieve is by difference.*

Date tested : 07-12/11/2025
Date reported : 12/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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Approved Signatory

Designation : *Senior Laboratory Technician (R. Steele)*
Date : 12/11/2025

ACCREDITED IANZ TESTING LABORATORY

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PF-LAB-099 (11/07/2020)

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

PRELIMINARY

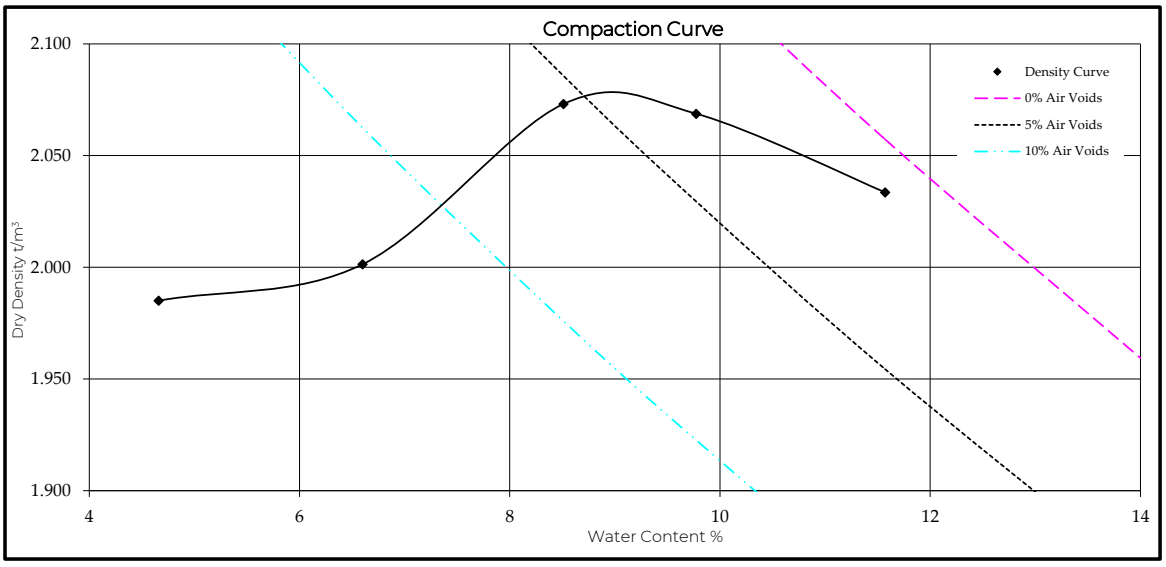
Project :	Waingawa Water Storage - Lab testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd
Contractor :	n/a
Engineer :	TLS
Date sampled :	Not Stated
Sampling method :	Test Pit
Sample description :	Gravel
Sample condition :	Moist
Solid density :	2.70 t/m³ (Assumed)
Source :	TP25 2.8m-3.0m

Project No :	5-22000.74
Lab Ref No :	OR4998/13
Client Ref No :	250338

Test Results

Maximum dry density	2.07	t/m³	Natural water content	5.3	%	
Optimum water content	9	%	Fraction tested	-19.0mm		

Sample ID								
Bulk density	t/m³	2.078	2.133	2.250	2.271	2.269		
Water content	%	4.7	6.6	8.5	9.8	11.6		
Dry density	t/m³	1.985	2.001	2.073	2.069	2.034		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	59% passing 19.0mm All information supplied by client.

Date tested : 23 - 29/10/2025
Date reported : 06/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

Approved Signatory

Designation : *Team Leader - Testing Services (Z. Francis)*
Date : 06/11/2025

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

PF-LAB-026 (19/01/2020)

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SOLID DENSITY TEST REPORT

Project :	Waingawa Water Storage - Lab Testing
Location :	145 Norfolk Road, Waingawa
Client :	Riley Consultants Ltd.
Contractor :	N/A
Engineer :	TLS
Sampled by :	Not stated
Date sampled :	Not stated
Sampling method :	Test Pit
Sample description :	See table
Sample condition :	See table

Project No :	5-22000.74
WSP Sample No :	See table
Client Ref No :	250338

Test Results

WSP Sample No:	OR4998.05	OR4998.13
Sample Source:	TP09 (0.50-0.90m)	TP25 (2.80-3.00m)
Sample Type:	Sandy GRAVEL	GRAVEL
Fraction tested (mm):	<19mm	<19mm
Solid Density (t/m^3):	2.63	2.70
Method of testing:	Pycnometer	Pycnometer

Test Method

NZS 4407 : 2015, Test 3.7.1

Date tested : 3-6/11/2025
Date reported : 6/11/2025

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

Approved Signatory

Designation : *Senior Laboratory Technician (R. Steele)*
Date : 6/11/2025

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Appendix F

Geotechnical Investigation Sketch Site Plan


FOR INFORMATION/NOT FOR CONSTRUCTION
N
Legend
Site Boundary
Investigations
Test Pits
Machine Holes
Contours (1m Interval)
Cobble Stockpiles
Pooled Water
Water Channel
MH01
TP01
TP08
TP05
TP02
TP12
TP15
TP09
TP06
TP03
TP13
MH04
TP22
TP19
MH03
TP10
TP07
TP04
MH02
TP16
TP20
TP23
TP17
TP14
TP11
TP24
TP21
TP18
MH05
TP25
400 m
300
200
100
0
Note:
Aerial, property boundaries and DEM from LINZ data service.
Investigation completed by Riley in October 2025.
Cobble stockpile location and size are estimated based on site observations during the 2025 site investigation.
Water channel and pooled water locations are estimated based on site observations during the 2025 site investigations.
made with QGIS
RILEY
Carterton District Council
247 Norfolk Road, Carterton - Waingaawa Water Storage Project
Sketch: 250338-SK1 (Rev A)
Drawn By RS | Checked By EM


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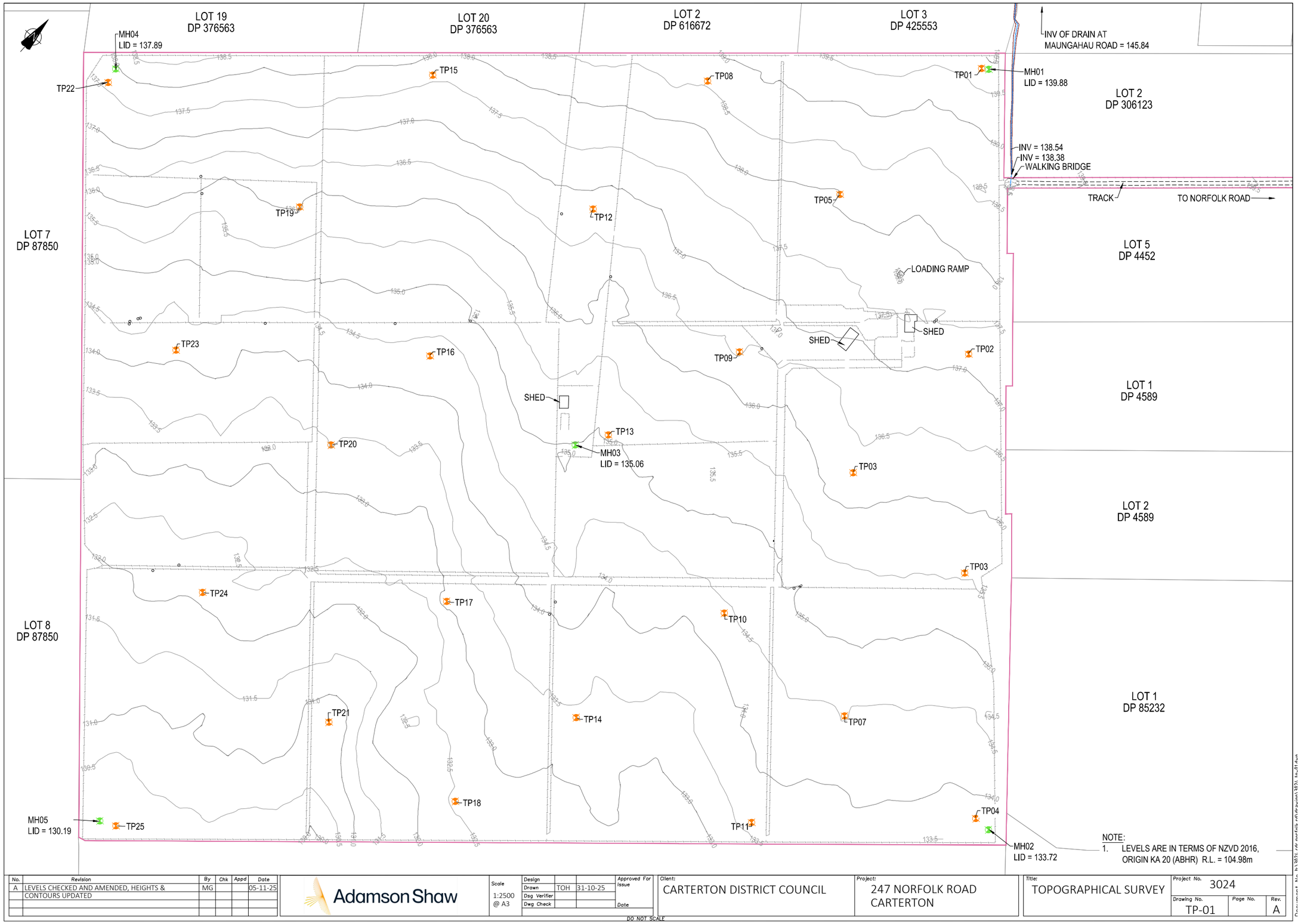
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DP 376563
LOT 20
DP 376563
LOT 2
DP 616672
LOT 3
DP 425553
LOT 2
DP 306123
LOT 5
DP 4452
LOT 1
DP 4589
LOT 1
DP 85232
LOT 2
DP 4589
LOT 7
DP 87850
LOT 8
DP 87850
MH04
LID = 137.89
MH01
LID = 139.88
MH03
LID = 135.06
MH05
LID = 130.19
MH02
LID = 133.72
INV OF DRAIN AT
MAUNGAHAU ROAD = 145.84
INV = 138.54
INV = 138.38
WALKING BRIDGE
TRACK
TO NORFOLK ROAD
LOADING RAMP
SHED
SHED
SHED
TP01
TP02
TP03
TP04
TP05
TP07
TP08
TP09
TP10
TP11
TP12
TP13
TP14
TP15
TP16
TP17
TP18
TP19
TP20
TP21
TP22
TP23
TP24
TP25
NOTE:
1. LEVELS ARE IN TERMS OF NZVD 2016, ORIGIN KA 20 (ABHR) R.L. = 104.98m
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Project: 247 NORFOLK ROAD CARTERTON
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Project No. 3024
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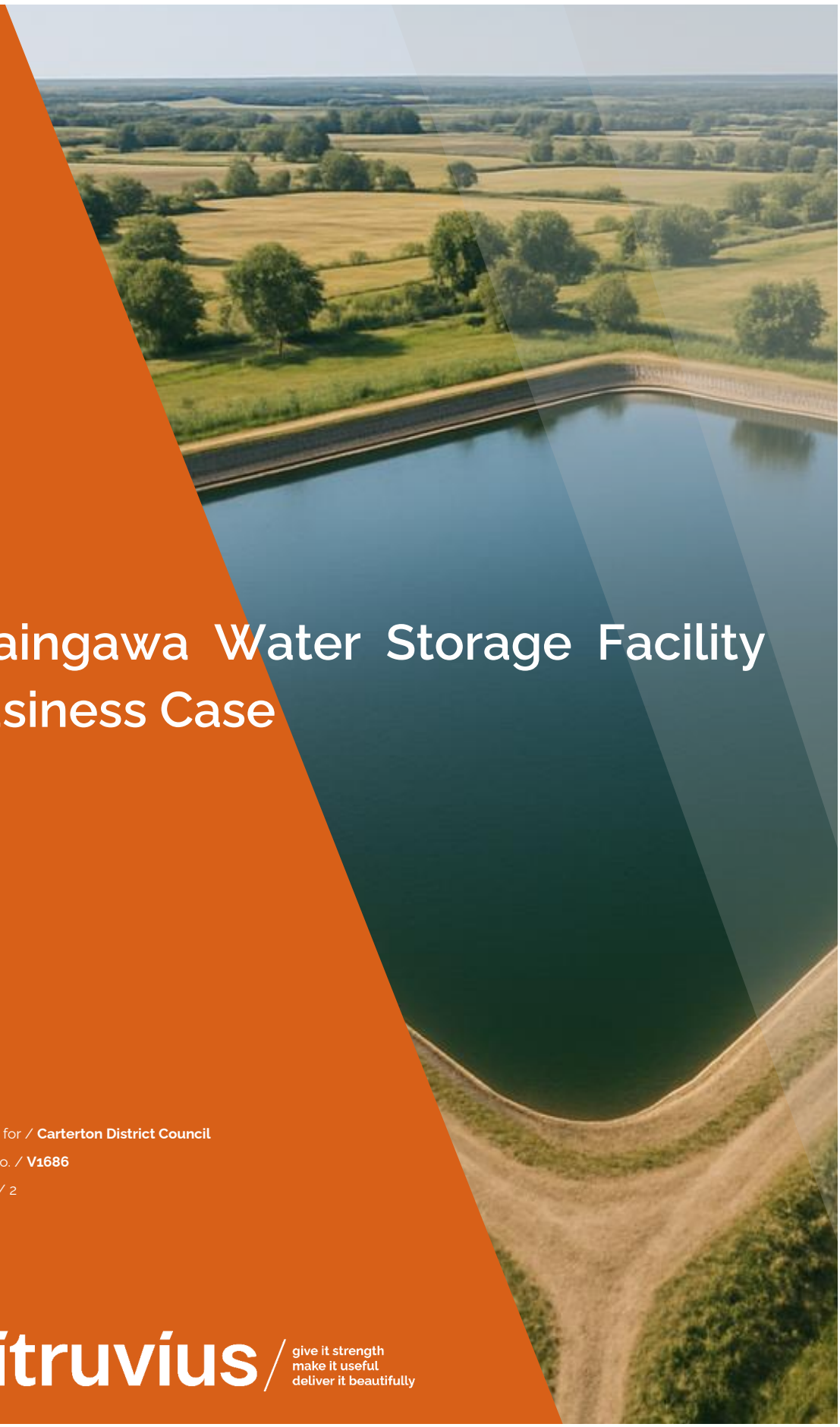
Page No.
Rev. A

Waingawa Water Storage Project Estimate			2/12/2025	
1	**Land purchase**			
	247 Norfolk Road		$	3,250,000.00
2	**Site Investigation**			
	Geotechnical Investigation			
2.1		Riley Engineering	$	65,500.00
2.2		Griffiths Drilling	$	71,955.00
2.3		Scotts Agcontracting - 20t digger	$	10,000.00
		Deer Farm Manager	$	3,000.00
2.4	Adams and Shaw - Topographical Survey		$	6,000.00
3	**Planning**			
3.1	Boffa Miskel - Earthworks additional water take Resou		$	38,810.00
3.2	Building Consent		$	50,000.00
4	**Profesional Services**			
4.1	Project mangement		$	50,000.00
4.2	Concept design - MMS - Concep+SOQ+BOP		$	25,000.00
4.3	Detailed Dam Design for Construction		$	150,000.00
4.4	Construction MSQA		$	250,000.00
4.5	Special Purpose Vehicle (SPV) Development		$	250,000.00
4	**Construction**			
4.1	Dam Construction - Engineers Estimate		$	8,541,840.50
4.2	Future Reticulation and Pumping provision		$	2,500,000.00
		Sub-total	**$**	**15,262,105.50**
		Contingency @ 20%	$	3,052,421.10
		Total	**$**	**18,314,526.60**

15 May 2025



Waingawa Water Storage Facility Business Case

Prepared for / **Carterton District Council**

Project No. / **V1686**

Revision / 2

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Sign Off

		Signature
Prepared By:	Vaughan Roberts Senior Advisor 15-May-2025	
Verified By:	Alana Bowmar Service Lead Civil and Water Engineering 15-May-2025	
Approved By:	Selwyn Blackmore Business Lead Wellington 15-May-2025	

Transmittal / Distribution

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9/05/25	Johannes Ferreira			Draft 1 of business case
15/05/2025	Johannes Ferreira			Final

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[1] Comment, Review, Draft, Approval, Final, As Requested, Copies for Distribution

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Executive Summary

This business case lite[2] (business case) has been prepared to support Carterton District Council's (CDC) funding application to the Regional Infrastructure Fund (RIF) for the Waingawa Water Storage Project (the project). While this is a 'lite' business case, its primary focus - at the request of CDC - is on analysing the economic and financial viability of the proposed options.

In early 2025, CDC began investigating the potential for a water storage scheme at 145 Norfolk Road, Waingawa. The site was seen as an opportunity to improve local water reliability - particularly for the partially developed Waingawa Industrial Park and for nearby irrigators.

The scheme's basic concept is to capture and store excess flows permitted under CDC's Taratahi Water Race resource consent during the winter, autumn, and spring months, and to use this stored water during the high-demand summer period.

The initial feasibility investigation was completed in late February 2025[3]. Among other findings, it recommended further analysis of the economic viability of a potential water storage scheme. In March 2025, with appropriate property access arrangements in place, CDC decided to proceed with this business case to assess the viability of such a scheme.

Following consideration of several storage options during the feasibility phase, CDC initially identified a preferred reservoir size of 270,000 m^3 to supply process water to the Waingawa Industrial Park and to local irrigators. However, for the purposes of this business case and based on a $25 million capital budget - CDC selected the following storage options for further investigation (for the same water supply purposes):

- Option A: 500,000 m^3
- Option B: 1,000,000 m^3

In addition, an "Option B Staged" approach was identified for investigation. This approach would begin with Option A (500,000 m^3) and then add the additional 500,000 m^3 (Option B) over time, if there is demand for more process water locally.

A comprehensive cost-benefit analysis (CBA) was completed for the options. It incorporated full capital, operational, and maintenance costs, and assessed benefits such as water sales to existing and future users in the Waingawa Industrial Park as well as to local irrigators. The analysis also accounted for the economic value of high-quality gravel expected to be extracted during reservoir construction in Year 1.

The CBA was developed using a set of key assumptions and scenarios, including:

- **For the Waingawa Industrial Park:** By offering process water at a competitive price of $1.25/$m^3$, the project is expected to help attract water-intensive industries to the currently undeveloped areas of the Waingawa Industrial Park over a 20-year period. This price is considered conservative, as it is significantly lower than CDC's listed rate of $2.25/$m^3$ and the Tararua District Council's rate of $1.57/$m^3$ for industrial users.
- **Irrigation scenarios:** Three scenarios were evaluated, with the *Dryland Dairy to Irrigated Dairy* scenario identified as the most applicable for the Taratahi Water Race Command Area. This scenario involved converting a portion of the catchment's 3,420 hectares of dryland dairy, specifically modelling a 150-hectare platform (e.g. 115 hectares irrigated and 35 hectares remaining as dryland). Under this scenario, operating profit was expected to increase by $1,980/ha (before water charges), rising from a baseline of $1,861/ha to $3,546/ha. With an

[2] It was agreed with CDC that this business case would be 'lite' due to funding constraints, and would be based on the NZ Transport Agency's Single Stage Business Case Lite format
[3] 145 Norfolk Road, Waingawa: Water Storage Options Report (Vitruvius, February 2025)

average additional capital investment of $6,480/ha (or $7,700/ha for the irrigated portion), this equated to a 26% return on investment before water costs. When accounting for an estimated annual irrigation water requirement of 3,910 m^3/ha and a water charge of $0.30/$m^3$, the additional operating profit decreased to $785/ha, resulting in a 12.1% return on the additional capital.

- **Gravel extraction:** The gravel extraction cost assessment incorporated per-cubic-metre estimates for extraction, on-site transport processing, and on-site storage, Revenue was projected using a conservative sale price of $43 per cubic metre, and profit was calculated by subtracting total costs from total revenue for each option. The analysis assumed a 70% gravel yield, consistent unit costs, and sufficient market demand to sell gravel as it is extracted, avoiding off-site storage. Profit from gravel sales is estimated to be $1,790,000 from Option A and $3,591,000 from Option B.

Sensitivity testing was undertaken for the CBA to evaluate the robustness of the economic evaluation findings for the Do-Nothing option as well as the three storage options. Net Present Values (NPVs) and Benefit-Cost Ratios (BCRs) were calculated (using a 4% discount rate as well as alternate discount rates, higher/lower capital costs, and reduced benefits). While the evaluation findings also identified potential benefits from land value uplift from irrigation, environmental improvements, and recreational benefits, these were not monetised due to uncertainty around their feasibility and uptake at this point in time.

The BCRs ranged from 1.4 to 2.1, with Option A (500,000m^3) delivering the highest ratio at 2.1. Even under the various sensitivity scenarios, all BCRs remained above 1, indicating economic viability. Payback periods for all options ranged from 18 to 24 years. Based on these findings, Option A was recommended as the preferred starting point, with the ability to expand the reservoir over time to 1,000,000 m^3 (Option B Staged). The final reservoir would use a high-density polyethylene (HDPE) liner, which is standard for this type of infrastructure.

Despite evidence of the project's long-term economic viability, this business case analysis highlights substantial upfront costs, which pose significant affordability challenges for both the project and CDC. Securing co-investment from the RIF will therefore be crucial to support further design and investigation work. RIF funding would ease the short-term financial burden associated with these early-stage activities, making it feasible to initiate the project. While long-term revenue streams from water sales and other sources are expected to ensure the project's financial sustainability, RIF support is essential to bridging the short-term affordability gap.

If funding is secured, the next step is the pre-implementation phase, scheduled to begin in June 2025, with consenting in July and construction starting in August. Key risks include potential delays in consenting (assumed to be non-notified), contractor availability, and the supply of the HDPE liner. Initial market engagement suggests contractor and liner availability risks are low, though it is recommended a consenting strategy be developed promptly to mitigate consenting uncertainty.

1 Introduction

This business case lite[4] (business case) has been prepared to support Carterton District Council's (CDC) funding application to the Regional Infrastructure Fund (RIF) for the Waingawa Water Storage Project (the project).

CDC is responsible for developing and maintaining a range of local assets and services for the Carterton District under the Local Government Act 2002. The district has a population of 10,107[5], and Stats NZ – Tatauranga Aotearoa predicts this will grow to 11,650 by 2048. As of 2023, 63% of the district's population was aged 15 years or older.

The purpose of this business case lite is to outline the strategic context of the project, assess the options considered, and evaluate the economic and financial performance of the preferred option, along with an overview of the commercial and management considerations. While this is a 'lite' business case, its primary focus - at the request of CDC - is on analysing the economic and financial viability of the proposed options.

1.1 BACKGROUND

The Wairarapa is experiencing increasing pressure on its freshwater resources due to the combined impacts of climate change, population growth, land use intensification, and ageing infrastructure. These pressures are particularly acute during the summer months (January to March), when water demand is highest, and water availability is lowest due to reduced rainfall and increased evapotranspiration.

Without intervention, projections indicate that by mid-century, the region will require at least 15% more water to maintain current activities, with this figure expected to rise to 30% by 2090[6]. At the same time, environmental regulations aimed at protecting low river flows and groundwater levels will place further constraints on water availability for abstraction.

The use of water storage is one strategic response to these challenges. This approach is aligned with the aims of the Wairarapa Water Resilience Strategy 2021 (the Strategy), which calls for an integrated, catchment-wide response to water scarcity, blending both supply and demand side initiatives to improve overall water resilience.

CDC began investigating water storage at 145 Norfolk Road, Waingawa (the Site) in early 2025, recognising its potential to improve the reliability of local water supply. Initial feasibility investigations were completed in late February 2025[7] and, among other findings, recommended further assessment of the economic viability of a possible storage scheme to provide water to the Waingawa Industrial Park and to local irrigators. In March 2025, CDC decided to proceed with this business case to test the scheme's economic viability.

1.1.1 Site Description

CDC have the appropriate property access arrangements in place to construct the project on the Site.

The Site is located at 145 Norfolk Road (LOTS 3–6 DP 340153) within the Carterton District. It lies immediately south of the Waingawa River and northwest of the Waingawa Industrial Park, covering an area of approximately 55 hectares. It is currently used for arable farming.

[4] It was agreed with CDC that this business case would be 'lite' due to funding constraints, and would be based on the NZ Transport Agency's Single Stage Business Case Lite format
[5] See: Aotearoa Data Explorer – Totals by topic for individuals, (RC, TALB, UR, SA3, SA2, Ward, Health), 2013, 2018, and 2023 Censuses
[6] Wairarapa Water Resilience Strategy (Wairarapa Water Resilience Strategy Group, 2021)
[7] 145 Norfolk Road, Waingawa: Water Storage Options Report (Vitruvius, February 2025)

The Wairarapa Combined District Plan identifies the zone for the Site as "General Rural Zone." This zoning classification permits a range of land uses, including agricultural activities, and is expected to allow for other compatible activities, such as water storage and small-scale quarrying, subject to resource consent requirements. The topography is generally flat, with elevations ranging from 125 to 131 metres above sea level. The site and its boundaries are illustrated in Figure 1:1 The below.

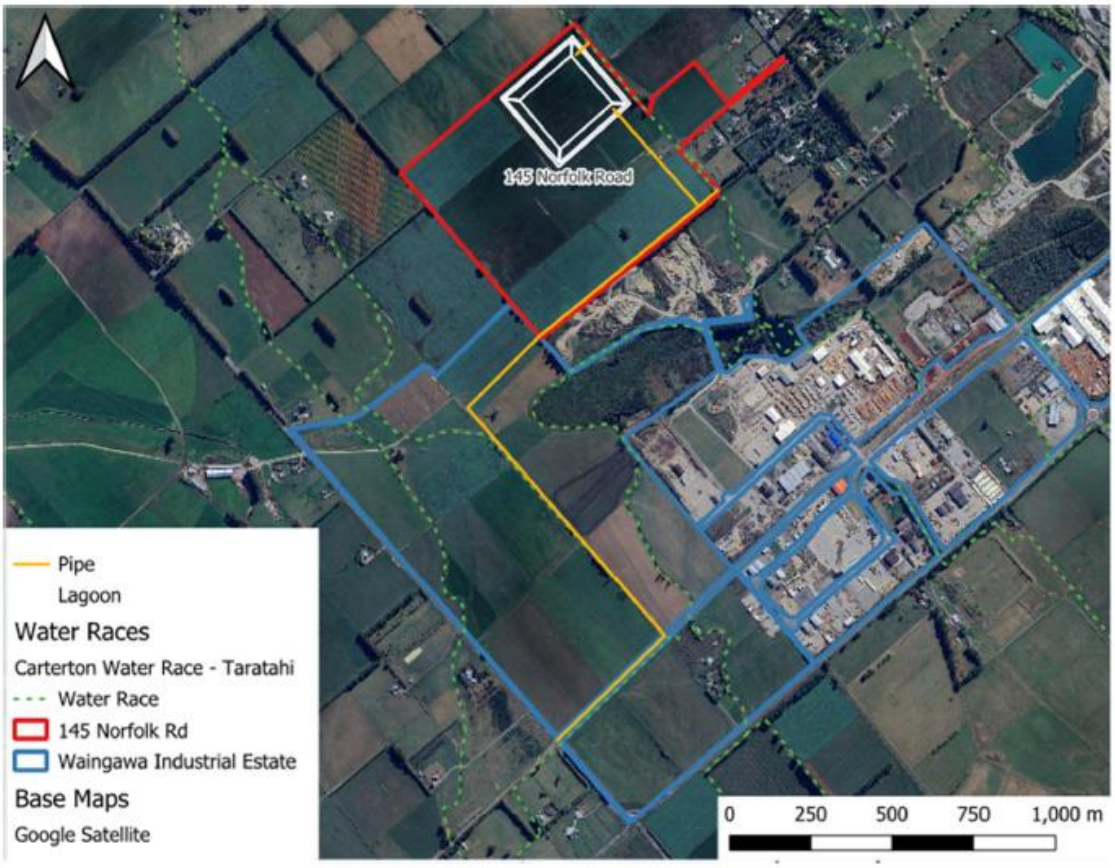

Figure 1:1 The proposed Site for the Waingawa Storage facility

1.2 SUMMARY OF THE WAINGAWA WATER STORAGE FEASIBILITY STUDY

The primary objective of the Study was to assess the potential economic viability of developing water storage at the Site. Five options were considered, with three shortlisted for more detailed evaluation. The Study outlined the high-level benefits, costs, and risks of each option, and provided recommendations for next steps. The full report is included as **Appendix A** and is further discussed in the Economic Case. Overall, the Study concluded that water storage at the Site could be viable and contribute meaningfully to regional water resilience and productivity.

A fundamental factor supporting the selection of the Site was its secured land access and its close proximity to the Taratahi Water Race (shown as the green dotted lines in Figure 1:1Figure 1:1 The), which provides a potential source of water for storage during high-flow periods, as well as a distribution system to potential irrigation uses.

1.2.1 Taratahi Water Race

An arm of the Taratahi Water Race Scheme runs through the Site. According to Wellington Region LiDAR data (2013–2014), the water race enters the Site at its northern corner at an elevation of approximately 134 metres (mRL) and exits at the eastern corner at around 130 mRL. As shown in Figure 1:2 the scheme's command area spans the land generally to the east of Carterton, bounded by the Waingawa River to the northeast and the Ruamahanga River to the southwest.

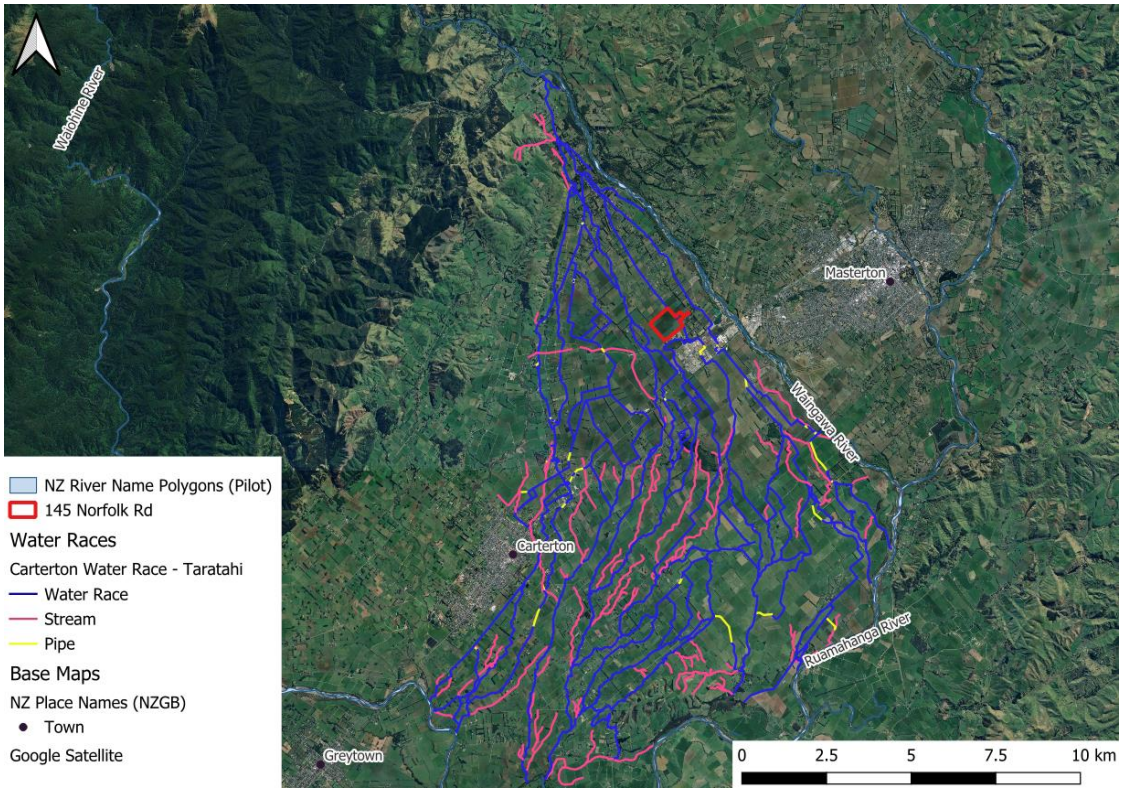

Figure 1:2 Taratahi Water Race's Command Area

The Taratahi Water Race consists of a network of earthen channels and some piped connections that rely on gravity to convey water abstracted from the Waingawa River. From the Site location (including adjacent races) this water is distributed across approximately 9,500 hectares of agricultural land, where it is used for stock water, frost protection, firefighting, and irrigation.

As outlined below, a critical success factor for the project is the use of water available under CDC's existing resource consent. This consent enables CDC to abstract water, manage the operation of the race system, and issue permits for stock water and other water uses. While the water races are owned by the landowners of the properties they traverse, their operation is funded through targeted rates paid by those landowners and is overseen by the Wairarapa Water Committee, which includes both property-owner representatives and CDC.

2 Strategic Case

A fit-for-purpose and "not reinventing the wheel" approach has been adopted in developing this business case lite. Accordingly, much of the strategic context supporting the need for water storage at the Site has been drawn from the Wairarapa Water Resilience Strategy 2021 (the Strategy), which effectively serves as a programme business case for this business case lite.

2.1 WAIRARAPA WATER RESILIENCE STRATEGY 2021

The Strategy outlines the key challenges, opportunities, and recommended actions for improving water resilience across the Wairarapa. Prepared in 2021 by the Wairarapa Water Resilience Strategy Group, the Strategy received formal support from Greater Wellington Regional Council (GWRC) in June 2022 for progressing its action plan[8]. This section of the business case provides a targeted summary of the Strategy's most relevant elements as they relate to the project; it is not intended as a comprehensive review.

The Strategy highlighted that freshwater is a fundamental resource for the Wairarapa but is increasingly at risk from climate change-related "shocks". These shocks were characterised through five key problem statements, which can be summarised as follows:

1. Increasing water deficit due to climate change.
2. Greater restrictions on water abstraction during low flows.
3. Increasing demand for water as population grows.
4. Loss of mauri.
5. Constrained local government budgets to invest in water resilience infrastructure.

The Strategy identifies several climate change impacts that will affect the Wairarapa, with some being particularly relevant to this project. These include:

- Currently, Masterton experiences an average of 31 hot days per year (defined as days over 25°C). However, this number is projected to increase to up to 52 hot days per year by 2040, and up to 101 hot days per year by 2090.
- Soils are generally projected to be drier in the Wairarapa plains, which may further impact pasture and crop growth and increase the need for irrigation.
- On average, 15% more water will be required by 2040 and 30% more by 2090 to maintain soil moisture levels assuming current land uses, due to rising temperatures and increasing potential evapotranspiration deficit.
- Drought conditions are projected to increase for all lowland parts of the region.
- River flows are likely to decline in the Wairarapa, with reduced flow reliability (i.e. the time during which river water takes are prohibited is projected to increase to maintain environmental flows).

The Strategy specifically highlights that climate change will exacerbate the water deficit issues experienced during the months of January to March.

The Strategy identified a series of high-level outcome statements, which can be summarised as follows:

- Make water resilience a community-wide concern and priority.
- Limit the worst climate change impacts to January–March, protecting the shoulder seasons.
- Capture and retain significant water from winter "freshes" and rainfall events.
- Slow water movement through the catchment and improve soil moisture retention.
- Maintain adequate river flows in the shoulder seasons to satisfy Te Mana o Te Wai requirements.
- Strategically protect nature-based assets (e.g. planting) from adverse climate effects.

[8] See: Wairarapa-Water-Resilience-Implementation-plan.pdf

The Strategy outlined two main categories of water resilience solutions: *Adaptive Solutions* and *More Available Water* (MAW) Solutions. Adaptive solutions focus on managing water demand by reducing, diversifying, or spreading it over time, while MAW solutions aim to increase the supply of usable water through methods such as capture, retention, storage, and efficient use.

Among the recommended solutions, water storage, such as this project, was identified as a viable option for ensuring reliable water availability, especially when reliability is critical. However, its feasibility depends on proving both economic and environmental viability. The Strategy also identified a set of principles to evaluate potential constructed water storage proposals, ensuring that they align with broader water resilience goals and can deliver long-term benefits for the region. The alignment of the preferred storage option with these broader goals and benefits is addressed in the economic case outlined in this report.

2.2 OTHER NATIONAL AND REGIONAL POLICY GUIDANCE

There are several key national, regional (in addition to the Strategy) and local policies / strategies that are relevant to development of this business case are set out in Table 2-1.Table 2-1:

Table 2-1: Relevant national, regional, and local policies / strategies

Type	Policy Name	Alignment Remarks
National	National Policy Statement for Freshwater Management 2020	This policy provides directives for managing freshwater resources, emphasising the protection of water bodies and ecosystems. It requires Regional Council's to set minimum environmental flows and limits, and corresponding water take limits to 'improve and maximise the efficient allocation of water' including economic and dynamic efficiency. Water storage supports maximising the efficient use of water, while maintaining minimum environmental flows.
Regional	Wellington Regional Freshwater Plan	Managed by the GWRC, this plan governs the sustainable management of freshwater resources in the Wellington region, including water allocation and use. There are several references to managing water sustainably, including encouraging efficient use of water and water conservation measures.
Local	Masterton District Council's Water Management	The council sources drinking water from the Waingawa River under a resource consent from the GWRC. Any new water storage projects must align with existing water management frameworks and consents.
	Carterton District Council's Infrastructure Strategy	This strategy outlines the provision of water services to support growth areas, including the Waingawa Industrial Park, and emphasizes the need for infrastructure planning to accommodate future development.

2.3 WAINGAWA WATER STORAGE PROBLEMS, BENEFITS, CRITICAL SUCCESS FACTORS AND INVESTMENT OBJECTIVES

2.3.1 Problems

The proposal to store water at 145 Norfolk Road has been identified as a key solution to address the growing water deficit issues highlighted in the Strategy. Specifically, for the Carterton District, the

project team identified one key problem statement that needed to be addressed by the project, which is as follows:

Problem Statement 1**: Inefficient use of water available in the Taratahi Water Race during winter, spring, and autumn - despite being allocated under CDC's resource consent - is leading to lost opportunities for water storage for resilience and limiting potential economic development.* ***(Weighting 100%)

Table 2-2: below sets out an estimated water balance for the Taratahi Water Race scheme in a 10-year annual recurrence interval (ARI) dry climate year. This shows that there is excess potential baseflow in the Taratahi Water Race, exceeding 4,200,000m^3/yr, which goes unused.

Table 2-2: Excess Water Available under CDC's Resource Consent for the Taratahi Water Race

Month	Primary Inflow from Waingawa River (10-year ARI)	Water Losses	Stock Water Use [3]	Process Water Use	Excess Water /Baseflow
Units	*1,000 m^3*	*1,000 m^3*	*1,000 m^3*	*1,000 m^3*	*1,000 m^3*
Jul	1,888	-850	-35	-559	445
Aug	1,883	-847	-35	-447	554
Sep	1,742	-784	-34	-432	492
Oct	1,911	-860	-35	-447	569
Nov	1,368	-616	-34	-432	286
Dec	1,550	-697	-35	-447	371
Jan	1,147	-516	-35	-447	149
Feb	1,002	-451	-32	-407	112
Mar	1,179	-531	-35	-447	167
Apr	1,243	-559	-34	-432	217
May	1,502	-676	-35	-447	344
Jun	1,769	-796	-34	-432	507
Total	**18,185**	**-8,183**	**-416**	**-5,374**	**4,212**

The primary inflows identified in Table 2-2: are based on maximising the CDC's authorised resource consent (WAR010227 V3A) with GWRC. This resource consent allows CDC to take water from the Waingawa River into the Taratahi Water Race Scheme. This consent has lapsed, as of 28/06/2023, and CDC is operating legally under section 124 of the Resource Management Act (RMA). CDC have applied for a new consent (WAR230259) - this is currently on hold for further information under section 92 of the RMA.

A key reason why the water is poorly used is that the excess water supply to the race occurs during the wet season (June to October), when the water take is less constrained as set out in Figure 2:1: Proposed site for the Waingawa Storage However, water demand from agriculture during the wet season is limited due to excess water from rainfall and low pasture/crop growth. It should be noted

that baseflow calculations are based on a series of high-level assumptions and may vary. But the seasonality of water availability will remain.



Figure 2:1: Proposed site for the Waingawa Storage facility

2.3.2 Benefits

Two key benefits from addressing the problem statement were also identified by the project team. These benefits, their weightings and supporting key performance indicators (KPI) are as follows:

- **Benefit 1 (Weighting 80 per cent): Improve Water Storage for the Summer Period**
  - Measure 1: Achieve a minimum of 500,000 m^3 of new water storage capacity by August 2026.
  - Measure 2: Increase the reliable volume of water available for use via the Taratahi Race Scheme by at least 2 times in summer, (December – February, inclusive) without increasing the authorised water take.
- **Benefit 2 (20 per cent): Increase local economic activity in the Carterton District**
  - Measure 1: At least 2 new or expanded agri-businesses or water-reliant industries established in Waingawa Industrial Park within the next 20 years.

2.3.3 Investment Objectives

Based on the benefit statements, and their associated KPIs, SMART[9] investment objectives for the project have identified:

- **Investment Objective 1 (50 per cent):** By 2026, establish storage infrastructure in the Waingawa area to capture and store excess process water available during winter, spring, and autumn under CDC's authorised water takes from the Taratahi Water Scheme.
- **Investment Objective 2 (50 per cent):** By 2026, establish water storage infrastructure in the Waingawa area, capable of supplying process water to local businesses, including farms, within the Taratahi Water Scheme Command Area.

2.3.4 Critical Success Factors

The following critical success factors (CSFs) were identified to help guide the evaluation of the options:

[9] SMART = Specific, Measurable, Achievable, Relevant and Timebound

- **Timely Delivery**: The solution must be able to be operational by 2026.
- **Regulatory Compliance**: The solution must comply with CDC's authorised water takes under the Taratahi Water Scheme.
- **Economic Feasibility**: The solution must demonstrate a viable cost-benefit ratio and be economically viable.

2.3.5 Summary of Problems, Benefits and Investment Objectives

Figure 2:2: sets out how the problems, benefits and investment objectives are linked.

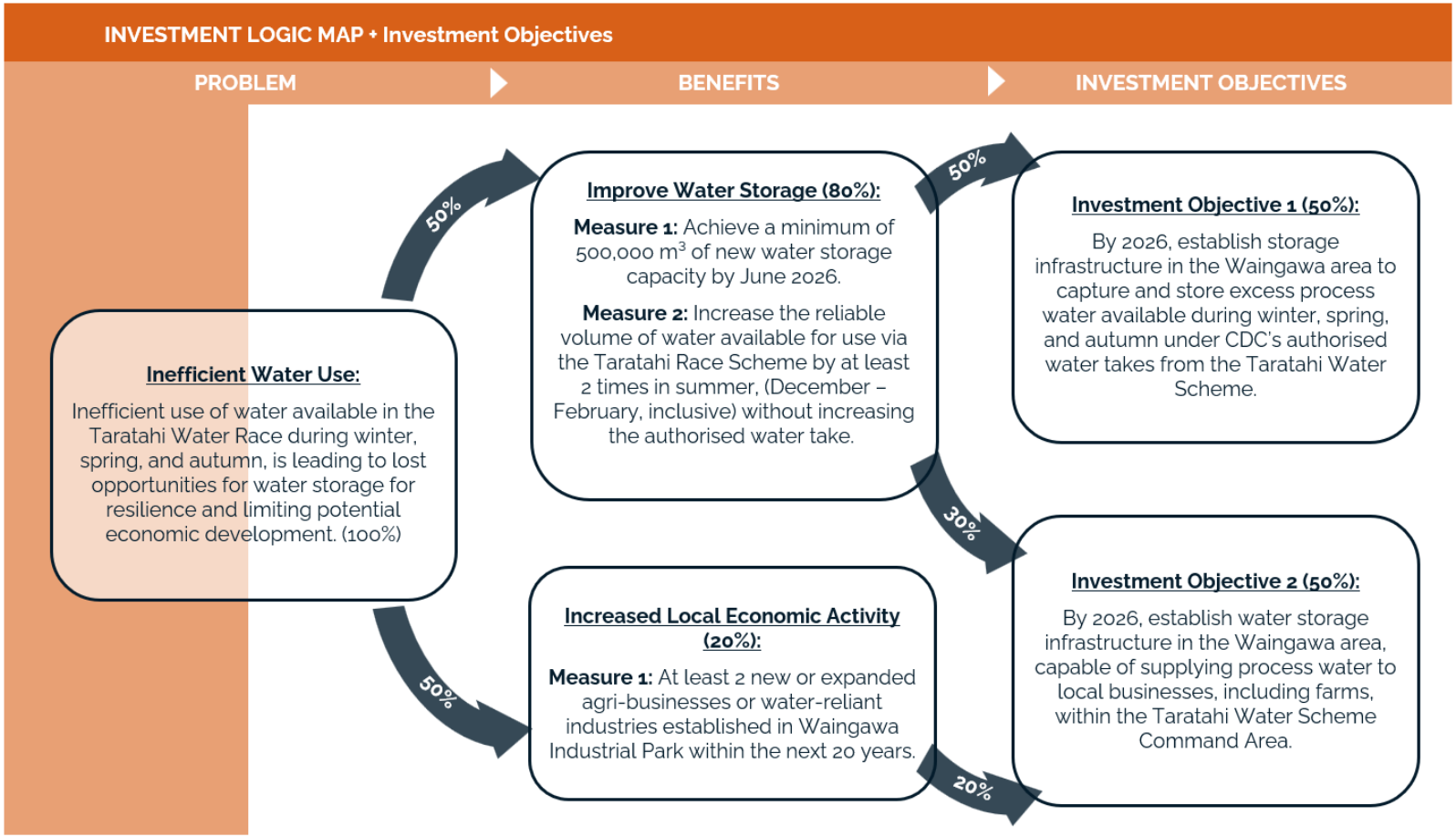

Figure 2:2: Problem, Benefits, and Investment Objectives

2.4 OPPORTUNITIES, CONSTRAINTS, DEPENDENCIES, ASSUMPTIONS AND UNCERTAINTY LOG

This section summarises the opportunities, constraints, dependencies, assumptions and uncertainties for the project. It is important to note that risk and opportunity management will continue throughout the project lifecycle. Therefore, the matters listed below are for strategic context purposes and are not exhaustive. As the project progresses, these matters will be further refined, and management strategies and risk registers will be developed to address them.

2.4.1 Opportunities

The key opportunities identified by the project team are as follows:

- Available water in the Taratahi Water Race during winter, spring, and autumn could be used during drier months for industrial water supply, irrigation, and environmental improvement purposes.
- The Site is positioned near the Taratahi Water Race. This means that the site comes with a water source and supply system, and a distribution system to a large area of land.
- Due to the Site topography and location, the storage would function offline from any waterways with ecological value (including the Taratahi Water Race). This is expected to reduce resource consent requirements and simplify the overall consenting process for the project.
- The Site is near the Waingawa Industrial Park, with approximately half of the park developed and the other half yet to be developed. Access to large volumes of process water could serve as a catalyst for the development of the undeveloped portions of the park.
- Initial assessments suggest that environmental, watercourse, wetland, archaeological, or natural hazard constraints at the Site are unlikely if it is developed for water storage.
- The Site is underlain by alluvial gravels, which are quarried by neighbouring properties. Based on nearby quarries with similar materials, it is considered that the material on-site could be crushed and/or sieved and reused for constructing the storage lagoon.
- The Site is flat, and earthworks are expected to be cut/fill balanced or maximise cut material to support gravel extraction.
- A water facility at the Site could provide potential for recreational water uses.

2.4.2 Constraints, Dependencies and Assumptions

Table 2-3: sets out the key constraints, dependencies, and assumptions that need to be considered and refined as the business case lite is developed.

Table 2-3: Key constraints, dependencies and assumptions

Constraints		Notes
C1	Funding is reliant on the RIF and is capped at $25M.	
C2	To meet the requirements set out in the RIF, the Project needs to demonstrate a return on investment.	

C3	The inflow of water to the Site is limited by the conditions set out under the current water take consent/s, among other factors such as losses, and other water takes.	The consent has lapsed, and CDC is operating legally under section 124 of the Resource Management Act (RMA). CDC have applied for a new consent (WAR230259) - this is currently on hold for further information under section 92 of the RMA.
C4	Compliance with consent conditions, which are yet to be determined.	Note that consent conditions can be influenced prior to consent being granted.
C5	Climate change will impact long-term water availability seasonally, impacting the long-term efficacy of the system.	Note that to maximise profits/sale of water, acts in tension with climate resilience. At this point 90th percentile climate conditions (1 in 10-year) as the balance between profits/sale of water and resilience has been selected. Under the effects of climate change, this could become an 80th percentile climate (1 in 5-year).
Dependencies		**Notes and Management strategies**
D1	Obtaining the required project consents that enable the Project to occur.	Expected to be earthworks consents, land use consents, building and/or dam consent at a minimum.
D2	Government decisions on changes to the National Environment Standards for Freshwater (NES: FW) will determine whether expansion of irrigation to pastoral land is permitted, requires consents or is prohibited.	
D3	Maximum ground water level will set the minimum storage height of the water storage system.	To be resolved via site-specific geotechnical investigation including groundwater level monitoring.
D4	Maximum storage height, and therefore embankment height will determine the dam classification and associates consenting requirements.	To be resolved with topographical survey and earthworks design.
Assumptions		**Notes and Management strategies**
A1	CDC's new resource consent application (WAR230259) for water take for the Taratahi Water Scheme will be authorised.	WAR230259 is currently on hold for further information under section 92 of the RMA.
A2	No upgrades to the Taratahi Water Race outside the Site boundary will be required.	Issues with the race may be identified during the project's pre-implementation phase.

A3	Providing large-scale process water storage for the Waingawa Industrial Park will attract new water-intensive industries to the area.	It is assumed that one to two new water-heavy users will choose to locate within the Waingawa Industrial Park over the next 20 years.
A4	Sourcing water from the new storage facility will be commercially preferable for new water-intensive industries at the Waingawa Industrial Park compared to groundwater supply.	The overall cost of obtaining process water from the new facility will be priced to be more commercially attractive. Noting that there is limited allocation available in the underlying aquifer.
A5	The proposal is likely to generate wider economic benefits, although these are difficult to quantify due to uncertainties around feasibility and uptake.	Water storage is likely to generate wider economic benefits, such as land value uplift from irrigation. However, these benefits are difficult to quantify at this stage and would need to be assessed following this business case lite.
A6	The reservoir must be designed to maximize cut material for gravel extraction, which will enhance returns through crushing, sieving, and sale.	The design should maximise gravel extraction, within feasible limits (i.e. above the groundwater kevel). The actual design will take place during the Pre-Implementation Phase.
A7	Water losses across the Taratahi Water Race scheme are assumed at 45%, based on work completed by others (WSP, 2022).	

2.4.3 Uncertainty Log

The uncertainty log for the business is provided in Table 2-4:

Table 2-4: Uncertainty log

Factors	Time	Uncertainty	Impact	Comments
Water race fall.	Near term	Medium	Medium	If water race fall is insufficient or out of alignment with the earthworks design a pump station will be required to maximise storage volumes within the site. **Action:** to be resolved with topographical survey and earthworks design.
Geotechnical information including groundwater information and presence of gravels.	Near term	Medium	Medium	Groundwater levels will impact the depth of the storage facility, and therefore the storage volume that can be achieved, Presence of gravels will impact gravel extraction and sale potential. **Action:** to be resolved via site-specific geotechnical investigation including groundwater level monitoring.

Factors	Time	Uncertainty	Impact	Comments
Baseflows in the Taratahi Water Race.	Short term	Medium	High	Actual available volumes for sale may vary depending on refill rates or baseflows, especially during the critical summer period. **Action:** water balance estimates to be progressively improved based on latest data through the project.
Full occupation of Waingawa Industrial Park by Year 20.	Long term	Medium	Medium	It is assumed there will be steady industrial development. However, timing and extent of occupancy remain uncertain.
Acceptability of water pricing.	Short and long term	Low	High	The proposed pricing for water from the storage facility may not be acceptable to all potential end users. This will need to be further investigated
Water quality for recreational use.	Short term	Low	Low	Some recreational opportunities - such as swimming - may be ruled out due to water quality issues associated with water supplied by the Taratahi Water Race.

2.5 THE CASE FOR CHANGE

The case for change can be summarised as follows:

- The project aligns with the Wairarapa Water Resilience Strategy (and other national, regional and local strategies), as it seeks to improve the water resilience of the region. In particular, the Strategy identifies water storage as one of the options that should be considered when opportunity arises. To this end, the appropriate property access arrangements have been put in place for the project,
- The scheme's basic concept is to capture and store excess flows permitted under CDC's Taratahi Water Race resource consent during the winter, autumn, and spring months, and to use this stored water during the high-demand summer period.
- The scheme's concept would help to address the problem statement and achieve the investment objectives.
- The investment objectives and CSFs focus on ensuring the project can be operational by 2026, that the preferred option must comply with CDC's authorised water takes under the Taratahi Water Scheme and be economically viable.
- Several constraints, dependencies and assumptions have been identified. These will need to be further investigated either in this business case or in the future pre-implementation phase (if progressed.

3 Economic Case

This section of the report evaluates the economic viability of developing a water storage reservoir at the Site to support industrial growth and irrigation.

A long-list evaluation of broader water resilience options was not conducted for this business case lite, as the characteristics of the Site limited feasible options to water storage - one of the options already identified in the Strategy. Consequently, the option development and assessment process focused exclusively on evaluating water storage options specific to the Site, as identified in the Study.

3.1 WAINGAWA FEASIBILITY STUDY OPTIONS ANALYSIS

As discussed above, the Study explored high-level costs and benefits of water storage opportunities at the Site. The primary objective of the Study was to evaluate whether viable water storage options existed that could be potentially economically viable if further investigated.

The Study's option development and assessment processes firstly considered the site's features and location, identifying both opportunities and constraints. Key opportunities identified included its proximity to the Taratahi Water Race (with access to surplus water under an existing resource consent), its location near existing and future developments at the Waingawa Industrial Park, potential for on-site reuse of alluvial gravels and use of excess water for potential irrigation uses.

Five water storage options were initially considered:

- **Option 1:** A seasonal irrigation water storage to supplement the Taratahi Water Race.
- **Option 2:** A process water storage to supply the Waingawa Industrial Park.
- **Option 3:** A combined irrigation and process water storage system.
- **Option 4:** Municipal water storage to support the Carterton urban network.
- **Option 5:** Municipal water storage to support the Masterton urban network.

Table 3-1 presents a summary of the options, cost estimates, and key differentiating opportunities and risks that were identified in the Study.

Table 3-1: Summary of Feasibility Study options

Option	Relative Capital Cost	Benefits and Opportunities	Risks
Option 1: Taratahi Water Races Irrigation Water Storage	$$$	Irrigation and increased productivity/land use change of up to 1,875 ha land. Efficient water use, reuse of existing infrastructure. Potential added value to construct using onsite quarry operations.	Consenting likely triggered by earthworks and dam creation. Security of ongoing water take under s124. Algal bloom risk.
Option 2: Waingawa Industrial Estate Process Water Storage	$	Enable heavy water industry of 120 ha industrial zoned land. Efficient water use, reuse of existing infrastructure.	Consenting likely triggered by earthworks and dam creation.

Option	Relative Capital Cost	Benefits and Opportunities	Risks
			Pressure on existing take consent and no security of ongoing take under s124
Option 3: Combined Process Water and Irrigation Water Storage	$$	Enable heavy water industry of 120 ha industrial zoned land. Irrigation and increased productivity/land use change of up to 450 ha land. Efficient water use, reuse of existing infrastructure. Potential added value to construct using onsite quarry operations.	Consenting likely triggered by earthworks and dam creation. Pressure on existing take consent and no security of ongoing take under s124
Option 4: Carterton Municipal Water Storage	Option not considered further.		
Option 5: Masterton Municipal Water Storage	Option not considered further.		

A high-level evaluation of each option was conducted, considering factors such as costs, benefits, opportunities, and risks. Cost estimates were prepared to an Association for the Advancement of Cost Engineering (AACEI) Class 4 level, with a 50% contingency. The assessment also identified key risks such as consenting requirements, dam classification under the New Zealand Building Code, potential impacts on water availability, and the risk of underutilization. Opportunities included alignment with the RIF, potential revenue from gravel sales, efficient water use through seasonal storage, and potential for water-based recreation.

Following the initial assessment, Option 3, a combined water storage solution (a 270,000m^3 reservoir, with 28,800m^3 allocated for industrial use), was identified as the preferred option by CDC.

The Study concluded that the combined water storage solution aligns with CDC's strategic vision and offers long-term economic benefits for the region, but further investigations were required to understand the economic viability of the scheme. The Study, including its recommendations for Option 3, were endorsed by CDC in March 2025.

Following completion of the Study, CDC decided to explore the economic viability of the preferred option, specifically, the use of stored water for both irrigation and supplying the Waingawa Industrial Park. However, CDC advised that the reservoir size would be either 500,000 m^3 or 1,000,000 m^3, rather than the 270,000 m^3 originally considered, and the 1,000,000 m^3 sized option could be staged over time. CDC also capped the initial capital cost of the preferred option at $25 million, instead of the earlier estimate of $15 million.

As such, this Economic Case builds on the option development and assessment undertaken for the Study but focuses specifically on exploring options for the following two reservoir sizes:

- Option A: 500,000 m^3
- Option B: 1,000,000 m^3

The analysis below also considers an "Option B staged" process. That is, constructing Option A first, followed by the subsequent development of the remaining storage capacity (an additional 500,000 m^3) over time.

In addition, as the Study had identified a potential opportunity to extract high-grade gravel during reservoir construction, the economic analysis below also includes consideration of this potential economic opportunity.

3.2 ECONOMIC ANALYSIS APPROACH

A comprehensive cost-benefit analysis (CBA) has been completed for the project, offering a clear and detailed assessment of the project's long-term economic viability and overall value for money. In alignment with Treasury guidelines, the analysis used a 40-year evaluation period and applied standard economic assessment methodologies. Sensitivity testing was undertaken to evaluate the robustness of the results under a range of assumptions.

The analysis considered the full range of capital and operational costs, including short-term construction costs, ongoing operational expenses, and long-term maintenance requirements. On the benefit side, the CBA quantified direct revenue from water sales, along with the broader economic uplift (including land value uplift) anticipated through improved water security to the Waingawa Industrial Park and surrounding rural areas.

The potential for revenue generation from gravel extraction during construction has been considered. Excavation activities are expected to generate significant volumes of commercially viable gravel. These volumes were evaluated in terms of material quality, processing costs, and market demand. Net revenues from the sale of extracted gravel have been included in the analysis as a capital offset, recognising that these revenues are time-limited and will cease at the conclusion of the construction phase.

The assessment also examined a range of construction options, including scenarios that maximise gravel extraction by increasing the relative depth of the reservoir. These options were assessed against the additional costs associated with higher embankments and other design requirements.

While the scheme may also offer future recreational benefits through the creation of a water body suitable for leisure use, these potential benefits have not been included in the economic assessment due to the uncertainty around water quality requirements and therefore their feasibility, uptake, and monetisation. Similarly, the project is expected to have positive impacts on the environment, which have not been quantified in this analysis, but are described qualitatively in this section below.

The economic analysis has considered the following options:

- Do Nothing (base case): No reservoir development.
- Option A: Development of a 500,000 m^3 reservoir.
- Option B: Development of a 1,000,000 m^3 reservoir.
- Option B Staged: Development of a 1,000,000 m^3 reservoir in two 500,000 m^3 stages, 10 years apart.

A CBA has been used to evaluate the economic viability of each of the above options. It was determined that Net Present Values (NPV) and Benefit-Cost Ratios (BCR) were to be calculated using a 4% discount rate over a 40-year time horizon.

3.2.1 Key Assumptions of the Economic Model

The economic model used in this analysis incorporates several key assumptions underpinning the economic evaluations. It's important to understand these assumptions, as they affect the interpretation of the results and highlight areas of potential uncertainty.

General Assumptions:

The following general assumptions apply to the economic analysis of all options:

- A 4% discount rate.
- A 40-year analysis period.

Inclusions:

The model includes the following key elements for each of the options:

- Capital and operational costs associated with the construction and operation of the reservoir.
- Revenue from water sales to industrial users, based on projected demand and pricing.
- Revenue from water sales for agricultural irrigation.
- Revenue from aggregate mining (gravel extraction), where applicable.
- Broader economic benefits, including industrial land value uplift and positive economic multiplier effects (e.g. job creation and increased regional output).

Exclusions:

The model does not explicitly monetise the following:

- Potential land value uplift for surrounding rural land due to irrigation. While the potential for significant uplift is acknowledged, as discussed in the "Land Value Uplift and Agglomeration Benefits" section below, it is not included in the core financial calculations.
- Full quantification of recreational benefits. While the potential for revenue from recreational use is noted, a detailed market assessment is required, and therefore these benefits are not fully incorporated into the current analysis.
- Environmental benefits. Potential positive impacts on the environment are acknowledged but not monetised.

Rationale for Exclusions:

Certain benefits are excluded from the core financial analysis due to:

- Difficulty in accurate quantification: Land value uplift and recreational benefits are subject to market fluctuations and require further detailed analysis to determine precise values.
- Focus on direct financial returns: The primary focus of the financial model is on the direct revenue streams and costs associated with the reservoir's construction and operation, to assess its financial viability.

Key Assumptions and Sensitivities:

Several key assumptions have a significant impact on the model's results:

- **Costs**
  - All Capital Expenditure (CAPEX) costs are incurred within a 1-year period for each reservoir.
  - In the Option B staged option, the CAPEX costs for stages 1 and 2 are spaced 10 years apart for the purposes of this analysis. Stage 2 could be brought forward or pushed back depending on demand.

- Operational Expenditure (OPEX) for all options was estimated by examining available data from the CDC Water Asset Management Plan from 2021.[10] The plan presented the total water asset replacement value ($31,816,801 in 2021 dollars) and the annual operational costs ($2,176,573 in 2021 dollars). The OPEX was calculated by dividing the annual operational costs by the total water asset replacement value, resulting in a proportion of 6.84%. This proportion was used to estimate the OPEX spend for each option.
- Project costs: Capital and operational cost estimates are subject to uncertainty. A 50% contingency has been included in the cost estimates, and sensitivity analyses have examined the impact of higher costs, including potential upgrades to the Taratahi Water Race.[11]
- It is assumed that there is zero charge for consented water taken from the Taratahi Water Race for the reservoir. This is because the reservoir's primary function is to support the wider water race network's performance, improving water security and resilience for all users. It is assumed that there will be no significant loss of water volume from the race, no significant degradation of water quality, and no material negative impacts on downstream users.

- **Benefits**
  - The Waingawa Industrial Park benefits are common to all options (excluding the do-nothing option), and include water revenue, industrial land value uplift, and economic multiplier benefits from increased jobs.
  - Gravel extraction costs and revenue are based on data provided by industry. All gravel volumes are assumed to be extracted during construction and sold immediately in Year 1.
  - The irrigation benefits are presented as a range due to the uncertainty regarding baseflows in the Taratahi Water Race, based on the latest water take information from CDC.
  - Benefits (and costs) associated with environmental impacts and any potential recreational opportunities associated with the development of the reservoir have been excluded from the quantitative analysis but are described qualitatively.
  - Wider economic benefits (e.g. land value uplift from irrigation and increased employment due to increased agricultural productivity and the potential for intensification and diversification of land use due to enhanced water reliability) are discussed but are not quantified in the analysis. There is the potential to explore this further in the pre-implementation phase.
  - Timing of benefits: The realization of benefits, particularly those related to industrial development, is dependent on development timeframes. A conservative approach has been taken with respect to uptake of industrial land.

- **Sensitivity Testing**
  - Sensitivity tests were used to assess the resilience of the analysis to uncertainty in key assumptions. Rather than isolating individual parameters, the modelling applied broad percentage changes to both costs and benefits to represent the cumulative effect of multiple uncertainties. This approach provides indicative ranges that encompass potential variations in the following areas:
  - Water demand from industrial users in the future Waingawa Industrial Park; This is dependent on the rate of industrial park development and the water consumption of future industries.
  - Water pricing: The model assumes a base industrial water price. There is potential to add a premium for increased water reliability.
  - Gravel extraction volumes and prices: Revenue from gravel extraction is based on estimates of extractable volumes and market prices, which can fluctuate.
  - Discount rate: The discount rate used to calculate NPV was explicitly varied in the sensitivity analysis to understand its impact.

[10] See: Water Supply Asset Management Plan | Carterton District Council
[11] See: Water Supply Asset Management Plan | Carterton District Council

Potential Risks and Mitigations:

The economic model and the project's financial viability are subject to several potential risks and uncertainties. Table 3-2 outlines these risks and proposes potential mitigation strategies:

Table 3-2: Risks and Mitigations

Risk	Mitigation Strategy
Lower than projected water demand from industrial users	Secure long-term water supply agreements with anchor industrial tenants.
Delays in industrial park development	Phased development of the reservoir to match the pace of industrial park construction.
Lower than expected water prices	Diversify revenue streams (e.g., industrial use, irrigation, recreation).
Fluctuations in gravel market prices or demand	Negotiate favourable gravel extraction contracts with price escalation clauses.
Capital cost overruns	Implement rigorous project management practices, including detailed cost estimation, value engineering, and risk allocation in contracts.
Operational cost increases	Conduct thorough life-cycle cost analysis and explore energy-efficient technologies to minimize long-term operating expenses.
Inaccurate estimation of land value uplift benefits	Continue to monitor comparable land value data from similar industrial areas and revise the land value estimates as necessary. If there is uncertainty, this could be removed from future economic viability assessments.
Uncertainty in realising the economic multiplier benefits	Advise industry and community of the potential for job creation through local labour and procurement policies. Monitor and report economic activity in the region, focusing on employment and increased regional output, after the reservoir is operational.

3.3 DO NOTHING OPTION

3.3.1 Description and Key Assumptions

- This scenario represents the continuation of the current situation. There is no reservoir development.
- The remaining 120 hectares of the Waingawa Industrial Park are developed for dry industrial use.
- Benefits to the community are limited to those generated by the development of the remaining 120 hectares of industrial land with dry industrial activities.
- There is no change to the surrounding rural land uses.
- There are no new revenue benefits to CDC ratepayers.
- There is a lost opportunity to improve the Wairarapa's water resilience.

Costs and benefits are zero for the Do-Nothing option for the purposes of this analysis.

3.4 WATER RESERVOIR OPTIONS

Table 3-3 summarises the capacity, key features, and benefits of each of the three reservoir development options. It identifies the inclusions and benefits specific to each scenario, allowing for clear comparison without repeating detailed descriptions.

Table 3-3: Option descriptions and key benefits

Item	Option A	Option B	Option B Staged
Capacity	500,000m^3	1,000,000m^3	1,000,000m^3 (2 × 500,000m^3 over 10 years)
Description	500,000m^3 reservoir to supply water to 120ha of industrial land, with buffer available to top up the race as required.	1,000,000m^3 reservoir to supply water to 120ha of industrial land. Includes additional irrigation supply.	1,000,000m^3 reservoir constructed in two stages 10 years apart to supply water to 120ha of industrial land and additional irrigation supply, enabling cashflow benefits. OPEX increases after stage 2.
Benefits			
Water supply to 120ha industrial land	✓	✓	✓
Irrigation water supply	Buffer only in dry years	✓	✓
Industrial water revenue	✓	✓	✓
Irrigation water revenue	Assumed to be zero	✓	✓
Land value uplift	✓	✓	✓
Job creation	✓	✓	✓
Increased economic activity	✓	✓	✓
Gravel sales revenue	✓	✓✓	✓✓

3.5 WATER RESERVOIR OPTION BENEFITS

The water reservoir options offer similar benefits and differ only by the size of the benefit created from the different amounts of available water supply and, in the case of the Option B staged option, the timing of the benefits. As such, the following sections describe the benefits of all options. Each section concludes with a table summarising the difference between the three options.

3.5.1 Waingawa Industrial Park Benefits

The Waingawa Industrial Park benefits are Water Revenue, Job Multiplier Impact, and Land Value Uplift. This section sets out the details for the quantification of the industrial benefits.

The core assumptions supporting the industrial benefits are as follows:

- Enabling water supply to the Industrial Park will help to attract 1-2 water-heavy industries (see Figure 3:1) to locate to the park.
- The remaining 120 hectares of industrial land will be fully developed for water-heavy industries.
- Taking water is commercially preferable to new groundwater takes or use of the current process water (there is only limited availability of both).
- The benefit model conservatively projects a slow uptake of the industrial land reaching full occupation of the 120 hectares by Year 20.

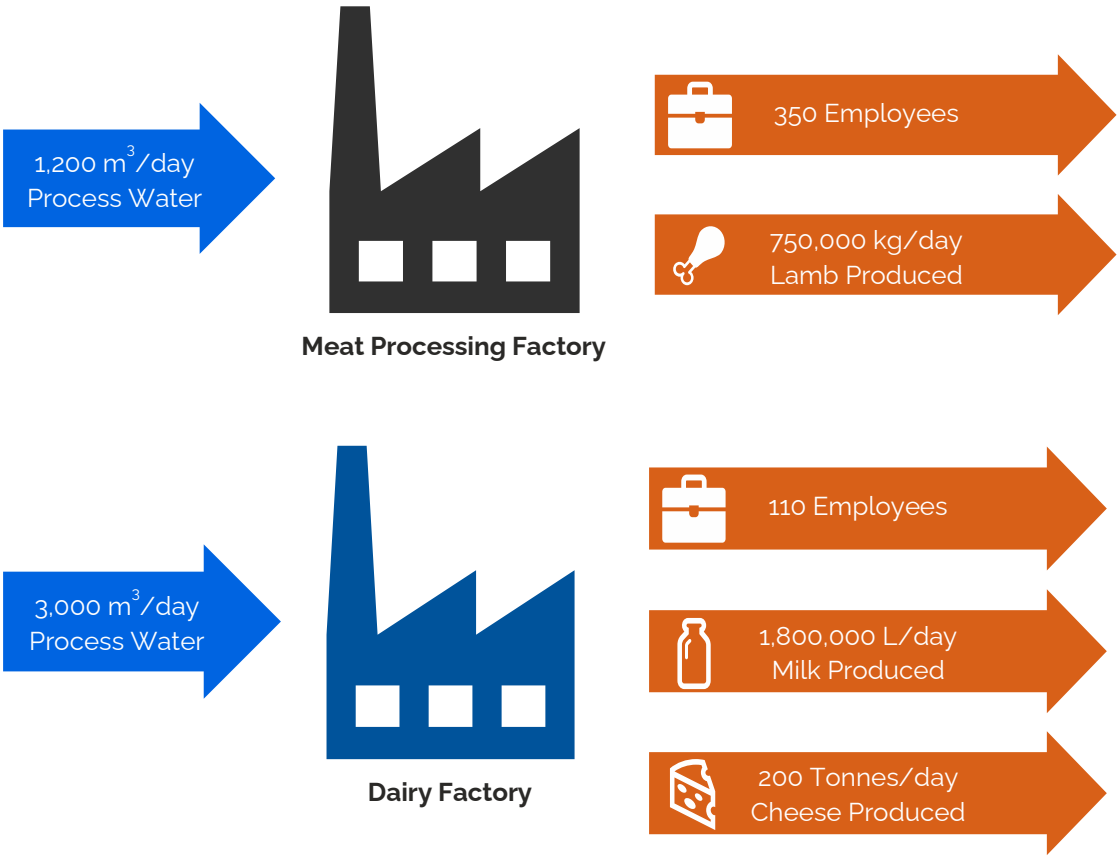

Figure 3:1: Water heavy industry examples that could occupy the site. Input and output values estimated based on Fonterra Stirling[12] and Blue-Sky Meats[13, 14, 15] consents, production and staffing data.

3.5.1.1 Water Revenue

The project is designed to provide a reliable and consistent water supply to support industrial activities, primarily within the planned industrial park. This reliable water access is a crucial enabler for industries that rely on significant water usage in their operations ("wet industries"). By ensuring a stable water source, the project not only facilitates the establishment and growth of these industries but also

[12] See: https://www.orc.govt.nz/media/14567/fonterra-limited-morgan-watt.pdf
[13] See: Consent Documentation
[14] See: https://bluesky.co.nz/about
[15] See: https://www.takeovers.govt.nz/assets/Transactions/Blue-Sky-Meats-Limited-2022-Target-Company-Statement-and-Independent-Advisers-Report.pdf

generates a direct revenue stream through the sale of water to these users. This revenue contributes to the financial viability of the project and helps offset the costs associated with its development and operation. The following outlines the methodology and assumptions used to estimate industrial water revenue.

Methodology/Assumptions:

- **Water Demand**: The annual water demand is estimated based on the projected industrial land area occupied by wet industries. A water usage rate of 12 litres per day per square metre (12 L/d/m^2) of industrial land is applied.[16]
- **Industrial Land Occupation**: The projected industrial land area is based on a stepped increase over 20 years, with a 2-year initial delay before development begins. This phased approach accounts for the gradual uptake of industrial land by wet industries once they become aware of the scheme.
- **Water Price**: The base water price is assumed to be $1.25 per cubic metre. This price is lower than the specified $2.25 per cubic metre price on the CDC website for "Water race – metered – for principally commercial/industrial use". It is also noted that the $1.25 per cubic metre price is also lower than the price that Tararua District Council sells potable water to industry at $1.57/m3. Accordingly, the assumed water price is considered conservatively appropriate.

Calculation:
The annual water revenue from industrial use is calculated by multiplying the required number of cubic metres of water (based on 12 L/d/m^2 x the amount of occupied land in m^2) by the average water price. This calculation is repeated for each of the 40 years of the model. Table 3-4 presents the annual industrial park water revenue calculation at full occupation (Year 20),

Table 3-4: Calculation of Industrial Park Water Revenue at full development

Variable	Calculation	Amount
Occupied Industrial Land Area	Total projected industrial land area developed (based on projections described above)	1,200,000 m^2
Industrial Area Water Demand	Wet Industry Peak Daily Usage figure from Watercare 2021[17]	12 L/d/ m^2
Daily Water Demand	Occupied Industrial Land Area x Industrial Area Water Demand	14,400,000 L
Annual Water Demand	Daily Water demand x 365/1000	5,256,000 m^3
Water Price	Assumed (described above)	1.25 $/$m^3$
Annual Water Revenue	Water Price x Annual Water Demand	$6,570,000

The total undiscounted benefit from the Waingawa Industrial Park water revenue over the 40-year analysis period is **$161,740,260.**

[16] cop_water_chapter_8648e958c8.pdf
[17] See: cop_water_chapter_8648e958c8.pdf

3.5.1.2 Industrial Land Value Uplift

The reliable provision of water to the industrial park, enabling the establishment of water-intensive industries, is expected to significantly increase the land's value[18]. This uplift is driven by several key factors:

- Increased Utility and Demand:
  - Industrial land value is fundamentally linked to its utility for businesses. A dependable water supply expands the range of industries that can operate on this site, particularly attracting high-value sectors like food processing, beverage production, and advanced manufacturing. As described above, the site is particularly suited to agricultural industrial processes such as beef/lamb or dairy processing. This increased potential directly translates to heightened demand for the land, driving its value upwards.
- Specialised Infrastructure Premium:
  - Land equipped with specialized infrastructure (e.g. a robust water supply, carries a premium). Similar to the increased value observed in land with rail or port access, the provision of "wet-industry-enabled" infrastructure reduces development costs and operational risks for potential businesses, making the land more desirable.
- Industry Clustering and Economic Growth:
  - A reliable water source fosters the development of industry clusters, where related businesses locate in proximity. This clustering generates economies of scale, promotes innovation, and stimulates job creation, all of which contribute to regional economic growth and, consequently, increased land values.
- Regional Development Alignment:
  - Regional development strategies often prioritize the attraction of water-intensive industries due to their significant economic contribution. By providing the required infrastructure, the project aligns with these strategies, further enhancing the land's value.
- Market Observations:
  - "Wet-industry-enabled" land commands higher prices compared to land limited to dry industrial activities.

Methodology/Assumptions:

- The land value uplift is estimated based on the increased attractiveness of the industrial park to wet industries due to the reliable water supply.
- The uplift is estimated using comparative sales data and land value analysis data from Quotable Value (https://qv.co.nz).
- The land uplift will be realised over the first 20 years of the project.

Calculation:

The Do-Nothing scenario assumes a constant real land value of $97,730 per hectare over the 40-year project timeline, reflecting the current value of developed industrial land in the area[19].

[18] This land value uplift differs from the potential irrigation land value uplift (which is discussed in the irrigation section below)
[19] Based on a sample of 15 properties that have already been developed in the industrial area. The average land value reflects the average of the medium sized lots (6-9 hectares) in the existing developed area

In contrast, the water supply project options incorporate the increased value associated with the ability to attract water-intensive industries. Based on conservative assumptions, the land value is estimated to increase by 20%[20] to $117,280 per hectare, representing an uplift of $19,550 per hectare.

The annual land value uplift was calculated by multiplying the $19,550 uplift per hectare by the number of hectares developed in each given year. This process was repeated for each of the 40 years of the analysis. The land value uplift for each hectare is modelled as a one-time benefit for each hectare.

The cumulative (undiscounted) land value uplift over the entire 40-year period is estimated to be **$2,346,000** ($19,550 x 120 hectares)[21]. This figure represents the total increase in land value attributable to the water reservoir options' ability to facilitate the establishment of water-intensive industries. Further land value uplifts due to inflation, the economic success of industries in the area, and broader agglomeration benefits are not included in the model.

This estimate is based on conservative assumptions and a projected development schedule. Actual land value uplift may vary depending on market conditions, industry demand, and the specific timing of development. However, this figure provides a reasonable assessment of the potential economic benefit associated with the project's potential impact on land values.

3.5.1.3 Job Multiplier Impact

This analysis evaluates the potential for job creation resulting from the transition to wet industries within the industrial park and subsequently assesses the broader economic impact of these new jobs.

Job Creation Calculation:

The number of additional jobs generated by wet industries, compared to dry industries, is estimated based on the differing land use intensities of these sectors. Dry industries are assumed to require 90 m^2 per job, while wet industries utilize 50 m^2 per job[22]. To calculate the total floor space available for each industry type, the projected occupied industrial land area each year is multiplied by the estimated Floor Area Ratio (FAR)[23]. A FAR of 0.4 is applied to dry industries, and 0.3 to wet industries[24]. This calculation reveals that wet industries can generate approximately 20% more jobs than dry industries for the same land area.

However, the analysis acknowledges the limitations imposed by Wairarapa's population and job demand.[25] The current number of filled jobs in the Carterton, Masterton, and South Wairarapa Districts is 20,000, serving a population of 50,000. Population projection data is used to estimate the future number of jobs needed in Carterton over the project's timeline. This indicates that while wet industries offer a higher job creation potential, this advantage is capped by the actual number of jobs needed in the area. Wet industries enable the industrial area to meet the required additional jobs faster, providing a significant short-term benefit, within the initial seven years of the project. Beyond this point, the

[20] This increase is assumed to be solely due to the addition of water supply. Any other variables that may result in land uplift have not been considered in this analysis to isolate the uplift due to water supply
[21] As the full quantum of industrial benefits are enabled in Option A, this estimate is the same for all 3 options
[22] The number of employees per m^2 varies widely depending on the industry and size of the building. Employment densities of 90 m^2/job for dry industries (e.g. manufacturing, logistics, warehousing) and 50 m^2/job for wet industries (e.g. meat processing) are based on a synthesis of published planning benchmarks and facility case studies. These figures reflect the upper end of observed ranges for warehousing and for labour-intensive food processing, particularly meat processing, as reported in the UK HCA Employment Density Guide (2015), Puget Sound Regional Council (2012), and workforce data from Tyson and Hormel facilities.
[23] FAR is the ratio of a building's total floor area to the size of the land it is built on. It indicates how intensively a site is developed
[24] Floor Area Ratios of 0.3 for wet industries and 0.4 for dry industries reflect typical industrial land use patterns, based on zoning provisions and case studies of food processing, warehousing, and manufacturing facilities (e.g. HCA Employment Density Guide (2015), Puget Sound Regional Council (2012)). These international data sources were sense-checked by analysing building area/land area across a sample of large meat/dairy processing and warehousing/ logistics sites in New Zealand using QV.co.nz.
[25] See: Aotearoa Data Explorer • Subnational population estimates (TA, community board), by age and sex, at 30 June 2023-24 (2025 boundaries)

number of jobs that could be generated by the dry industry (i.e. do-nothing) scenario begins to exceed local demand.

Under the above assumptions, a total of 352 additional jobs are created up to Year 7 of the model, before supply of jobs exceeds demand.

Economic Multiplier Effect:
To estimate the broader economic impact of these new jobs, an economic multiplier of 1.5 has been applied. This multiplier acknowledges that when new jobs are created and wages are paid, the effects ripple through the local economy.

- **Direct Impact:** The new jobs provide income for workers.
- **Indirect Impact:** These workers then spend their income at local businesses (groceries, restaurants, retail). This spending becomes income for those businesses.
- **Induced Impact:** Those businesses then use their increased income to buy supplies, pay their own employees, and so on.

The multiplier aims to capture this chain reaction of spending. A multiplier of 1.5 suggests that for every dollar earned in new wages, an additional $0.50 of economic activity is generated in the local economy. This figure is a reasonable and conservative estimate, reflecting a moderate level of local spending and inter-business transactions.

This approach allows us to estimate the total economic contribution of the new jobs, beyond just the initial wages paid. It encompasses the increased economic activity generated by the wages being spent in the local economy and includes the increased tax revenue that results from this increased economic activity. Therefore, the multiplier effect provides a more comprehensive picture of the project's economic benefits to the local community.

Assumptions:

- Wet industries use a lower floor area ratio (0.3) than dry industries (0.4)[24].
- Dry industries require 90 m^2 per job, and wet industries utilise 50 m^2 per job[22].
- Average wage is based on the average wage in Carterton: $73,889 per year[26].
- Job creation numbers will increase proportionally with the increase in industrial land occupation.
- An economic multiplier of 1.5 is appropriate to calculate indirect economic activity.
- Population projection data accurately reflects future job demand in Carterton.

Calculation:

Based on the above assumptions, the total undiscounted economic multiplier benefit is calculated by multiplying the number of additional jobs (352) by the Carterton average annual wage ($73,889) by the economic multiplier (1.5). Accordingly:

- Calculation: 352 jobs x $73,889 annual wage x 1.5 = **$38,991,166**

[26] We explored the idea of determining a wage differential between wet and dry industries, but without knowing the specific industries that would occupy the industrial park in each scenario, it was not possible to assume an average wage for each industry type. Although it is likely that wet industries will derive higher wages, we have opted to conservatively apply no difference between wet and dry industries. Instead, we have opted to use the data available, the average wage data in Carterton. based on business employment data from Stats NZ. business-employment-data-september-2024-quarter.xlsx

3.5.1.4 Industrial Benefits Summary

Table 3-5 presents the total industrial benefits of each option. As the benefits are realised in Option A, there is no difference between the options.

Table 3-5: Industrial benefits of each option

Benefit category	Option A	Option B	Option B Staged
Industrial Water Revenue	$161,740,000	$161,740,000	$161,740,000
Industrial Land Value Uplift	$2,346,000	$2,346,000	$2,346,000
Economic Multiplier	$38,991,000	$38,991,000	$38,911,000
Total Industrial Benefits	$216,350,000	$216,350,000	$216,350,000

NB. These are total undiscounted benefits. The Net Present Value of these benefits is presented in Table 5-9.

3.5.2 Gravel Extraction Benefits

Gravel extraction at the Site presents an opportunity to generate economic benefits. This section details the process of quantifying these potential benefits, which involves evaluating the financial viability of extracting and selling gravel, considering extraction volumes, costs, and revenues.

3.5.2.1 Estimation of Gravel Yield

For each extraction option and stage, an estimated percentage of gravel within the total extracted material volume has been determined based on existing borehole data and local knowledge from experienced gravel extractors in the area. The estimated percentages of gravel extracted are 70% of the total material extracted for Option A, and 90% for Option B. For simplicity, and to provide a conservative estimate, 70% for all Options has been adopted.

3.5.2.2 Reservoir Design is to Maximise Gravel Extraction

The initial feasibility study for the water reservoir project focused on a "Cut to Fill Balanced" earthworks approach. This methodology prioritises minimising the overall volume of earth moved by strategically balancing excavated material with the fill required for constructing key features, such as the lagoon bund. The primary objective of this approach is to optimise construction efficiency and reduce earthworks costs.

However, the potential for gravel extraction, as explored within this business case, necessitates a fundamentally different earthworks strategy. To maximise the recovery of valuable gravel resources, a design approach that prioritises deeper and more extensive excavation within identified gravel deposits is required. This contrasts directly with the "Cut to Fill Balanced" method, which aims to minimise excavation.

The change in design necessitated by gravel extraction involves a deeper excavation profile within the reservoir basin compared to the Feasibility Study's balanced approach. This design modification, visually represented in Figure 3:2 below, allows for the targeted removal of significant gravel volumes. While excavating to greater depths inherently increases the unit cost of excavation due to factors such as increased haul distances and potentially more complex excavation techniques, these additional costs are anticipated to be offset, and indeed exceeded, by the revenue generated from the sale of the extracted gravel.

Beyond the direct costs and revenues associated with gravel extraction, the revised, deeper excavation design also yields a notable construction saving. By excavating a larger volume of material from the reservoir basin (to access the gravel), the revised design allows for the construction of lower

bunds, resulting in a reduced footprint for both the bund and the overall reservoir area, and consequently, a lower cost for bund construction. This reduction in the necessary fill volume translates into a direct cost saving in the overall earthworks budget, which we term the "earthworks offset."

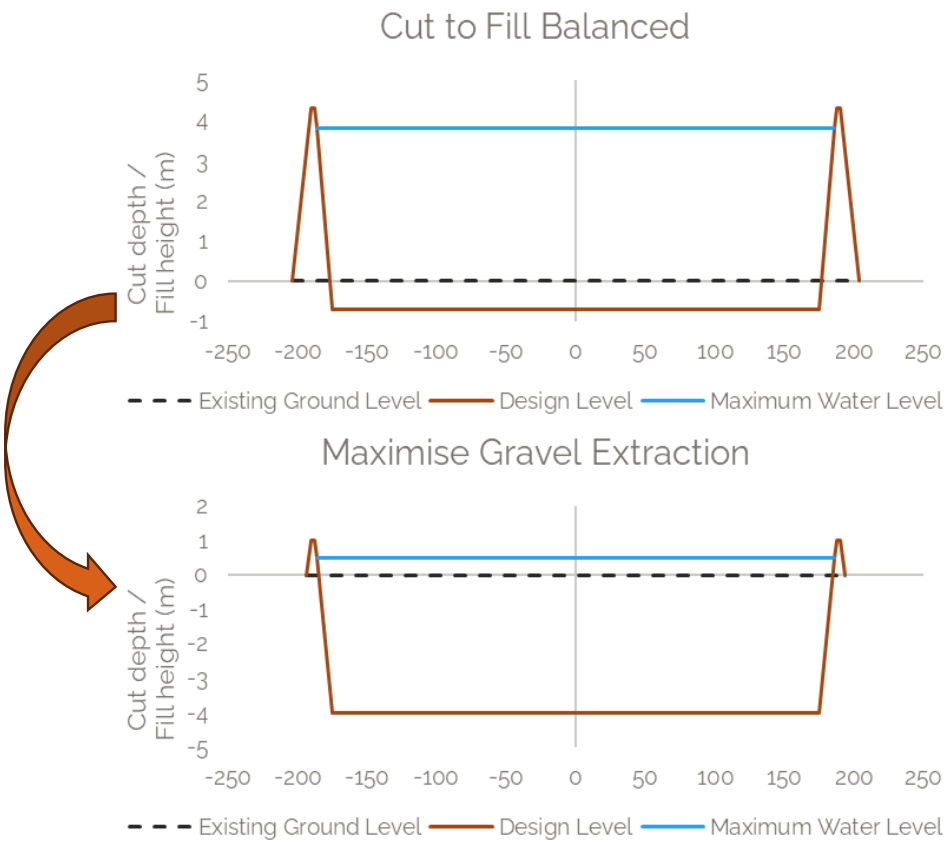

Figure 3:2: Comparison of Reservoir Excavation Profiles - Balanced Cut to Fill vs. Gravel Extraction Design

Gravel Extraction Cost Assessment:

The economic analysis incorporates several cost components associated with gravel extraction based on industry consultation:

- **Extraction and On-site Transport:** A per-gravel-cubic-meter cost of $14.50 is applied to account for the physical removal of the material from the reservoir area and its transportation to an on-site stockpile. This cost is assumed to be consistent across all extraction volumes.
- **Processing:** A per-cubic-meter processing cost of $20.70 is applied to the estimated volume of gravel to prepare it for sale. This cost is also assumed to be consistent across all gravel volumes.
- **Storage and Transport (Off-site):** This cost component could vary depending on whether there is demand for gravel at the time it is extracted. On-site storage is assumed for all options incurring a per-cubic-metre storage cost of $2. However, for Option B and Option B Staged, unless the gravel can be sold as it's extracted, there may be a point where the extracted volume will exceed the space available on-site, at which point gravel will need to be transported and stored offsite at a cost of $10 per cubic metre.

The total cost of gravel extraction for each option and stage is calculated by multiplying the respective gravel volumes by the corresponding per-unit costs above and summing these components.

Revenue Projection:

Potential revenue is projected based on an assumed sale price per cubic meter of gravel of $43. This sale price is influenced by factors such as market demand, gravel quality, and the scale of the operation.

The total revenue for each option and stage is calculated by multiplying the estimated gravel volume by the assumed sale price.

Profit Calculation:

The potential profit for each extraction option and stage is determined by subtracting the total costs from the total revenue. This provides a preliminary indication of the financial viability of each scenario.

Assumptions Underlying the Analysis:

The economic assessment is based on several key assumptions:

- The estimated gravel percentages (70%) are accurate.
- The per-cubic-meter costs for extraction, on-site transport, and processing are consistent with the estimates provided.
- The assumed sale price per cubic meter of gravel is achievable in the relevant market.
- Gravel can be sold as it is extracted such that offsite storage is not required.

Table 3-6 summarises the financial implications of incorporating gravel extraction into the reservoir design. It presents the initial estimated construction cost using the balanced 'Cut to Fill' approach from the feasibility study, the cost reduction achieved in earthworks due to the revised, deeper excavation (the 'earthworks offset'), and the projected profit from gravel sales for each development option. This table allows for a direct comparison of the potential financial impact of integrating gravel extraction into the project.

Table 3-6: Gravel Extraction Cost and Revenue for each option

Cost/Benefit	Option A	Option B	Option B Staged
Base Estimate (Cut to Fill approach)	$25,300,000	$42,100,000	$42,100,000
Earthworks Offset	-$ 2,346,000	-$2,346,000	-$2,346,000
Gravel Extraction Cost	$ 11,482,000	$23,033,000	$23,033,000
Gravel Revenue	-$13,272,000	-$26,624,000	-$ 26,624,000
Gravel Profit	-$1,790,000	-$3,591,000	-$3,591,000

Next Steps:

This analysis is based on preliminary estimates for the purposes of this business case. The future pre-implementation phase provides an opportunity to refine these assumptions and provide a more robust assessment of the economic viability of gravel extraction. This could include further geotechnical analysis, detailed cost quotations, comprehensive market research, and an evaluation of logistical and environmental considerations.

3.5.3 Irrigation Benefits

3.5.3.1 Irrigation Demand Analysis Summary

To evaluate the potential value proposition of providing irrigation water from the proposed reservoir, Perrin Ag Consultants Ltd (Perrin Ag) conducted an irrigation demand analysis for three representative agricultural land use change scenarios within the Taratahi Water Race's target catchment. Their report is attached as **Appendix B**. This section provides a summary of their key findings.

The PerrinAg analysis explored the economic impacts of transitioning existing dryland operations to irrigated systems for the following land uses within the 10,717-hectare target catchment are:

- **Dryland Dairy to Irrigated Dairy:** A scenario examining the conversion of a portion of the catchment's 3,420 hectares of dryland dairy, specifically modelling a 150-hectare platform (e.g. 115 hectares irrigated, 35 hectares remaining dryland).
- **Dryland Arable to Irrigated Arable:** An assessment of converting a portion of the catchment's 1,460 hectares of dryland arable land, focusing on a 60-hectare barley grain operation with winter lamb finishing.
- **Dryland Sheep and Beef to Irrigated Viticulture:** An evaluation of converting a small portion of the catchment's 3,916 hectares of dryland sheep and beef farmland to a 10-hectare Pinot Noir grape vineyard, representing the catchment's existing 2% viticulture land use.

The core of the PerrinAg analysis involved forecasting the change in operating profit (EBIT) for each land use scenario following the introduction of irrigation and/or land use change, relative to the necessary additional capital investment. This allowed for the determination of the potential return on investment for irrigators.

Key Findings:

- **Dairy:** The transition from dryland to irrigated dairy was projected to increase operating profit by $1,980/ha (before water charges), from a baseline of $1,861/ha to $3,546/ha. With an average additional capital investment of $6,480/ha (or $7,700/ha for the irrigated portion), this yielded a 26% return on investment before water costs. Factoring in an estimated annual irrigation water requirement of 3,910 m^3/ha and a water charge of $0.30/$m^3$, the additional operating profit decreased to $785/ha, equating to a 12.1% return on the additional capital.
- **Arable:** Irrigating dryland arable land was forecast to increase operating profit by $861/ha (before water charges), from $1,170/ha to $2,031/ha. The additional capital investment for irrigation infrastructure was estimated at $6,433/ha, resulting in a 13.4% return on investment before water costs. With an estimated annual water requirement of 4,940 m^3/ha for a 9.0 t/ha barley yield, a water charge below $0.05/$m^3$ would be necessary to achieve a 10% return on the irrigation investment, highlighting the sensitivity of this land use to water costs.
- **Viticulture:** Converting dryland sheep and beef to irrigated Pinot Noir viticulture showed the most significant increase in operating profit, by $2,930/ha (before water charges), from $509/ha to $3,439/ha. However, the high capital investment for vineyard development ($97,000/ha) resulted in a relatively low 3.0% return on investment before water costs. With an estimated annual water requirement of 1,150 m^3/ha and a water charge of $0.30/$m^3$, the return decreased slightly to 2.7%. The lower water demand in viticulture mitigated the impact of water charges on profitability, but the overall return on the significant capital outlay remained modest, suggesting limited potential for widespread land use conversion to Pinot Noir based solely on irrigation provision.

3.5.3.2 Water Availability and Irrigation Potential: Impact of Baseflow Conditions and Reservoir Capacity

The feasibility of irrigation from the reservoir is significantly influenced by the available water, which in turn is dependent on seasonal inflows and baseflow conditions, particularly during the critical summer irrigation period. Analysis of the water balance, evolving from average climate scenarios to a more conservative 90th percentile dry year, highlights the variability in water availability. This conservative approach, coupled with an upward revision of estimated water losses to 45%, aims to ensure a secure water supply for on-farm participation, even in drier years.

The water balance modelling also incorporates an assumed summer baseflow or storage recharge rate of 100,000 m^3/month. This assumption is crucial in determining the net available water for irrigation after accounting for primary inflows, water losses, and essential process water use.

Given the inherent variability and the need to ensure reliability, the lower end of the irrigation range (0 hectares) represents a scenario where summer baseflow is insufficient to significantly supplement stored water after accounting for losses and process water use. This conservative interpretation is crucial for risk management and ensuring that irrigation commitments can be met even under unfavourable climatic conditions.

Visualised in Figure 3:3, the seasonal dynamics of water availability are evident. Excess water during the winter and spring months allows for reservoir storage accumulation. However, during the summer irrigation season (December to March), this stored water is drawn down to supplement the significantly reduced excess water and meet irrigation demands, alongside a relatively constant industrial process water requirement.

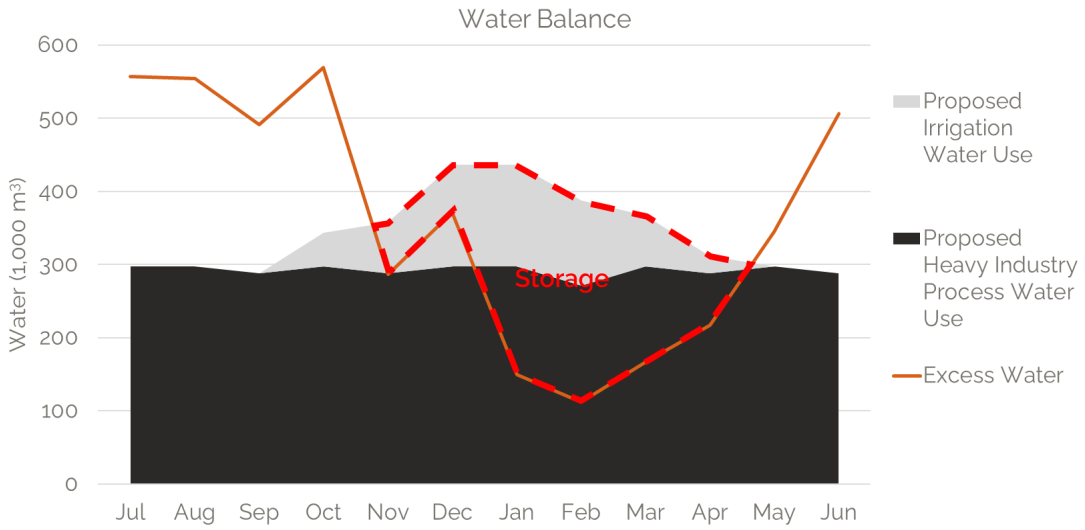

Figure 3:3: Illustrative Monthly Water Balance[27]

Building upon the irrigation demand analysis, the project team, utilising the project's water balance model, calculated the potential irrigable dairy land area under different storage options. Its findings indicated that Option A, with a capacity of 500,000 m^3, could potentially irrigate between 0 and 190 hectares of dairy farmland depending on summer baseflow conditions, resulting in an average annual irrigation water supply ranging from 0 to 700,000 m^3. Increasing the storage capacity to 1,000,000 m^3 under Option B allows for a greater irrigation potential, ranging from 0 to 295 hectares of dairy

[27] The graph is intended to demonstrate the concept of a monthly water balance and the interplay of its components using example data, rather than representing specific results

farmland, with a corresponding average annual irrigation water supply of 0 to 1,200,000 m^3 (see Table 3-7). This calculation focused on the dryland to irrigated dairy scenario due to its demonstrated stronger ability to absorb water charges and generate a reasonable return on investment, making it the most economically viable large-scale irrigation demand within the considered land uses. The wide range in irrigable area reflects the sensitivity of the water balance model to various input parameters.

Table 3-7: Option Comparison: Storage and Irrigation Capacity

Scenario	Storage	Summer Baseflow	Irrigation Area	Average Irrigation Water Supplied (m^3/yr)
Option A	**500,000 m^3**	100,000 m^3/month	0 ha	0 m^3/yr
		(0 – 300,000 m^3/month)	(0 – 190 ha)	(0 – 700,000 m^3/yr)
Option B	**1,000,000 m^3**	100,000 m^3/month	100 ha	400,000 m^3/yr
		(0 – 300,000 m^3/month)	(0 – 295 ha)	(0 – 1,200,000 m^3/yr)

The implications of these baseflow conditions are particularly pertinent when considering the potential irrigation areas under different storage options. The conservative approach adopted in the water balance model, prioritising a secure supply even in dry years, necessitates a cautious interpretation of the irrigation potential under Option A. Therefore, while Option A technically presents a potential irrigable area of up to 190 hectares in more favourable baseflow scenarios, a prudent approach for this business case, particularly in the financial modelling, requires acknowledging the possibility of a zero irrigable area under more constrained baseflow conditions. This highlights the greater resilience and irrigation security offered by the larger storage capacity of Option B.

3.5.3.3 Water Revenue

Water revenue from irrigation is calculated by multiplying the average irrigation water supplied by the proposed water charge for the Dairy scenario of \$0.30/m^3. Irrigation water is assumed to be available and utilised across all irrigated hectares from year 2 of the analysis period. Water revenue from irrigation for each option is presented in *Table 3-8*.

Table 3-8: Water revenue from Irrigation for each option

40-year cost/benefit	Option A	Option B	Option B Staged
Irrigation benefit (undiscounted)	\$ -	\$4,680,000	\$3,720,000

3.5.3.4 Land Value Uplift from Irrigation and Agglomeration Benefits

The provision of irrigation water can lead to a significant increase in land values, representing an additional economic benefit. Other similar irrigation schemes have highlighted that the conversion of land to more productive uses, such as horticulture, can drive substantial land value uplift. Some of these schemes have indicated that land values in the relevant command area may have increased as result of having access to water from \$30,000/ha to \$115,000/ha - an uplift of \$85,000/ha.

Whilst similar economic benefits could accrue from the project, they have not been monetised for this business case due to uncertainty regarding the potential for irrigation. However, potential value uplifts from irrigation could be explored further at a later stage in the project if desired.

Beyond the direct impact on land values, the project offers the potential for agglomeration benefits. The co-location of water-dependent industries in the undeveloped portions of the industrial park, coupled with the availability of irrigation for surrounding rural land, can foster synergistic economic activity. This clustering of related businesses and enhanced agricultural productivity can lead to increased efficiency, innovation, and overall regional economic growth. These wider economic benefits, while significant, are indirect and will not directly impact the project's financial cash flows or payback period.

3.5.4 Environmental Benefits

The development of a reservoir within the existing water race network presents a range of potential environmental benefits and disbenefits. While a full quantification of these impacts is beyond the scope of this business case assessment, a qualitative description provides valuable insight into the project's potential environmental implications.

Potential Environmental Benefits:

The reservoir offers opportunities for controlled water storage and regulation, particularly beneficial during dry periods, and the potential to buffer peak flows within the water race network. It can also act as a settling basin, improving water clarity if the water races carry turbid water, and may offer limited nutrient reduction. The creation of a new aquatic habitat, along with potential wetland development at the reservoir margins, can support diverse species. If managed appropriately, it can enhance fisheries and provide habitat for wildlife. Additionally, reservoirs can contribute to carbon sequestration and provide various ecosystem services within their local area.

Potential Environmental Disbenefits:

Conversely, the project may lead to increased water demand and extraction, potentially reducing downstream flows and creating water allocation conflicts. Increased evaporation is also a concern. The reservoir could experience water quality degradation through stratification, algal blooms, sedimentation, and increased contaminant concentration. Habitat loss and fragmentation are potential disbenefits, as is the inundation of terrestrial habitats and disruption of fish migration. The reservoir's construction and operation could also contribute to greenhouse gas emissions, particularly methane. Furthermore, changes to nutrient cycling, the introduction of invasive species, and alterations to local micro-climates are potential ecosystem disruptions.

Qualitative Assessment:

A preliminary qualitative assessment suggests that the balance between benefits and disbenefits is context dependent. Controlled release for critical needs, water quality improvement for severely degraded waters, and habitat creation in degraded landscapes are scenarios where benefits may outweigh disbenefits. Conversely, increased water demand for non-essential uses, significant downstream impacts, habitat loss of high-value ecosystems, and high GHG emissions are likely to result in disbenefits outweighing benefits.

Next Steps:

This qualitative assessment provides a foundational understanding of the potential environmental impacts. An environmental impact assessment (EIA) is recommended for the next stage of the project. This assessment will enable the quantification of these benefits and disbenefits, allowing for a more detailed analysis and the development of appropriate mitigation measures. It will also be important to engage with stakeholders, including environmental groups, local communities, and water users, to ensure that all perspectives are considered in the project's long-term sustainability planning.

3.5.5 Recreational Benefits

This section outlines the potential recreational benefits associated with the proposed water reservoir. It is important to note that this is a preliminary assessment, and a more comprehensive recreational economic viability study could be conducted in the future if desired.

Potential Recreational Options:

Several recreational options have been identified for the Site, ranging from active water-based activities to passive land-based amenities. These options include:

- Water-Based Activities (Subject to Water Quality):
  - Initial investigations have indicated that the water within the reservoir, sourced from the water race network, is unlikely to be of a suitable standard for swimming without significant water treatment. Therefore, options that involve direct immersion, such as swimming, wakeboard parks, and inflatable waterparks, are considered unviable. However, should water treatment be considered, these options could be re-evaluated.
  - Alternative water-based activities that minimise direct contact, such as kayaking, sailing, and remote-controlled boating, are still viable options.
  - Trout fishing tourist activities.
- Land-Based Activities:
  - A golf driving range / hole-in-one challenge (like the one at Lake Taupō).
  - Nature trails and hiking paths, including cycling trails.
  - Bird watching and wildlife viewing areas.
  - Picnic and BBQ areas.
  - Outdoor event spaces.
  - Dog walking park.
- Industrial Staff Amenity:
  - There is the potential for the Site to provide a valuable amenity for staff working in nearby industrial areas.
  - A well-designed boardwalk-style path around the reservoir, incorporating native planting and seating areas, could create a pleasant environment for walking, taking breaks, and enjoying lunch.
  - This would offer a significant improvement in the quality of the local industrial environment, and contribute to staff well-being, adding additional benefits to the project.

Next Stage Considerations:

Future investigations could involve:

- Detailed market research to assess the demand for each recreational option.
- A cost-benefit analysis of recreational options, including capital and operating expenses. Part of this will include health and safety requirement costs to maintain safe operation of the water storage facility whilst also enabling access for recreation.
- An assessment of the potential economic impact on the local tourism industry.
- A deeper investigation into the water quality, and the costs associated with water treatment.
- Consultation with local stakeholders and community groups.

This will provide a more robust understanding of the economic viability and potential benefits of each recreational option.

3.6 CONSOLIDATED ECONOMIC RESULTS

Table 3-9 presents a consolidated summary of the economic results for the three development options (Option A, Option B, and Option B Staged) over a 40-year cost-benefit analysis period. It details the key cost components, including CAPEX, OPEX, and gravel extraction costs, alongside the identified benefits, such as irrigation benefits, industrial park water revenue, industrial land value uplift, economic multiplier effects, and revenue from gravel sales. The table culminates in the NPV of both costs and benefits, and the resulting BCR for each option, providing a clear overview of their potential economic viability.

Table 3-9: Economic analysis results for the three options

40-year NPV	Option A	Option B	Option B Staged
CAPEX	$ 22,172,000	$37,774,000	$32,712,000
OPEX (40 years)	$14,901,000	$23,255,000	$19,592,000
Gravel Extraction Cost	$11,482,000	$23,033,000	$23,033,000
Total NPV Costs	**$48,555,000**	**$84,062,000**	**$75,338,000**
Irrigation benefit	$ -	$2,260,000	$1,483,000
Industrial Park Water Revenue	$ 56,486,000	$56,486,000	$ 56,486,000
Industrial Land Value Uplift	$1,395,000	$1,395,000	$1,395,000
Industrial Park Economic Multiplier	$29,357,000	$29,357,000	$29,357,000
Gravel revenue	$ 12,762,000	$25,600,000	$21,728,000
Total NPV Benefits	**$99,999,000**	**$115,098,000**	**$110,448,000**
BCR (NPV Benefits / NPV Costs	**2.1**	**1.4**	**1.5**

3.6.1 Sensitivity Analysis

The sensitivity tests presented in Table 3-10 are designed to provide a high-level assessment of the project's economic viability under various potential changes to key assumptions underpinning the BCR calculations. By adjusting the NPV of costs, the NPV of benefits, and the discount rate, these tests examine how the BCRs for the options might change under different scenarios. These sensitivity scenarios are designed to cover variability in the following:

- The price of water for industrial and irrigation uses.
- Industrial land value uplift lower than modelled.

- Zero change in additional jobs in the industrial area (and therefore zero economic impact).
- An increase in water storage facility costs.
- No onsite storage for gravel extraction.

A lower sale price for gravel.Table 3-10 summarises the BCR for a 40-year cost-benefit analysis under these different sensitivity scenarios, providing insight into the robustness of the economic case to variations in the initial assumptions.

Table 3-10: Sensitivity Tests

40-year cost/benefit	Option A	Option B	Option B Staged
25% higher cost	1.6	1.1	1.2
6% Discount Rate	1.4	1.0	1.1
25% lower benefits	1.5	1.0	1.1
25% higher benefits	2.6	1.7	1.8

3.7 RECOMMENDED OPTION

The recommended option is Option A, to construct a 500,000m^3 reservoir to provide seasonal water storage for the Waingawa Industrial Park and for irrigation within the Taratahi Water Race Command Area. Importantly, this option allows for future staging, with the potential to incrementally expand the reservoir to a total capacity of 1,000,000m^3 over time (i.e. Option B Staged).

Overall, the project is expected to enhance water resilience in the Wairarapa. An assessment of the recommended option against the Wairarapa Water Resilience Strategy's guiding principles[28] for water storage projects is provided in Table 3-11.

Table 3-11: Assessment against the Wairarapa Water Resilience Strategy's Guiding Principles

Wairarapa Water Resilience Strategy's Guiding Principles	Remarks and Alignment
Equity *The load of improving resilience needs to be widely shared across the whole community, though not necessarily equally in terms of geography, seasons or use type.* *Access to water and the benefits of resilience need also to be widely shared. This includes rural and urban communities, enterprises and industries.*	The project will enable enhanced seasonal water availability to all potential water users that can use it to generate revenue, within the Command Area. This is considered appropriate given the non-potable water source and limited urban uses. It is expected that the communities within the Wairarapa will share in the wider economic benefits to the region. Alignment Assessment: **Medium - Excellent**

[28] Wairarapa Water Resilience Study, 2021, Section VII, Chapter 11: Principles and preferences, page 87

Wairarapa Water Resilience Strategy's Guiding Principles	Remarks and Alignment
Natural resilience *Any measures taken need to blend natural and constructed solutions. There needs to be a strong emphasis on the enhancement of ecosystems that support natural resilience – that is, the capacity of the environment to renew and sustain itself. This includes ideas such as natural character and indigenous biodiversity. On the other hand, towns are an artificial concentration of people requiring specific, predominantly constructed, solutions.*	The Project does not include ecosystem development at the water storage site. However, it's location and function protect existing ecosystems and biodiversity in the Waingawa River. This is achieved by maximising winter water takes, to provide water to support economic development, without putting additional pressure on summer water flows, which are more critical for ecological health. In addition, the "offline" construction will result in minimal disruption to ecosystems developed in the Taratahi Water Race Scheme. Alignment Assessment: **Medium**
Mauri *The integrity of the water as water is vital to Māori. The gradually restoration and protection of the mauri of Wairarapa water is both a principle and an objective.*	For *mauri* to be truly upheld, the project would need to demonstrate a commitment to not only water quantity but also water quality and the broader health of the ecosystem, as the "integrity of the water as water" is paramount. This requires a deep understanding of Māori values and a genuine partnership in decision-making to ensure the project contributes to the gradual restoration and protection of the *mauri* of Wairarapa water, rather than diminishing it. By optimising water availability within existing environmental constraints (set by the water take consent conditions), the Project prioritises the mauri of the Waingawa River in low flow times. However, wet industry (enabled by the water storage) is reasonably expected to produce higher volumes of industrial wastewater. This will require close management to ensure that water quality objectives and cultural aspirations to restore mauri are achieved before it is returned to the environment. Enabling on-farm intensification via irrigation of pastoral land will result in increased aquifer recharge. But also, increased aquifer contamination by nitrates and potentially other leachable parameters. On-farm practices that promote sustainable use of nutrients and minimise nutrient losses should be enables and promoted. Alignment Assessment: **Medium**

Wairarapa Water Resilience Strategy's Guiding Principles	Remarks and Alignment
Prosperity *Actions that might emerge from the Strategy need to be measured with regard to contribution to community prosperity and the viability of businesses and enterprises, mindful of other principles such as equity and natural resilience.*	The BCR for the project is above 1, indicating that the project is economically viable. Local benefits will arise from new industries relocating to the Waingawa Industrial Park, along with secondary benefits such as job creation, environmental improvements, and enhanced recreational opportunities. Land values are also expected to increase. **Alignment Assessment: Excellent**
Value *The focus of the use of water needs to be on best value, though value needs to be assessed not just in economic but social and cultural terms.*	The project promotes more efficient use of water by storing excess water available under an existing resource consent during periods of low demand. This stored water will later be used to support economic activities - such as additional industry and irrigation - which, in turn, will contribute to local job creation. **Alignment Assessment: Excellent**
Knowledge *Increasing and improving our knowledge and understanding of water and water resilience where knowledge includes scientific and cultural understanding such as Matauranga Māori. This includes public understanding of water resilience through information and education.*	The preferred option could present an opportunity to educate the local community about sustainable and resilient water systems, how water supply for industry in their community is impacted by climate change and solutions, like this project, that are being put in place to mitigate these effects. **Alignment Assessment: Medium**
Reliability/consistency *Contemporary urban communities and farming enterprises rely heavily on reliability and consistency of the availability of water. The importance of this principle is increasing, while reliability, as a result of climate change, is abating. The gap is widening.*	The preferred option mitigates the impact of seasonal availability of water by providing a more reliable year-round supply of water to local communities. **Alignment Assessment: Excellent**

Wairarapa Water Resilience Strategy's Guiding Principles	Remarks and Alignment
Multiple solutions *No one solution is going to do the job. Multiple solutions add a security factor in that where one fails or partially succeeds, another might succeed. This principle also draws on the collective effect of multiple interventions which might act as multipliers of each other.*	The preferred option represents one potential "solution" within the "Multiple solutions" objective of the Wairarapa Water Resilience Strategy. By providing a stored water resource, it offers a buffer against drought and low flow conditions, contributing to the overall water management toolkit for the region. A key opportunity lies in strategically integrating the project within a broader portfolio of water resilience solutions. To fully realise the "Multiple solutions" objective, future efforts should focus on actively developing and implementing complementary approaches that directly enhance the benefits of the facility. This includes investing in and promoting water efficiency measures for those utilising water from the storage, exploring the potential of the facility to support the diversification of water sources, and supporting land management practices within the catchment that can improve the quality and longevity of the stored water. **Alignment Assessment: Medium**
Rural and urban as one *Water resilience applies in both rural and urban areas and is a challenge in both settings. Solutions are favoured that add value in both settings.*	The preferred option's site, whilst set in a rural area, offers a connection to urban resilience by promising improved water security for businesses in the Waingawa Industrial Park. A reliable water supply offers potential synergies between irrigated rural land and the industrial area, such as supporting the establishment or expansion of meat and dairy processing plants within the industrial park. This direct link between rural agricultural output and urban economic activity creates an agglomeration effect, where the success of one sector bolsters the other, and fosters a more integrated and resilient regional economy. **Alignment Assessment: Excellent**

4 Financial Case

The purpose of the Management Case is to describe likely revenue generation, capital and operational costs of the recommended option.

4.1 CAPITAL AND OPERATIONAL COSTS

The capital expenditure (CAPEX) and operational expenditure (OPEX) for the options, as determined by the completed economic case analysis, are as follows:

Cost Category	Option A	Option B	Option B Staged
Water Reservoir CAPEX	$22,172,000	$37,774,000	$37,774,000
OPEX (40 years)	$30,372,000	$47,539,000	$43,939,000
Gravel Extraction	$11,482,000	$23,033,000	$23,033,000

Water reservoir costs encompass the construction of the reservoir(s) and the ongoing operational requirements for water treatment and distribution to the industrial park. A breakdown of CAPEX cost estimates for each option are presented in **Appendix C.**

4.2 EXPECTED REVENUE

The primary revenue streams for the project, as identified in the economic case, are:

- **Water Revenue (Industrial Use):** Revenue is generated from the sale of water to wet industries within the developed industrial park.
- **Revenue from Irrigation:** Revenue is generated from the sale of water for agricultural irrigation purposes.
- **Revenue from Gravel Extraction:** Revenue is generated from the extraction and sale of gravel from the reservoir site (for the "Gravel" inclusive options).

Other potential benefits and wider economic benefits include:

- **Industrial land value uplift:** Quantifiable uplift in land value because of shifting the remaining undeveloped industrial land from dry to heavy water use industry (included in the economic model).
- **Economic multiplier (industrial park):** Quantifiable direct and indirect benefits of increased jobs in the industrial area doe to wet industry (included in the economic model).
- **Irrigation land value uplift and increased employment on rural land:** Potential direct and indirect benefits of intensification and diversification from the addition of irrigation to nearby rural land (potential to be quantified at a later stage).
- **Revenue from recreational use:** Revenue could be generated from user fees, licenses, or concessions related to recreational facilities developed at the reservoir site.
- **Environmental benefits:** There is the potential to quantify environmental benefits at a later stage.

4.3 BENEFICIARY PAYS APPROACH AND PROPOSED FUNDING SOURCES:

This section outlines a proposed *beneficiary pays* approach for funding the project. Under this model, costs are allocated to those who directly or indirectly benefit, ensuring financial responsibility is aligned with the advantages gained. Identifying and quantifying these benefits is crucial to developing a fair and sustainable funding model.

Beneficiaries and Funding Contributions:

The key beneficiaries of the project and their associated funding contributions are:

- **Council and Ratepayers:** Benefit from enhanced regional water security, economic growth, and potential land value uplift. Funding would come through council rates, the base water charge, and revenue from water sales to users.
- **Industrial and Irrigation Users**: Benefit directly from a secure and reliable water supply, enabling business growth and profitability. They would contribute through connection fees and usage charges.
- **Wider Economy**: Gains from indirect benefits such as job creation, economic multipliers, and broader land value increases. These benefits are not directly charged for but are considered when assessing the project's overall economic value.

Funding Sources:

The anticipated funding sources aligned to the beneficiaries are:

- Revenue from water sales to industrial and irrigation users (collected by CDC).
- Council ratepayer contributions through targeted rates or general rates funding the core water supply infrastructure.[29]
- A potential low-interest loan from MBIE's RIF, with repayments integrated into CDC water charges.
- User fees from recreational users, if applicable.

Revenue and Benefit Flows:

- Water sales revenue is collected by the council from industrial and irrigation users, supporting operational costs and loan repayments.
- Industrial and irrigation users realise business benefits from reliable water supply but do not receive direct revenue from the project.
- Broader economic benefits, such as job creation and land value uplift, accrue to the region as a whole.

Table 4-1 presents the proposed cost share based on the following assumptions

- 50/50 split of economic multiplier benefits between CDC and the wider economy.
- CDC ratepayers derive 100% of water rate revenue and 100% of gravel sale profits[30].

Further Considerations

- Potential purchase or lease agreement for the reservoir land will impact the cost share.
- The specific terms of any Regional Infrastructure Fund loan will influence the final funding model.

[29] There is the potential for Masterton and South Wairarapa District ratepayers to benefit from the increased availability of jobs and economic uplift for the region. The next phase should explore the potential of a cost share agreement between the three councils

[30] This assumes that CDC purchase the property at 145 Norfolk Road.

- The profitability of gravel extraction and the appropriate level of the landowner's premium water charge (if applicable) will need to be analysed in more detail.
- Long-term operational and maintenance costs must be factored into the financial model and fairly allocated across beneficiaries.

Adopting a beneficiary pays approach will ensure the financial burden of the project reflects the value received by each stakeholder, promoting fairness and long-term sustainability. The next step will involve detailed financial modelling to develop a robust funding strategy.

Table 4-1: Beneficiary cost share

Beneficiary	Option A	Option B	Option B Staged
Council Ratepayers	$73,141,000	$76,689,000	$72,039,000
Wider economy	$15,376,000	$15,376,000	$15,376,000
Total	$ 88,518,000	$92,065,000	$87,415,000
Percentage cost share	**Option A**	**Option B**	**Option B Staged**
Council Ratepayers	83%	83%	82%
Wider economy	17%	17%	18%
NPV Cost split	**Option A**	**Option B**	**Option B Staged**
Council Ratepayers	$40,121,000	$70,023,000	$62,086,000
Wider economy	$8,434,000	$14,040,000	$13,252,000

4.4 FORECAST COST/REVENUE PROFILE AND AFFORDABILITY:

The detailed year-by-year forecast of costs and revenues, forming the basis for the NPV and BCR calculations, demonstrates the projected cash flows for each development option over the 40-year project timeline. The affordability assessment, based on these projections, indicates the project's potential to meet operational costs, service potential debt obligations, and provide a return on investment.

It is important to note that all benefits that cannot be realised as cash in the economic analysis are not included in the projected cashflows. Figure 4:1 presents the projected cashflow for the three options.

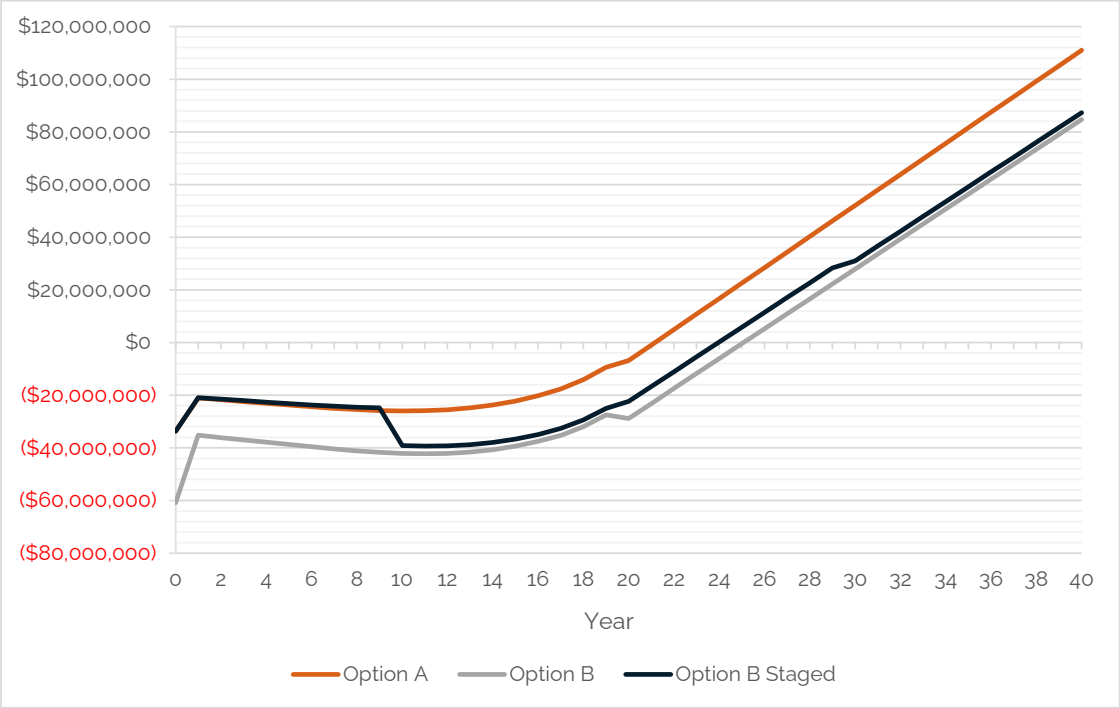

Figure 4.1: 40-year cashflow of each option

Table 4-2 below presents key financial metrics for each project option, highlighting the significant upfront investment required to initiate the reservoir development. Given the scale of these initial outlays, particularly for Option B and Option B Staged, external funding, such as a low-interest loan from the RIF or similar sources, will be crucial to bridge the gap between initial expenditure and the realisation of revenue streams. The *Initial Funding Requirement* represents the maximum negative cumulative cash flow, indicating the peak funding needed. It's worth noting that the cost estimates include a 50% contingency, suggesting a potential opportunity for actual costs to be lower, which would improve the financial metrics.

The *Payback Period* is a critical metric, indicating the time required to recoup this initial investment. Several factors could affect the actual payback period, introducing potential risks. Delays in the Waingawa Industrial Park development or slower-than-projected uptake of irrigation water could push revenue generation further into the future, extending the payback period. Conversely, fast-tracking the development of the industrial park could accelerate revenue generation and shorten the payback period. To mitigate risks related to revenue, strategies such as phased development (as explored in Option B Staged) and securing firm commitments from key industrial water users could be employed. Furthermore, robust contract terms for gravel extraction and proactive management of construction costs are essential to maintain the projected financial timeline and improve the payback period.

Table 4-2: Affordability and cashflow metrics for each option

Financial Metric	Option A	Option B	Option B Shared
Initial Funding Requirement	-$33,654,000	-$60,808,000	-$33,654,000
Total Funding Requirement	-$38,594,000	-$69,150,000	-$52,035,000
Payback Period	22 years	26 years	24 years
Internal Rate of Return	3%	-1%	1%
Total net profit (undiscounted) at 40 years	$110,986,000	$84,698,000	$87,257,000

While all options demonstrate strong long-term revenue potential, the significant upfront capital requirements, extended payback periods, and relatively low internal rates of return (IRRs) mean that securing external funding support will be critical to project delivery. As shown in Table 4-3, substantial capital and operating expenditure is required across all options, particularly for Options B and B Staged. Combined with long payback periods and modest IRRs, this reinforces the need for a low-cost financing solution, such as a RIF loan, to bridge the early funding gap.

Securing appropriate funding will be essential not only to manage early cashflow pressures but also to enhance overall project affordability and financial resilience. A detailed funding and financing strategy will be developed for the next project to confirm the best approach for progressing the preferred option.

Table 4-3: Funding/financing required for each option

	Option A	Option B	Option B Shared
Capital expenditure	$22,172,000	$37,774,000	$37,774,000
Operating expenditure	$30,372,000	$47,539,000	$43,939,000
Total expenditure	$52,544,000	$85,313,000	$81,714,000
Revenue	$163,530,449	$170,011,465	$169,051,465
Capital required	-$38,594,000	-$69,150,000	-$52,035,000

4.5 SUMMARY

The economic and financial case for the project demonstrates its significant long-term economic viability. The project is projected to deliver substantial benefits to the region, including increased industrial output, enhanced agricultural productivity, and regional economic growth. These benefits, quantified through the cost-benefit analysis, confirm the project's potential to generate a positive return on investment and contribute to the Wairarapa's economic resilience.

However, the analysis also highlights substantial upfront costs, posing significant affordability challenges for the project and / or CDC. The capital expenditure required for reservoir construction necessitates external funding support to ensure the project's progression.

In this context, securing co-investment from the RIF to undertake further design/investigations will be important. RIF funding would alleviate the short-term financial burden on the CDC for design / investigations, making the project feasible to initiate. While the long-term revenue streams from water sales and other sources are projected to ensure the project's financial sustainability, RIF support is essential to address the short-term affordability gap.

5 Commercial Case

The commercial case outlines the following:

- The scope for the design and construction phases of the recommended Option A (500,000 m3 reservoir).
- The proposed procurement arrangements for the pre-implementation and implementation phases.
- The key recommendations for consenting.

5.1 INVESTIGATION AND DESIGN SCOPE

The key design scope elements for the preferred option are as follows:

- Geotechnical design and associated investigations to inform site-specific embankment dimensions with appropriate resilience to earthquake loading, settlement, hydraulic pressures.
- Civil design and associated investigations of the 500,000 m3 HDPE lined earthen lagoon/s.
- Civil and waters design and associated investigations of the:
  - Fill rate and intake from the Taratahi Water Race Scheme.
  - Discharge rate and outlet from the water storage to the Taratahi Water Race Scheme.
  - Reticulation to the Waingawa Industrial Estate.
- Potential civil design and associated investigations of culverts or open drains to increase conveyance capacity through key sections of the Taratahi Water Race that may be required to maximise intake and/or distribution.
- Potential civil/mechanical/electrical design of a pumpstation at the intake or outlet as required.

5.2 LIKLEY CONSENTING REQUIREMENTS

5.2.1 Key Consenting Issues

The key consents identified for the project to date are as follows:

- Earthworks consent.

  Noting the site is not identified as HAIL, but there is potential for the earthworks management and consenting complexity to increase if site specific investigations identify contaminated land.
- Building consent and/or dam consent (depending on the embankment height).
- Land use.

Other key issues include:

- A full planning assessment and strategy for the project has not been completed, it is possible that other consents may be triggered by the Project.
- Public notification of resource consent applications, which may extend the project timeline.

A related consenting issue is the timing of when CDC's new resource consent for the Taratahi Water Race will be obtained. It is also noted that individual farmers may require resource consents if they choose to intensify their existing land uses if they decide to use water from the project.

5.2.2 Recommendations

It is recommended that a consenting strategy be developed for the project as a matter of priority.

5.3 IMPLMENTATION PROCUREMENT RISKS AND OPPORTUNITIES

At this stage, several notable procurement-related risks and opportunities have been identified for the implementation phase:

Risks:

- Limited availability of contractors to undertake construction within a short timeframe.
- Potential difficulty in sourcing the appropriately volume of HDPE liner within required timeframes. Noting, that this could be purchased by CDC as a Principal's supplied item to mitigate the risk of long lead times.
- Risk of CDC committing too early to a specific procurement model for the implementation phase, potentially resulting in reduced value for money.

Opportunities:

- Opportunity to retain the existing professional services supplier to support continuity and efficiency through the pre-implementation phase.

The pre-implementation and implementation phases of the project are expected to be delivered through CDC's standard traditional procurement processes.

5.4 OPERATIONAL PROCUEMENT

The procurement approach for maintaining and operating the reservoir has yet to be confirmed. However, the operating model will be further developed during the pre-implementation phase. It is anticipated that a trust or limited company will be established to take on responsibility for the operation and maintenance of the reservoir facility. In the interim, should it be necessary, CDC has the capacity to manage and operate the reservoir on a short to medium term basis.

The allocation of stored water via permits, the commercial collection of water rates etc will continue to be managed via the same commercial set up as the Taratahi Water Race.

6 Management Case

The purpose of the Management Case is to describe the arrangements to be put in place for the successful delivery of the project. It identifies who will be responsible for project delivery and how scope changes and risks will be managed.

6.1 PROJECT MILESTONES

The key project milestones are summarised below in Table 6-1.

Table 6-1: Project milestones

Task	Duration	Start	End	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25	Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26
Planning assessment and strategy	3 weeks	2-Jun-25	20-Jun-25	■														
Site investigations	6 weeks	2-Jun-25	11-Jul-25	■	■													
30% Design	5 weeks	30-Jun-25	1-Aug-25		■													
Hold Point 1 Client Review	2 weeks	4-Aug-25	15-Aug-25			■												
100% Design	8 weeks	18-Aug-25	10-Oct-25			■	■	■										
Hold Point 2 Client Review	2 weeks	13-Oct-25	24-Oct-25					■										
Resource Consent Application and Processing	12 weeks	18-Aug-25	7-Nov-25			■	■	■	■									
Hold Point 3 Client Review	2 weeks	10-Nov-25	21-Nov-25						■									
Building Consent Application	1 week	24-Nov-25	28-Nov-25						■									
Building Consent Processing	4 weeks	1-Dec-25	26-Dec-25							■								
Tender and Contract award	6 weeks	24-Nov-25	2-Jan-26						■	■	■							
Construction	35 weeks	2-Jan-26	7-Oct-26								■	■	■	■	■	■	■	■

6.2 GOVERNANCE AND MANAGEMENT ARRANGEMENTS

Figure 6:1 and Table 6-2 set out the governance and management arrangements for the project.

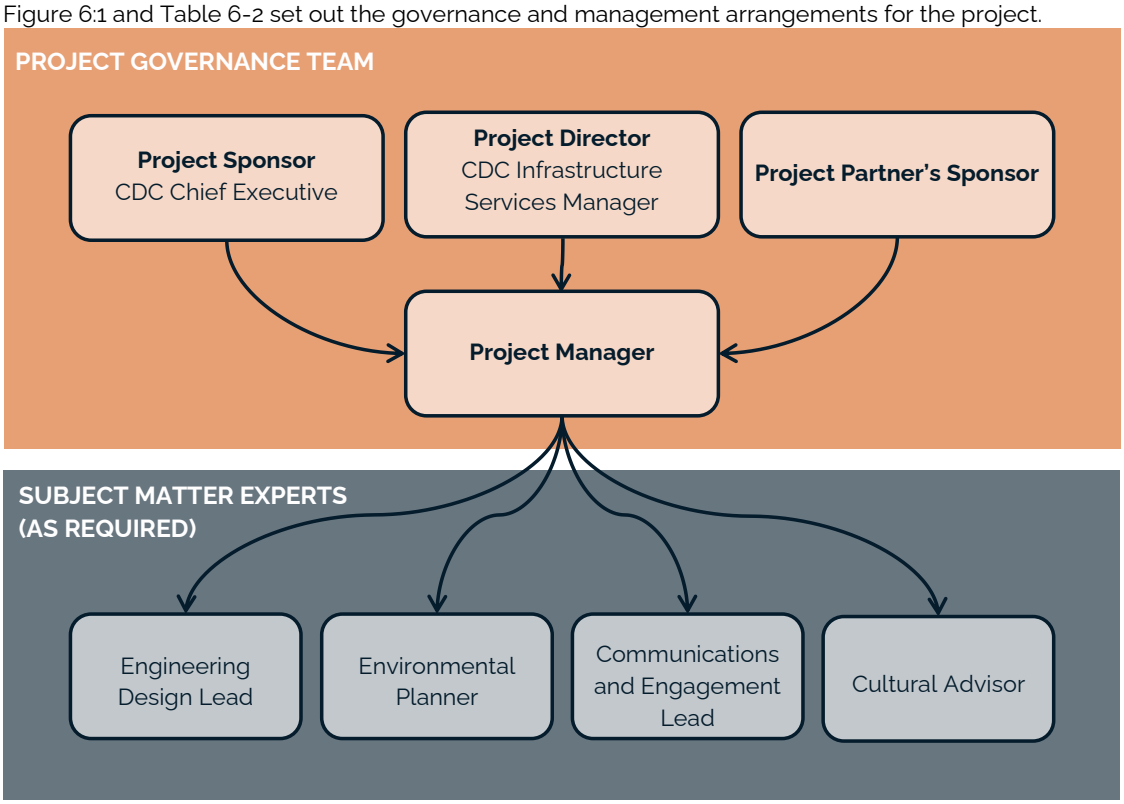

Figure 6:1: Project management arrangements

Table 6-2: Key roles and responsibilities for the project

Role	Responsibilities
Project Governance	CDC Policy and Project Committee.
Project Sponsor	CDC Chief Executive. Internal champion for the project. Assures ongoing alignment with agreed project outcomes.
Project Director (PD)	Infrastructure Services Manager. Will ensure the project is successfully delivered, providing the intended benefits and outcomes across the pre-implementation and implementation phases. Will also be responsible for reporting to Project Governance and Sponsor.
Project Manager	Responsible for day-to-day management of the project team and ongoing engagement with key stakeholders. Will ensure that all workstreams are supported and integrated to deliver the project successfully for the remaining project phases (this would include managing any scope change requests).
Other Subject Matter Experts (required from time to time)	• Environmental Planner (e.g. for consent advice). • Engineering Design Lead • Communications and Engagement Lead (e.g. project communications and engagement). • Cultural Advisor (i.e. assist with hapū engagement).

6.3 ISSUES MANAGEMENT

Key risks and issues for the project are expected to be managed through the *Waingawa Project Risk Register*. The Project Manager will be responsible for escalating all issues and risks to the Project Director as well as updating the risk register when required.

6.4 CHANGE CONTROL

Changes to the project scope will be the responsibility of the Project Manager. All changes will be recorded in the *Waingawa Change Control Register* by the Project Manager and reported to the Project Director as appropriate. The purpose of this register is to ensure that the interdependencies of any changes are managed appropriately. In general, any significant possible changes in the scope to the project, including adjustments to costs, programme and quality will be subject to the approval of the Project Director.

6.5 REPORTING ARRANGEMENTS

Reporting on the progress of the project will be the responsibility of the Project Director and Project Manager. Reporting is likely to involve updates on project progress, costs and risks. Reporting is likely to occur monthly.

6.6 COMMUNICATIONS AND ENGAGEMENT ARRANGEMENTS

Communications on the project will be led by CDC's Communications and Engagement Lead. It is expected that a fit-for-purpose Communications and Engagement Plan will be developed to cover the design and construction period. This Plan will be put in place in mid-2025.

It is noted that development of the Communications and Engagement Plan for the project will be premised on the International Association for Public Participation (IAP2) processes. Accordingly, any plan will include among other matters key communication and engagement activities / milestones, key stakeholders and engagement risks for the programme roll out.

6.7 KEY DELIVERY PROJECT RISKS

The Project Manager will be responsible for managing the risks. A detailed *Waingawa Project Risk Register* will be developed at the commencement of the pre-implementation phase.

To help inform future risk analysis the following high level risk register was identified and is summarised in Table 6-3 below.

Table 6-3: Key project delivery risks

Description	Likelihood	Consequence	Risk Rating	Mitigation	Residual Risk Rating	Owner
Pre-implementation phase funding may not be secured in a timely manner, leading to project delays.	Likely	Severe	High	Engage early with MBIE regarding potential resilience infrastructure funding. CDC to contribute to pre-implementation funding requirements	High	Project Director
The consenting process may become complex and take longer than anticipated, placing pressure on the timeline for construction.	Possible	Severe	High	Develop a consenting strategy as a priority, ensuring the consent process is expedited.	Medium	Project Director
A contractor may not be available, delaying the project's operational start date.	Likely	Severe	High	Conduct early market sounding with industry and escalate any concerns to Project Governance.	Medium	Project Director

Description	Likelihood	Consequence	Risk Rating	Mitigation	Residual Risk Rating	Owner
The HDPE liner may not be available on time, delaying the project's operation.	Possible	Severe	High	Conduct early market sounding with industry and escalate any concerns to Project Governance.	Medium	Project Director

7 Next Steps

The next steps for the project are as follows:

- Apply to MBIE for RIF funding to support the pre-implementation phase.
- Once funding is approved, CDC to confirm procurement of the professional service providers for the pre-implementation phase.
- Commence **Pre-implementation Phase**, including:
  - Mobilise the pre-implementation team.
  - Develop a consenting strategy.
  - Prepare concept designs, including topographical survey and geotechnical investigations.
  - Complete a 30% design hold point, followed by a cost review.
  - Update CBA to reflect refined costs and benefits
  - Develop and implement communications and engagement plan.
  - Commence detail design and resource consents.
  - Investigate legal entity options for the operation and maintenance of the water storage scheme.
- Initiate **Implementation Procurement**, including:
  - Develop and implement the procurement strategy for construction and HDPE liner.
  - Undertake market sounding to confirm industry capability and interest in construction of the storage facility.
  - Conduct the implementation tender process for construction and HDPE liner.
  - Secure a construction contractor.

Appendix

A

Waingawa Water Storage Feasibility Study

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Appendix

B

Irrigation Demand Analysis

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Appendix

C

Cost Estimates: Options A and B/B Staged

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Cost Estimate

Waingawa Water Storage - 500,000 m^3 Lagoon Storage

ITEM	DESCRIPTION	UNIT	QTY	Rate	Amount
1.0	**Preliminary and General**				
1.01	Preliminary and General	%	15	$11,176,775	$1,676,516
				Sub Total	$1,676,516
2.0	**Inlet Works**				
2.01	DN 525 intake pipe	m	10	$874	$8,742
2.02	DN 525 intake structure	ea	1	$2,622	$2,622
2.03	DN 525 valve and manhole	ea	1	$9,882	$9,882
				Sub Total	$21,246
3.0	**Storage Lagoon**				
3.01	Cut to Fill	m^3	9,501	$10	$95,013
3.04	Underdrains	m	10,434	$70	$730,380
3.05	Geotextile	m^2	123,879	$4	$495,517
3.06	Gas strips	m	15,308	$3	$45,924
3.07	Sand blinding	m^2	123,879	$25	$3,096,980
3.08	1.5mm HDPE liner	m^2	123,879	$25	$3,096,980
3.09	Anchor trench	m	1,474	$125	$184,250
3.10	Stripping top soil to stockpile to sell, give away or disperse	m^3	37,164	$10	$371,638
3.11	Stripping topsoil to stockpile and reuse	m^3	9,643	$7	$67,499
3.12	Topsoil and regrassing the outer slopes	m^2	32,142	$15	$482,136
				Sub Total	$8,666,316
4.0	**Outlet works to water races**				
4.01	DN 750 outlet pipe	m	30	$1,100	$33,000
4.02	DN 750 outlet structure	ea	3	$3,300	$9,900
4.03	DN 750 valve and manhole	ea	3	$9,882	$29,646
				Sub Total	$72,546
5.0	**Outlet Works to Waingawa Industrial Estate**				
5.01	Reticulation (provided by CDC)	LS	1	$1,666,667	$1,666,667
				Sub Total	$1,666,667
6.0	**Electrical and Control**				
6.01	Electrical and Control	LS	1	$750,000	$750,000
				Sub Total	$750,000
Professional Sevices					
Professional Sevices		%	15	$12,853,291	$1,927,994
				Sub Total	$1,927,994
Contingency					
Contingency		%	50	$14,781,285	$7,390,642
				Sub Total	$7,390,642
Cost Estimate (Class 4 -30%/+50%)				**Total**	**$22,171,927**
Gravel Extraction Costs					
3.01	Gravel Extraction	m^3	308,653	$15	$4,475,473
3.02	Gravel Processing	m^3	308,653	$20.70	$6,389,124
3.03	Gravel Storage	m^3	308,653	$2	$617,307
				Sub Total	$11,481,904
Gravel Sale Revenue		m^3	308,653	-$43	-$13,272,093
Gravel Sales Profit					-$1,790,189
Profit per unit sold			308,653		-$6

Cost Estimate

Waingawa Water Storage - 1,000,000 m^3 Lagoon Storage

ITEM	DESCRIPTION	UNIT	QTY	Rate	Amount
1.0	**Preliminary and General**				
1.01	Preliminary and General	%	15	$19,041,907	$2,856,286
				Sub Total	$2,856,286
2.0	**Inlet Works**				
2.01	DN 525 intake pipe	m	10	$874	$8,742
2.02	DN 525 intake structure	ea	1	$2,622	$2,622
2.03	DN 525 valve and manhole	ea	1	$9,882	$9,882
				Sub Total	$21,246
3.0	**Storage Lagoon**				
3.01	Cut to Fill	m^3	10,677	$10	$106,769
3.02	Underdrains	m	21,125	$70	$1,478,750
3.03	Geotextile	m^2	240,230	$4	$960,919
3.04	Gas strips	m	436	$3	$1,309
3.05	Sand blinding	m^2	240,230	$25	$6,005,746
3.06	1.5mm HDPE liner	m^2	240,230	$25	$6,005,746
3.07	Anchor trench	m	2,050	$125	$256,250
3.08	Stripping top soil to stockpile to sell, give away or disperse	m^3	72,069	$10	$720,689
3.09	Stripping topsoil to stockpile and reuse	m^3	17,461	$7	$122,226
3.10	Topsoil and regrassing the outer slopes	m^2	58,203	$15	$873,045
				Sub Total	$16,531,448
4.0	**Outlet works to water races**				
4.01	DN 750 outlet pipe	m	30	$1,100	$33,000
4.02	DN 750 outlet structure	ea	3	$3,300	$9,900
4.03	DN 750 valve and manhole	ea	3	$9,882	$29,646
				Sub Total	$72,546
5.0	**Outlet Works to Waingawa Industrial Estate**				
5.01	Reticulation (provided by CDC)	LS	1	$1,666,667	$1,666,667
				Sub Total	$1,666,667
6.0	**Electrical and Control**				
6.01	Electrical and Control	LS	1	$750,000	$750,000
				Sub Total	$750,000
Professional Sevices					
Professional Sevices		%	15	$21,898,194	$3,284,729
				Sub Total	$3,284,729
Contingency					
Contingency		%	50	$25,182,923	$12,591,461
				Sub Total	$12,591,461
Cost Estimate (Class 4 -30%/+50%)				**Total**	**$37,774,384**
Gravel Extraction Costs					
3.01	Gravel Extraction	m^3	619,173	$15	$8,978,013
3.02	Gravel Processing	m^3	619,173	$21	$12,816,888
3.03	Gravel Storage	m	619,173	$2	$1,238,347
				Sub Total	$23,033,248
Gravel Sale Revenue		m^3	619,173	-$43	-$26,624,453
Gravel Sales Profit					-$3,591,205
Profit per unit sold			619173.33		-$6

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Irrigation Demand Analysis - Waingawa Water Storage DRAFT

Prepared for

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Report prepared by

Perrin Ag Consultants Ltd

24 April 2025

perrin ag®
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Executive summary

The Carterton District Council ("CDC") are exploring land use options for a 73-hectare property located at 145 Nolfolk Road, Waingawa, Carterton. Vitruvius initially completed a high-level feasibility report for the property and have subsequently been engaged to complete a business case on a water storage facility at the subject property.

There are two pond sizes being considered, 500,000 m³ (Option A) and 1,000,000 m³ (Option B), with the stored water suggested to be utilised by the proposed industrial park at Waingawa and/or or the surrounding agricultural land via the Taratahi Water Race Scheme.

Perrin Ag Consultants Ltd (Perrin Ag) have been engaged to complete an irrigation demand analysis for three potential agricultural land uses. This report provides a high-level assessment of the value proposition of providing irrigation water to the following land use change scenarios.

i. Dryland dairy to irrigated dairy (150 ha total – 115 ha irrigated and 35 ha dryland)
ii. Dryland arable to irrigated arable (60 ha - Barley grain with winter lamb finishing).
iii. Dryland sheep and beef to irrigated viticulture (10 ha - Pinot Noir grape production).

While the scope of this report was limited to exploring three land uses, these land uses are the prominent land uses within the target catchment. Of the 10,717-hectare target catchment, sheep and beef farming represents 3,916 hectares (37%), Dairy 3,420 hectares (33%), arable 1,460 hectares (14%) and viticulture (2%). Of the 2,340 hectares already irrigated within the target catchment, 1,923 hectares (82%) is irrigated dairy farmland, 42 hectares (2%) irrigated arable, and 112 hectares (5%) irrigated viticulture.

To understand the value proposition for these businesses operating profitability was forecast before and after the addition of irrigation and/or land use change relative to the additional capital investment required.

Operating profit (EBIT) in the dairy scenario is forecast to increase from $1,861/ha as dryland dairy to $3,546 under irrigation, an increase of $1,980/ha before paying for irrigation water. The additional capital investment required averaged $6,480/ha across the 150-hectare dairy platform ($7,700/ha across the 115 ha irrigated), representing a return on investment of 26%. Assuming an average climatic year with 3,910 m^3 of irrigation water required, and an irrigation water charge equivalent to $0.30/$m^3$ the additional operating profit from the investment equated to $785/ha which equates to a 12.1% return on the additional capital investment.

Operating profit (EBIT) in the arable scenario is forecast to increase from $1,170/ha as dryland arable to $2,031 under irrigation, an increase of $861/ha before paying for irrigation water. Assuming additional capital investment for the irrigation infrastructure of $6,433/ha this resulted in a 13.4% return on the additional capital invested. In an average climatic year, it is estimated that 4,940 m^3 of irrigation water would be required annually to achieve the forecast barley yield of 9.0 t/ha. Given the lower returns and higher average water requirement, water charges of less than $0.05/$m^3$ would be required to achieve a 10% return on the irrigation investment.

Operating profit (EBIT) in the viticulture scenario is forecast to increase from $509/ha as dryland sheep and beef to $3,439/ha as an irrigated vineyard producing Pinot Noir grapes, an increase of $2,930/ha per hectare before paying for irrigation water. Assuming additional capital investment for the development of the vineyard at $97,000/ha this resulted in a 3.0% return on the additional capital invested. In an average climatic year, it is estimated that 1,150 m^3 of irrigation water would be required

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annually. If a water charge of \$0.30/m^3 was applied this would decrease the return on the additional investment to 2.7%. As the annual water requirement of a vineyard is lower the effect on profitability of paying for water is reduced. However, with a return on investment of around 3.0%, it is unlikely that significant land use conversion to Pinot Noir production would be pursued.

Marlborough viticulture operating profit per hectare is significantly higher, partially due to the land and climate (enabling production of a wider variety of grapes) but also improved through technologies such as mechanical harvesting. If viticulture profitability increased in the Wairarapa due to a changing climate or technologies, then a viticulture land use would be worth further investigation as a water user particularly given the lower water requirements relative to the other land uses (due to crop requirements and irrigation methods).

Vitruvius have calculated, based on their water balance model, that between 0 ha and 190 ha of dairy land could be irrigated under storage Option A, and between 0 and 295 ha of dairy land could be irrigated under Option B. This was based on the dryland dairy to irrigated dairy scenario given this land use had the best ability to pay for water. The large range in irrigatable dairy area is due to having multiple variables within the water balance model.

When extrapolating out the potential value of the irrigation water for dairy it needs to be considered that the modelling for the dairy scenario was based on a 150 ha dairy farm with 115 ha irrigated. Therefore, the expected levels of financial return from adding irrigation and subsequent ability to pay for irrigation water will change as the area irrigated changes, particularly if the proposed irrigated dairy area decreases below 115 ha.

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1 Methodology

1.1 Project scope

Vitruvius have completed a high-level feasibility report for Carterton District Council ("CDC") exploring land use options for a 73 ha property located at 145 Nolfolk Road, Waingawa, Carterton. Vitruvius have subsequently been engaged to complete a business case on a water storage facility at the said property. The intent would be to supply water to the Waingawa Industrial Estate as well as the surrounding agricultural land via the existing Taratahi Water Race Scheme.

This report provides an initial understanding of the value proposition of providing irrigation water to the surrounding agricultural landowners. It will look at likely land use changes through access to irrigation and the potential ability to pay for irrigation by these new irrigated land uses. Understanding these aspects will inform the business case for the water storage facility.

1.2 Methodology

To provide this assessment and inform the business case for the water storage facility the following methodology has been utilised:

1. *Identify current and potential land uses through the target area.*
2. *Assess the most likely land uses to adopt irrigation, the water requirements for these options and considerations for the adoption of irrigation such as capital requirements and regulatory constraints.*
3. *Create example base financial models to represent an existing (non-irrigated) land use and subsequently for the identified irrigated land use to determine the value proposition of converting dry land to the proposed irrigated land use. This could be within the same land use, e.g. dryland dairy to irrigated dairy and an associated intensification of the farm system, or an alternative land use, e.g. pasture to horticulture.*
4. *Assess the capacity for landowners to pay for irrigation water (including commentary on capital costs and operational costs).*
5. *Identify key considerations with regard to production (products and volume), financial, employment and environmental (at a high level based on typical land use profiles).*

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2 Current and potential land uses through the target area

2.1 Target irrigation area

The target area for irrigation is agricultural land which has water supplied to, or near, the property via the Taratahi Water Race Scheme, downstream from the proposed storage location at 145 Nolfolk Road, Waignawa. Figure 1 outlines the target area, this outline was provided by Vitruvius.



Figure 1: Target area for irrigation uptake

2.2 Current land use

AgriBase data was accessed at property level, for the target irrigation area. Existing land uses are displayed in Figure 2. Existing irrigation areas (as of 2020) have been overlayed onto Figure 2.

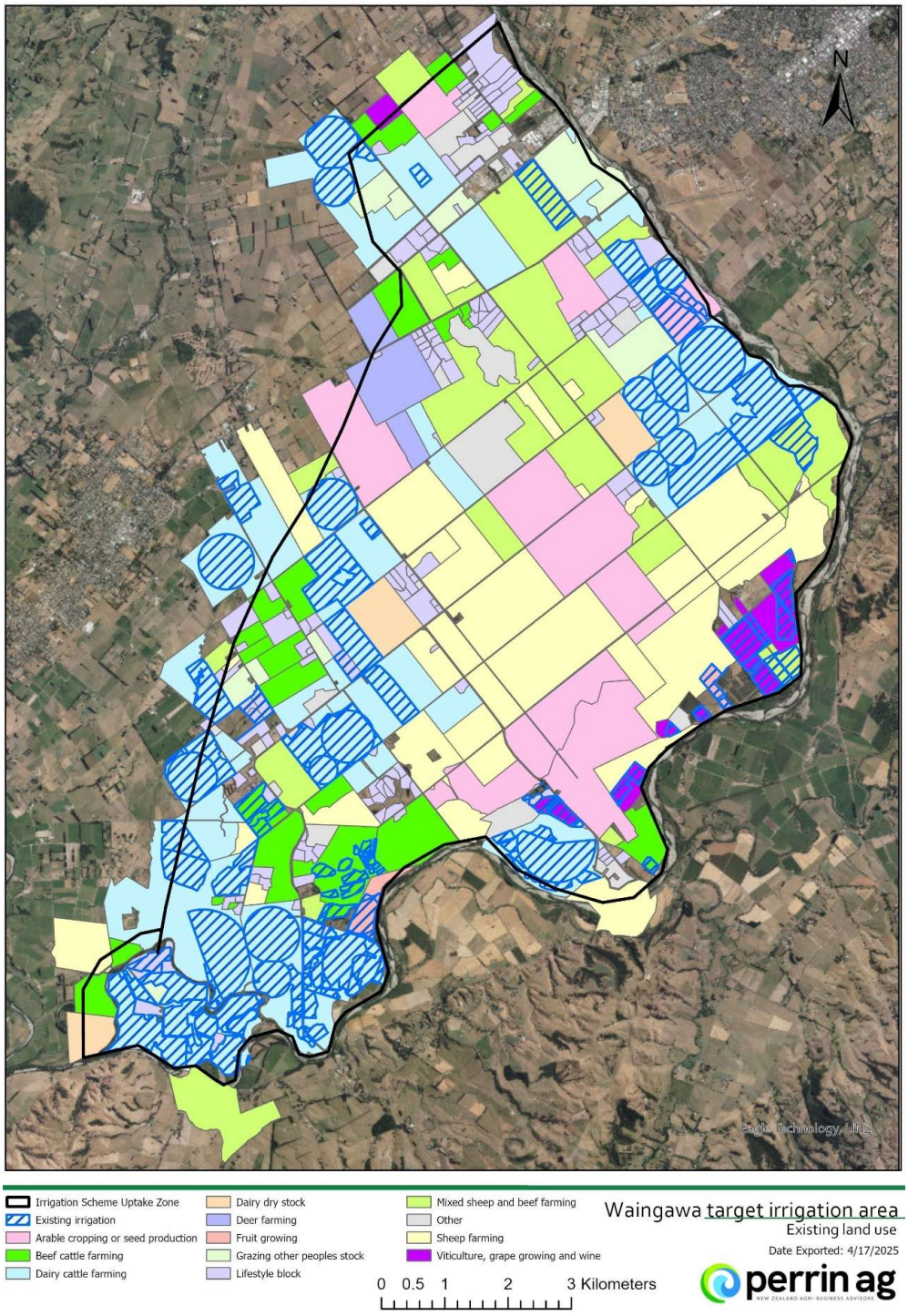

Figure 2: Land uses within the potential irrigation area

When including all properties that either fully or partially fall within the target irrigation area, the rural land area totals 10,718 hectares ("ha"). Of this area, Ministry for the Environment (MFE) data indicates that 2,340 ha are already under irrigation (Table 1).

Table 1: Land use in the potential irrigation area (AgriBase)

Land use	Non-irrigated (hectares)	Irrigated (hectares)	Total area (hectares)
Arable cropping or seed production	1,418	42	1,460
Beef cattle farming	659	70	730
Dairy cattle farming	1,496	1,923	3,258
Dairy dry stock	188	0	188
Deer farming	190	0	190
Fruit growing	15	53	68
Grazing other peoples stock	281	0	282
Lifestyle block	614	44	658
Mixed Sheep and Beef farming	1,221	96	1,317
Sheep farming	1,870	0	1,870
Viticulture, grape growing and wine	92	112	204
Other (includes native bush, horse grazing, not farmed etc.)	333	0	333
Total	**8,377**	**2,340**	**10,717**

It should be noted that at property level, the arable cropping and seed production land use includes sheep (6,675 head) and beef cattle (171 head). It also includes 450 hectares of arable land (but it does not specify what arable crops this is) and 105 ha of fodder crops.

Livestock on the mixed sheep and beef land use totals 30,628 sheep and 2,619 cattle. The sheep farming category includes 140 dairy cattle, 152 beef cattle and 10,112 sheep.

The AgriBase data does not specify information on types of crops. The StatisticsNZ Agricultural Production Survey for 2022 includes information on the Carterton District (Table 2). Carterton includes 118,000 ha of land compared to the potential irrigation land which is 10,718 ha (including land that falls full and partially in the target area). However, it provides information on the detailed land use in the Carterton District and therefore is a more detailed indication of land use in the target irrigation area.

As seen in Figure 2 the existing irrigation in the potential irrigation area is primarily dairy with a small collection of other land uses including some sheep and beef, viticulture and arable areas. Approximately 60% of dairy land in the target area is already irrigated, with an additional 1,500 ha of existing dairy land that is currently not irrigated. Conversely the majority of arable is not irrigated. Approximately half (55%) of the existing viticulture area is irrigated.

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Table 2: Land use in Carterton District (StatisticsNZ Agricultural Production Survey, 2022)

Land use	Crop	Hectares harvested	Tonnes harvested	Yield (tonnes/ha)
Grain and seed crops	Wheat	103	839	8.17
	Barley	528	3,337	6.32
	Oats	23	104	4.6
	Maize grain	64	866	13.53
	Peas, seed/field (exclude processed peas)	177	369	2.08
	Herbage seeds for seed production	145	Not disclosed	
	Vegetable seeds	60	Not disclosed	
Supplementary feed crops	Lucerne grown and used or sold	233	Not disclosed	
	Forage brassicas (swedes, turnips, kale) grown and used or sold	1,547	Not disclosed	
	Other supplementary feed crops grown and used or sold	664	Not disclosed	
Horticulture	Feijoas	0.4		
	Wine grapes	150		
	Table grapes	0.8		
	Olives	22.5		
	Chestnuts	0.9		
	Walnuts	2.6		
	Hazelnuts	0.9		
	Potatoes	2.2		
	Pumpkin/Squash	2.8		
	Total outdoor area used for growing vegetables and cooking herbs	12.2		

The StatisticsNZ Agricultural Production Survey for 2022 also includes irrigation information for the wider Carterton District. This includes information on the type of irrigation and type of irrigated land (Table 3).

Table 3: Irrigation use in Carterton District (StatisticsNZ Agricultural Production Survey, 2022)

	Category	Hectares
Irrigation system	Center pivots and linear moves	1,573
	Other travelling and sprayline systems	1,913
	Micro systems	192
Irrigation used for	Dairy and dairy grazing	2,591
	Other livestock	694
	Grain, seed and arable crops	585
	Outdoor fruit crops	127
	Other horticulture crops	32

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2.3 Potential land uses

Based on the above information, this report will look at three scenarios which could be supported by access to irrigation within the target irrigation area. This is not an exhaustive list of what land uses could occur with irrigation however further land use changes were beyond the scope of this initial assessment.

In addition, no judgement is made on the extent of change that can occur for the three land uses changes. Though this is explored in Section 4, which considers how many hectares could potentially be serviced by the water storage facility.

The three land use change scenarios that are considered in this assessment are:

1. Dryland dairy to irrigated dairy.
2. Dryland arable to irrigated arable.
3. Dryland sheep and beef to irrigated viticulture.

2.3.1 Dryland dairy to irrigated dairy farms

Dairy is the most common land use in the target irrigation area (3,258 ha). Approximately 60% of dairy land in the target area is already irrigated, with an additional 1,500 ha of existing dairy land that is currently not irrigated (Table 1). Moving to irrigated dairy is realistic given contour, size of dairy farms (the average dairy size in Carterton was 154 effective hectares) and the presence of irrigated dairy land in the Carterton District.

This scenario will see unirrigated dairy land become irrigated. This will be irrigated with a pivot irrigator with an efficiency of 80% and additional grass growth will be utilised for additional cows and production. Target application efficiency for irrigation in New Zealand should be at least 80%. While center pivots have an average efficiency of 85%, the 80% assumption is aligned with the methodology in IrriCalc which has been used in this assessment to determine irrigation use. This assumption may lead to an over estimation of water use if pivot irrigators are designed, maintained, and operated at, a higher level of efficiency[1].

2.3.2 Dryland arable to irrigated arable

As seen in Table 2 the most common arable crop in the potential irrigation area is likely barley if it is assumed that the potential irrigated area has the same land use pattern as the Carterton District. Given that the arable land use in the AgriBase data also has sheep it is most likely this is a spring barley grain rotation with a lamb finishing component.

This scenario will take a spring barley grain with lamb finishing rotation and add irrigation. It will be irrigated using a travelling irrigator system and additional production will be largely focused on barley grain yield. The irriCalc model assumes a 77% irrigation efficiency for a travelling irrigator system. This can vary significantly between the types of travelling irrigation used, with a travelling gun having an application efficiency of approximately 70% through to a hand-shift system (e.g. k-lines) having 80%.

2.3.3 Dryland sheep and beef to irrigated viticulture

Wine grapes are the most common horticulture crop in the Carterton District which also aligns with the AgriBase data. It is likely that most vineyards are already irrigated as there is 150 ha of wine grapes in

[1] https://www.irrigationexpress.co.nz/wp-content/uploads/2019/03/irrigation-code-of-practice.pdf

the StatisticsNZ data as well 127 ha of outdoor fruit crops (including grapes) that are irrigated by micro/drip systems and not any other significant fruit crops. In Table 1, 204 ha of viticulture was identified in the target irrigation area with approximately 55% of this irrigated. While there is approximately 90 ha of unirrigated viticulture in the target area, this scenario looked at the likely outcomes from new vineyards being established with irrigation. This could come from areas that are non-irrigated but currently in land uses like sheep and beef farming will change small tracts of suitable land to viticulture. Most permanent horticulture crops are irrigated using micro/drip irrigation. These have a very high efficiency (between 90-100%)

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3 Economic impact of land use change scenarios

This section describes the 'pre' and 'post' economic performance of the three land use change scenarios.

3.1 Dairy

This scenario analyses the change in economic performance from an example dryland (un-irrigated) dairy farm to an irrigated dairy farm. Farmax Dairy has been used to model a 150 ha (effective) dairy model as both dryland and subsequently as an irrigated farm. This aligns with the average dairy farm size in the Carterton district of 154 ha.

3.1.1 Base dryland dairy model

The 150 ha dryland dairy model assumes pasture growth of 11.8 tonnes of dry matter per hectare per year ("t DM/ha/yr"), which is similar to the DairyNZ pasture growth data for Kaiwaiwai (dryland) of 12.5 t DM/ha/yr[2].

At a stocking rate of 2.9 cows/ha, pasture offered equates to 3.6 t DM/cow/yr with supplements and off-farm cow grazing of 1.4 t DM/cow/yr assumed. This dryland system forecasts milk production of 985 kg of milk solids per hectare per year ("kg MS/ha/yr") or 340 kg MS/cow/yr.

3.1.2 Irrigated dairy model

The irrigated model assumes two centre pivots are added to the 150 ha property covering a total of 115 ha or 76% of the effective area.

Pasture growth on the un-irrigated area (35 ha) remains unchanged from the base dryland model at 11.8 t DM/ha/yr. Pasture growth under the irrigated model totals 14.6 t DM/ha/yr.

As seen in Figure 3, the irrigated daily pasture growth rates are unchanged from the dryland model between June and October, with higher pasture growth rates between November and May under the irrigated model due to mitigating the soil moisture deficit.

A stocking rate of 3.1 cows/ha has been assumed under this model. With the increased pasture supply (4.3 t DM/cow/yr) supplements and off-farm cow grazing have been reduced to 1.0 t DM/cow/yr. The irrigated system forecasts milk production of 1,225 kg MS/ha/yr or 391 kg MS/cow/yr.

[2] https://www.dairynz.co.nz/media/2xucxamj/facts_and_figures_dnz30-001_updated_dec_2021_v6.pdf

Table 4: Dairy system physical comparison

FARMAX

Compare Physical Summary

Jun 25 - May 26

		Dryland	Irrigated	Difference	
Farm	Effective Area	150	150		ha
	Stocking Rate	2.9	3.1	0.2	cows/ha
	Comparative Stocking Rate	85.4	80.7	-4.6	kg Lwt/t DM offered
	Potential Pasture Growth	11.8	13.9	2.1	t DM/ha
	Nitrogen Use per total ha	117	120	3	kg N/ha
	Feed Conversion Efficiency (offered)	14.8	13.6	-1.2	kg DM offered/kg MS
Herd	Cow Numbers (1st July)	440	475	35	cows
	Peak Cows Milked	434	469	35	cows
	Days in Milk	238	242	4	days
	Avg. BCS at calving	5.0	5.0	0.0	BCS
	Liveweight per total ha	1,249	1,363	114	kg/ha
Production	Milk Solids total	148,524	186,292	37,768	kg
(to Factory)	Milk Solids per total ha	990	1,242	252	kg/ha
	Milk Solids per cow	342	397	55	kg/cow
	Peak Milk Solids production	2.05	2.09	0.03	kg/cow/day
	Milk Solids as % of live weight	79.2	91.1	11.8	%
Feeding	Pasture Offered per cow *	3.7	4.5	0.8	t DM/cow
	Supplements Offered per cow *	1.0	0.6	-0.5	t DM/cow
	Off-farm Grazing Offered per cow *	0.4	0.4	0.0	t DM/cow
	Total Feed Offered per cow *	5.1	5.4	0.3	t DM/cow
	Pasture Offered per total ha	10.7	14.0	3.3	t DM/ha
	Supplements Offered per total ha	3.2	2.1	-1.2	t DM/ha
	Off-farm Grazing Offered per total ha	2.7	3.3	0.6	t DM/ha
	Total Feed Offered per total ha	16.6	19.3	2.7	t DM/ha
	Supplements and Grazing / Feed Offered *	27.2	17.4	-9.8	%
	Bought Feed / Feed Offered *	12.7	8.1	-4.5	%

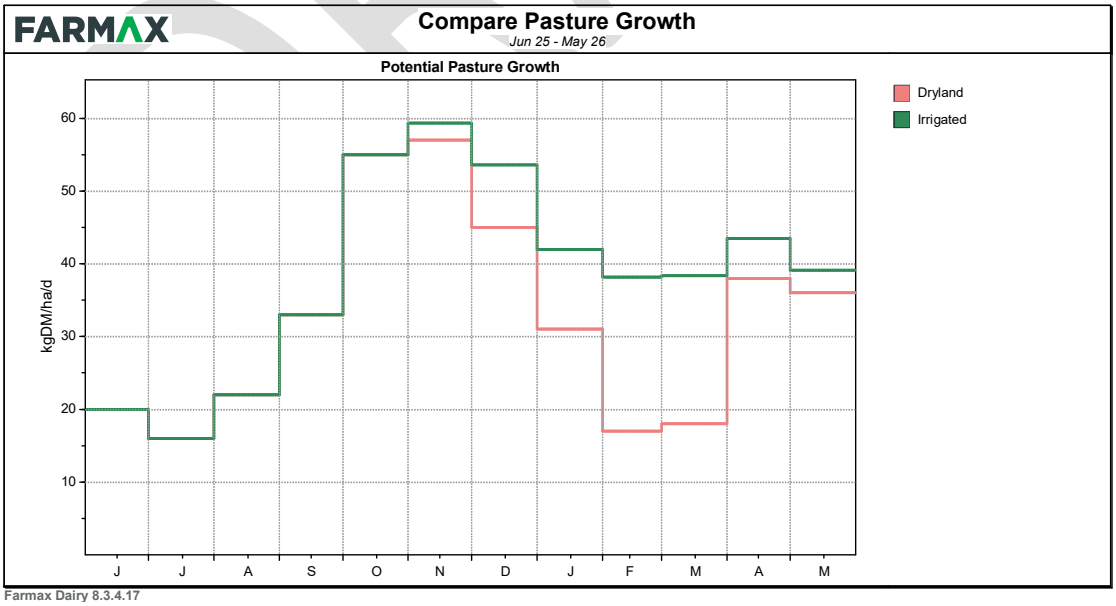
(*) feed offered to females > 20 months old / peak cows milked

Farmax Dairy 8.3.4.17

FARMAX

Compare Pasture Growth

Jun 25 - May 26



Farmax Dairy 8.3.4.17

Figure 3. Daily pasture growth data by month for dryland and irrigated dairy (kg DM/ha/day)

3.1.3 Dairy operating profit comparison

An average efficient dairy operation has been assumed for both dairy models. The 3-year average Fonterra milk price of $8.68/kg MS has been assumed in the revenue assumptions along with current pricing expectations for operating expenses. Operating expenses are detailed for each dairy model in Appendix 1 and Appendix 2.

The primary increase in operating profitability from the irrigated system is due to increased pasture growth which enables the following advantages:

- Increased total milk production due to increased feed supply through the second half of the season.
- Increased feed conversion efficiency as a result of higher production per cow which reduces the proportion of feed being used for (cow) maintenance.
- Increased per cow production also dilutes fixed animal health and breeding costs, increased total production dilutes fixed farm specific costs such as building maintenance or administration.
- Increased irrigation running costs are offset by decreased supplement and pasture conservation (silage) costs due to a lower requirement for supplement through summer under the irrigated model.

The additional irrigation operating expenses (R&M, electricity, labour) are assumed at $45,000 which equates to $300/ha ($391/irrigated ha) or $0.10/$m^3$ of irrigation water used in an average year. Despite this, total farm working expenses decreases from $6.71/kg MS in the dryland model (Appendix 1) to $5.51/kg MS in the irrigated model (Appendix 2).

On a per hectare basis, total (gross) revenue increases by $2,236/ha with operating expenses increasing by $256/ha resulting in an increased surplus (EBITDA) of $1,980/ha when adding 115 ha of irrigation to this 150 ha dryland dairy farm scenario.

Table 5: Dairy operating profit per hectare comparison - 150 ha dairy farm

	Dryland Dairy	Irrigated Dairy	Variance
Revenue			
Milk Revenue (Total)	$8,509	$10,693	$2,184
Net Livestock Sales	$489	$541	$52
Total Gross Revenue ($/ha)	$8,998	$11,234	$2,236
Total Farm Working Expenditure ($/ha)	$6,643	$6,900	$256
EBITDA ($/ha)	$2,355	$4,334	$1,980
Depreciation/Annual Capex offset	$ 493	$ 764	$ 271
EBIT ($/ha)	**$1,861**	**$3,571**	**$1,709**

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3.1.4 Capital expenditure

The capital expenditure required to move from the dryland dairy model to the irrigated dairy model (115 ha irrigated and 35 ha dryland) consists of the irrigation development and increasing cow numbers from 440 cows in the dryland model to 475 in the irrigated model along with replacement heifers at 25% of cow numbers. The remaining farm infrastructure is assumed to be sufficient given the small increase in cow numbers. Total additional capital expenditure for increased capital livestock ($86,450) and the irrigation system ($885,545) is forecast at $972,000 ($6,480/ha).

Table 6: Assumed capital expenditure (CapEx) for additional livestock under the irrigated dairy system

Additional livestock	Head	$/head	Total ($)
MA cows	35	$ 2,200	$ 77,000
Replacement heifers	9	$ 1,050	$ 9,450
Total Livestock CapEx ($)			**$ 86,450**
Total Livestock CapEx ($/ha)			**$ 576**

Table 7: Assumed capital expenditure (CapEx) for 115 ha centre pivot system for irrigated dairy system

Centre Pivot (115 ha)	Total ($)
Bore/water storage	$ -
Land/fencing preperation	$ 60,000
Power to pump	$ 100,000
Pump shed	$ 10,000
Surface mounted electric pump + VSD	$ 35,000
Electrical	$ 20,000
Pump headworks	$ 15,000
Water meter	$ 6,000
Electrical cable to pivot	$ 16,000
Mainline Pivots	$ 48,545
Centre Pivot (2 x 429m)	$ 475,000
Other (consenting/admin/general)	$ 100,000
Total Capital Expenditure ($)	**$ 885,545**
Total CapEx ($/irrigated ha)	**$ 7,700**
Total CapEx ($/total ha)	**$ 5,904**

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3.1.5 Additional information dryland dairy to irrigated dairy

Table 8 summarises the additional information for the dairy models. This information includes estimates for direct employment by farm system as well as indicative environmental impacts based on high level OverseerFM modelling of the example dairy systems as well as literature for sediment and *E. coli* estimates.

Table 8: Additional labour and environmental information for the dairy scenarios

	Dryland Dairy	Irrigated Dairy	Comments
FTEs	1 FTE plus casual per 200 cows (Total 3.0 FTE)	1 FTE plus casual per 200 cows (Total 3.2 FTE)	
Nitrogen loss (kg N/ha/yr)	43	52	OverseerFM. Assuming moderately well drained soil.
Phosphorus loss (kg P/ha/yr)	0.8	1.6	OverseerFM. Assuming flat contour
Sediment loss (t sediment/ha/yr)	0.57	1.03	Monaghan et al. (2021) based on warm, flat well drained typology with dryland = 'dry' and irrigated = 'moist' as no irrigated warm typologies.
E. coli loss (tera *E. coli* /ha/yr)	4.1	4.1	Daigneault & Elliott (2017)
GHG emissions (t GHG/ha/yr)	11.0	12.8	OverseerFM.

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3.2 Arable

This scenario analyses the change in economic performance from an example dryland barley and lamb finishing unit (un-irrigated) to an irrigated barley and lamb finishing unit. An excel model has been created to model a 60-ha operation both as dry land and subsequently as an irrigated farm.

3.2.1 Base arable and lamb finishing model

The 60 ha dryland model assumes a barley grain yield of 5.5 tons of dry matter (DM) per hectare and a forage yield of 1.0 t DM/ha, based on yield data from the Foundation of Arable Research (FAR) and adjusted for location. The assumption is that barley is planted in October and harvested in late March / early April, with both the grain and forage being harvested.

In the lamb finishing model, lambs are introduced on the 1st of June with an initial live weight of 34 kg. They are sold in two batches, one in mid-September and the other at the end of September, each with a carcass weight of 21 kg CWT. The model assumes liveweight gains of 150 g/hd/day. The land's carrying capacity has been determined using growth rates from DairyNZ's Facts and Figures for the Taratahi and Kaiwaiwai areas. It is assumed that the land can support 26 lambs per hectare. This cropping and finishing land is considered to have a growth capacity similar to that of dairy land.

The gross margin for the dryland arable and lamb finishing model can be found in Appendix 3 and Appendix 4.

3.2.2 Irrigated arable and lamb finishing model

The irrigated model assumes gun irrigation is installed covering 100% of the effective area.

The yield from the barley grain and forage is assumed to lift to 9 t DM and 1.7 t DM under the irrigated scenario. Yields have been based off data from FAR with adjustments made for local growing conditions.

The lamb finishing model assumes that lambs can for a month longer than in the dry land scenario. This is assumed because annual ryegrass can be planted earlier and will have better establishment under irrigation. In the irrigation model it is assumed that lambs arrive on farm at a 30 kg LWT rather than 34 kg LWT under the dryland scenario.

The gross margins for irrigated arable and land finishing can be found in Appendix 5 and Appendix 6.

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3.2.3 Barley and lamb finishing operating profit comparison

Table 9: Barley and lamb finishing operation profit (EBITDA) comparison

	Dryland Total ($/ha/yr)	Irrigated Total ($/ha/yr)	Variance
Revenue			
Barley grain	2860	4680	1820
Barley straw	121	198	77
Net lamb sales	1364	1702	338
Wool sales	49	49	0
Total revenue	**$4,394**	**$6,629**	**$2,235**
Expenses			
Cost of production - barley	1637	2255	618
Cost of production - lamb and wool	1216	1248	32
Overheads			0
Repairs and maintenance	107	171	64
Accounting / administration	67	67	0
Rates	55	55	0
Insurance	26	90	64
ACC	7	7	0
Total farm expenditure	**$3,115**	**$3,894**	**$779**
EBITDA	**$1,278**	**$2,735**	**$1,456**

For barley grain and straw production, cost estimates are based on the Lincoln Farm Budget Manual (Volume 41). Financial models for the lamb finishing have been developed using a combination of beef and lamb data, along with our own experience in budgeting for lamb finishing.

The primary driver of increased operating profit (EBITDA) in the irrigated scenario compared to the dryland scenario is due to:

- An increase in barley grain yield from 5.5 to 9 t DM/ha, and straw yield from 1.0 to 1.7 t DM/ha.
- Higher net lamb sales, enabled by purchasing lambs one month earlier at 30 kg LWT instead of 34 kg LWT. Under both scenarios, lambs are slaughtered at 21 kg CWT.

The cost of production in the irrigated barley scenario rise by $591, with $430 of that attributed to irrigation costs. The remaining increase is due to additional fertiliser needed for higher crop yields.

The cost of lamb and wool production increases by $32 under irrigation, primarily due to the additional labour required to manage lambs on-farm for an extra month compared to the dryland system.

Repairs and maintenance costs are also higher in the irrigated model, reflecting the additional equipment that requires maintenance — assumed at 1% of the irrigation equipment's value. Similarly, insurance expenses increase proportionally to reflect the increased asset level for insuring.

Overall, the irrigated scenario delivers an additional $1,456 in EBITDA compared to the dryland model.

3.2.4 Capital cost of irrigation establishment

Table 10 summarises indicative capital costs for the installation of big gun irrigation system. It is assumed that water is delivered to the property via the Taratahi Water Race.

Property specific costs such as supply of power may vary significantly between properties depending on the location relative to the existing power supply. The size and shape of the property will also impact the type of irrigation that is most suitable for use.

Table 10: Assumed capital expenditure for big-gun irrigation over 60 hectares

Big Gun (60 ha)	Total ($)
Bore/water storage	$ -
Power to pump	$ 100,000
Pump shed	$ 8,000
Surface mounted electric pump + VSD	$ 26,000
Electrical	$ 20,000
Pump headworks	$ 8,000
Water meter	$ 6,000
Mainline (1,450m)	$ 58,000
Big Guns x 2	$ 160,000
Other (consenting/admin/general)	$ 50,000
Total Capital Expenditure	**$ 436,000**
Total $/ha	**$ 7,267**

3.2.5 Additional information dryland arable to irrigated arable

Table 11 summarises the additional information for the arable models. This information includes estimates for direct employment by farm system as well as indicative environmental impacts based on literature.

Table 11: Additional labour and environmental information for the arable scenarios

	Dryland Arable	Irrigated Arable	Comments
FTEs	0.5	0.53	Additional labour for lamb finishing under irrigation[3]
Nitrogen loss (kg N/ha/yr)	17.1	23.12	Thomas, Zyskowski & Francis (2007) Norris et al. (2018)
Phosphorus loss (kg P/ha/yr)	0.84	0.84	Norris et al. (2018)
Sediment loss (t sediment/ha/yr)	0.9	0.9	Daigneault & Elliott (2017)
E. coli loss (tera *E. coli* /ha/yr)	0.2	0.2	Daigneault & Elliott (2017)
GHG emissions (t GHG/ha/yr)	1.0	1.0	Daigneault & Elliott (2017)

[3] The increase in labour comes from the additional requirement to manage sheep for an extra month under the irrigated scenario. This is equivalent to an additional 60 hours worked per year (0.03 of a FTE.)

3.3 Viticulture

As discussed in Section 2.3.3, this land use change scenario is based on a dryland sheep and beef farm changing a small tract of land to viticulture. To calculate the economic impact of this change three key assumptions are required, a base sheep and beef profit, a capital cost of conversion and an irrigated viticulture profit. It is assumed that the size of this block would be 10 ha because approximately 80% of vineyards in the Wairarapa are less than 10 ha (MPI, 2016)[4].

3.3.1 Base sheep and beef operating profit

To calculate the base operating profit for this land use change, the Eastern North Island (Gisborne, Hawke's Bay, Wairarapa) Class 5 'finishing' model was used[5]. This was chosen as the sheep and beef farms in the potential irrigation area are typically smaller, flatter and more intensive than other areas in the Eastern North Island group. This operating profit is presented on a per hectare basis as it is assumed that as only a 10 ha vineyard, the loss of 10 ha will not fundamentally change the economics of the sheep and beef farm. Table 12 summarises the base sheep and beef profit. It is based on the average of the 2020-2025 seasons (approximately 407 ha (effective) with 8.9 stock units).

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[4] Viticulture-Gross-Margin-Benchmarking-report-2016-web.pdf
[5] https://beeflambnz.com/industry-data/farm-data-and-industry-production/sheep-beef-farm-survey

Table 12: Base sheep and beef operating profit before depreciation

	$/ha/yr
Revenue	
Wool	25
Sheep	536
Cattle	666
Cash crop	71
Other	86
Total gross revenue ($/ha)	**1,381**
Expenditure	
Wages	72
Managerial salaries	8
Animal health	54
Shearing expenses	50
Seeds	24
Weed and pest control	23
Fertiliser and lime	97
Vehicle expenses	39
Fuel	32
Electricity	14
Feed and grazing	44
Dog expenses	11
Cultivation and sowing	34
Cash crop expenses	5
Repairs and maintenance	107
Cartage	27
Administration expenses	45
Total working expenses ($/ha)	**684**
Rates and insurance	74
ACC levies	7
Total farm expenditure ($/ha)	**764**
EBITDA ($/ha)	**616**

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3.3.2 Vineyard profit

The 2016 Viticulture Gross Margin Benchmarking Report, developed by New Zealand Wine in partnership with the Ministry for Primary Industries (MPI), served as the foundation for calculating viticulture gross margins. To ensure the figures reflected inflation-adjusted values, the Farm Enterprise Price Index (FEPI) was applied to the 2016 data. The FEPI measures the change in cost that relate to specific farming enterprises, in the same way that the more commonly understood, consumer price index (CPI) measures inflation. Based on the FEPI data, a multiplier of 1.38 was applied to the original gross margin to align it with current values. In addition to the MPI Gross Margin, the Lincoln 2022 Farm Budget Manual was used to estimate the additional working costs such as rates, insurance, levies and admin to convert the gross margin to an EBIT equivalent to the other land uses in this study. The estimated EBITDA is highlighted through Table 13.

This is based on an approximate 10 ha vineyard growing pinot noir grapes with a yield of 5.4 tonnes/ha and approximately 2,900 vines/ha. It assumes that grapes are grown and sold, not processed and marketed.

The returns for viticulture in the Wairarapa are not as high as viticulture in other situations. For example, the gross margin for Pinot Noir in 2016 in the Wairarapa was $4,450/ha and Marlborough Pinot Noir was $15,240/ha[6]. This is likely influenced by a few factors, including:

- The yield is lower for Pinot Noir in the Wairarapa (5.4 t/ha) than Marlborough Pinot Noir (8.5 t/ha) in 2016.
- Wages were 50% higher for Pinot Noir in the Wairarapa versus Marlborough in 2016. Vine density can contribute to this, but it is primarily due to the presence of hand harvesting rather than machine harvesting.
- Weather conditions, there is higher rainfall in the Wairarapa than Marlborough and wind and frost can be a problem at flowering time. Despite this, 2016 (which the yields here are based on) was considered a good growing year.

Table 13: Viticulture operating profit before depreciation

	Total ($/ha/yr)
Revenue	
Yield (tonnes)	5.4
Total gross revenue	**$27,051**
Expenditure	
Hand harvesting	2,145
Pruning	5,037
Canopy and crop management	7,694
Other wages	2,546
Weed and pest control	749
Fertiliser and lime	280
Vehicle expenses	320
Fuel	471
Electricity	228
General	325
Machine harvesting	134
Repairs and maintenance	816
Administration expenses	285
Total working expenses ($/ha)	**$21,030**
Rates and insurance	582
Compliance and levies	340
Total farm expenditure ($/ha)	**$21,952**
EBITDA ($/ha)	**$5,099**

[6] Later MPI Benchmarking reports do not include Wairarapa and so 2016 is used for this comparison as there is both a Marlborough and Wairarapa Pinot Noir model.

3.3.3 Capital cost of vineyard establishment

Table 14 summarises an estimate of the capital costs of establishing a vineyard. It should be noted that it will take approximately 4 years to reach full production (included as capitalised operating losses during establishment for years 1-3) and the vines have a life span of approximately 50 years. This excludes the cost of land purchase and excludes the change in land value.

Table 14: Capital costs of vineyard establishment

	Total ($/ha)
Land preparation	$10,000
Trellising and posts	$25,000
Irrigation system (micro/drip)	$10,000
Vines (2,900/ha)	$15,000
Planting and labour	$8,000
Fencing and miscellaneous	$8,000
Capitalised operating losses during establishment (Yrs 1-3)	$21,000
Total cost of conversion ($/ha)	**$96,000**

3.3.4 Summary viticulture land use change

Table 15 summarises the third scenario, dryland sheep and beef to irrigated viticulture.

Table 15: Summary of viticulture model

	Sheep and beef ($/ha)	**Viticulture ($/ha)**	**Variance**
Revenue			
Total Gross Revenue ($/ha)	$1,381	$27,051	$25,670
Total Vineyard Expenditure ($/ha)	$764	$21,952	$21,188
EBITDA ($/ha)	$617	$5,099	$4,482
Depreciation/Annual Capex offset	$ 108	$ 1,660	$ 1,552
EBIT ($/ha)	$509	$3,439	$19,636
Cost of conversion ($/ha)	$ -	$ 97,000	$ 97,000

3.3.5 Additional information viticulture land use change

Table 16 summarises the additional information for the third scenario, dryland sheep and beef to irrigated viticulture. This information includes estimates for direct employment by land use as well as environmental impacts. These estimates are sourced from the literature not farm-specific models.

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Table 16: Additional information for the viticulture model

	Sheep and beef	Viticulture	References
FTEs	1.5 per 407 ha	Varies monthly, peak of 3.6 FTEs/10 ha in July to a low of 0.5 FTEs/10 ha in April	Beef+LambNZ Economic Survey Scarlatti (2024)
Nitrogen loss (kg N/ha/yr)	30	9	Monaghan et al. (2021) Archer & Brookes (2018)
Phosphorus loss (kg P/ha/yr)	1.2	0.58	Monaghan et al. (2021) Archer & Brookes (2018)
Sediment loss (t sediment/ha/yr)	3.49	2.6	Monaghan et al. (2021) Daigneault & Elliott (2017)
E. coli loss (tera *E. coli* /ha/yr)	4.0	1.6	Daigneault & Elliott (2017)
GHG emissions (t GHG/ha/yr)	2.0	1.5	Daigneault & Elliott (2017)

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4 Irrigation demand and supply

4.1 Irrigation demand

IrriCalc is a computer model developed by Aqualinc that simulates the operation of irrigation systems on various land uses. It calculates the irrigation water requirements based on daily climate data, starting from 1 July 1972, as well as soil, crop, and irrigation system data. This model generates a daily soil water balance, which helps determine how much irrigation is needed to support a specific crop. The irrigation water requirements depend on the irrigation method, soil type, and crop chosen. IrriCalc assumes that Good Management Practice (GMP) is applied, which is the best approach to achieve maximum production while maintaining irrigation system efficiency. GMP considers the type of irrigation method, soil, and crop, and aims to use water efficiently.

The model has been split further into 'average' and the '90th percentile'. The average explains what would be required for irrigation required over the given month on average. This value can be used for general planning and gives an idea of what the irrigation needs are likely to be in typical circumstances. The 90th percentile represents a more conservative, higher value. Meaning that in 90% of cases, the irrigation requirement will be less than or equal to this value. The remaining 10% of cases will require higher irrigation requirements than what is presented. In other words, the 90th percentile provides a value that covers the higher end of the range of irrigation needs which is especially important for ensuring that irrigation systems can cope with greater periods of water demand such as during droughts.

IrriCalc was used to estimate monthly irrigation demand for the three land use change scenarios (Table 17). All scenarios were based on a plant available water (PAW) of 60 mm this was based on the coordinates used in IrriCalc (in the center of the potential irrigation area). All scenarios were based on a 1 ha area with an annual rainfall of 896 mm.

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Table 17: Estimated monthly irrigation demand

	Pasture (dairy)				Arable				Viticulture			
Irrigation method	Pivot				Travelling irrigator				Micro/drip			
% of time Soil Moisture > 50% full	95%				99%				100%			
Average system efficiency	80%				77%				100%			
Units	**m^3/ha**		**mm/ha**		**m^3/ha**		**mm/ha**		**m^3/ha**		**mm/ha**	
Month	**Average**	**90%ile**	**Average**	**90%ile**	**Average**	**90%ile**	**Average**	**90%ile**	**Average**	**90%ile**	**Average**	**90%ile**
July	0	0	0	0	0	0	0	0	0	0	0	0
Aug.	0	0	0	0	0	0	0	0	0	0	0	0
Sep.	10	0	1	0	180	520	18	52	0	0	0	0
Oct.	280	460	28	46	320	520	32	52	10	40	1	4
Nov.	430	690	43	69	730	1,050	73	105	200	290	20	29
Dec.	960	1,390	96	139	1,140	1,580	114	158	350	460	35	46
Jan.	1,000	1,390	100	139	1,240	1,580	124	158	330	460	33	46
Feb.	780	1,160	78	116	800	1,080	80	108	200	400	20	40
March	360	690	36	69	410	790	41	79	60	150	6	15
April	90	230	9	23	120	260	12	26	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0	0	0
Annual	3,910	6,010	391	601	4,940	7,380	494	738	1,150	1,800	115	180

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4.2 Irrigation supply

Vitruvius has created a water balance models for both Option A (500,000m3 storage pond) and Option B (1,000,000m3 storage pond).

The models include assumptions for the inflow of water from the Waingawa River, existing livestock water use, existing process water use, losses from evapotranspiration, the proposed industrial water use and the monthly water demand (90th percentile year) for dairy land use from Table 17.

Vitruvius have calculated based on their water balance model that between 0 hectares and 190 hectares of dairy land could be irrigated under Option A and between 0 and 295 hectares of dairy land could be irrigated under Option B. This was based on the dryland dairy to irrigated dairy scenario given this land use had the best ability to pay for water. The large range in irrigatable dairy area is due to having multiple variables within the water balance model.

Given that the modelling for the dairy scenario was based on a 150 hectare dairy farm with 115 ha irrigated, the financial models and expected levels of return from adding irrigation will vary as the area irrigated area changes, particularly if the irrigated area decreases.

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5 Value of irrigation water

5.1 Dairy

Converting a dryland dairy unit to an irrigated dairy unit would typically be a sound value proposition for a dairy farm owner given they have existing capital invested and irrigating pasture would typically result in increased pasture growth and a lower cost of production. However, environmental regulation such as the National Environmental Standards for Freshwater (NES-F) and also total water supply volumes have constrained the intensification from dryland dairy to irrigated dairy in recent years.

Given the scope constraints, land use intensification and nutrient management rules either at a national or regional level have not been considered within this report. This allows an understanding of the economic returns prior to such regulation. Regulatory due diligence of each proposed land use is recommended if the project progresses.

The ability to pay for irrigation water to convert dryland dairy to irrigated dairy will largely be driven by the return on the additional investment.

The property value of irrigated dairy farms is typically higher than dryland dairy farms due to the greater profit potential per hectare of the irrigated land. However, in this instance where the water will have a cost to the user, any capital gain on the property through installing irrigation will be constrained by the cost of the water as this will impact the return on investment for the irrigation. For instance, if the cost of the irrigation water was such that the additional operating profit was only sufficient to cover the irrigation capex itself, then the underlying land value may not necessarily increase.

As such we recommend the value proposition for irrigation water be firstly assessed using the change in operating profitability relative to the return on the additional capital investment.

5.1.1 Dryland dairy return on additional investment - no water charge

As per Section 3.1, the dryland and irrigated dairy operating profit (EBIT) is summarised in Table 18. Assuming the capital expenditure requirements outlined in Table 6 and Table 7 totalling $6,480/ha, and no additional charges for the water, the return on the additional capital investment (livestock and irrigation) from converting dryland dairy to irrigated dairy is 26%.

Table 18. Annual EBIT for the 150 ha Dryland and Irrigated Dairy models, additional capital expenditure required and the return on additional investment assuming no irrigation water charge.

	Dryland Dairy	Irrigated Dairy	Variance
EBITDA ($/ha)	$2,355	$4,334	$1,980
Depreciation/Annual Capex offset	$493	$789	$295
EBIT ($/ha)	$1,861	$3,546	$1,685
Additional Capital Required	$0	$6,480	$6,480
Return on Investment (Additional EBIT/Capex)			**26.0%**

5.1.2 Dryland dairy return on additional investment with water charge

Irrigation scheme charges often have a fixed charge under irrigation along with a variable charge per cubic meter (m³) of water used. Having a combination can assist to strike a balance between water efficiency (variable charge) and ensuring fixed scheme costs are covered if water use is down in a given year.

In 2022 IrrigationNZ updated an earlier survey assessing the cost of delivering surface water to the farm gate[7]. The average scheme costs in 2022 were presented per hectare ($1,180/ha/year) and per cubic meter of water ($0.21/m³).

We expect that a dryland dairy farm business would require a return on the additional investment of at least 10-12% to justify converting dryland dairy to irrigated dairy land.

Assuming average irrigation water requirements of 3,910 m³ and an irrigation water charge (inclusive of fixed and variable costs) of $0.30/m³ this would result in an annual cost of $1,173 per irrigated hectare (115 ha) or $899/ha across the entire 150 ha dairy platform model. At this price point, the return on the additional investment is forecast at 12.1% (Table 19).

Table 19. Annual EBIT for the 150-ha dryland dairy and irrigated dairy (115 ha irrigated + 35 ha dryland) models, additional capital expenditure required and the return on additional investment assuming total charges of $0.30/m³ for irrigation water at the average expected annual water use of 3,910m³.

	Dryland Dairy	Irrigated Dairy	Variance
EBITDA ($/ha)	$2,355	$4,334	$1,980
Depreciation/Annual Capex offset	$493	$789	$295
Average annual irrrigation water use (m3/ha/yr)		*3,910*	
Irrigation water rate ($/m³)		***$0.3000***	
Irrigation charge ($/irrigated ha)		***$1,173***	
Irrigation water charge ($/ha)	**$0**	**$899**	**$899**
EBIT ($/ha)	$1,861	$2,647	$785
Additional Capex Required	$0	$6,480	$6,480
Return on Investment (Additional EBIT/Capex)			**12.1%**

We have sensitised the return on the additional investment in Table 20. which would align more closely with the IrrigationNZ Canterbury Survey form 2022 ($0.21/m³).

Table 20. Return on additional capital investment sensitised to water use (m³/yr) and irrigation water cost.

			Irrigation water cost ($/m³)				
			$ 0.2000	$ 0.2500	**$ 0.3000**	$ 0.3500	$ 0.4000
Annual water use (m³/ha)	*Avg.*	**3,910**	16.7%	14.4%	**12.1%**	9.8%	7.5%

[7] irrigationnz.co.nz/KnowledgeResources/ Schemes/CostSurvey

5.2 Arable

The feasibility of paying for irrigation water to convert dryland barley and lamb finishing into an irrigated operation will primarily depend on the return generated from the additional investment, in the same way as the dairy scenario (section 5.1).

While irrigated land typically holds a higher capital value than non-irrigated land, this increase may be limited in this proposal as water for irrigation comes at a cost. The expense of the water directly affects the return on investment for irrigation, thereby constraining potential capital gains. For example, if the cost of irrigation water is such that the resulting increase in operating profit merely offsets the capital expenditure of installing irrigation, the underlying land value may not necessarily rise.

5.2.1 Dryland barley and lamb finishing return on additional investment – no water charge

Assuming the capital expenditure requirements outlined in Table 10 totalling $7,267 per hectare, and no additional charges for the water, the return on the additional capital investment (irrigation equipment) from shifting to dryland barley and lamb finishing to irrigated barley and lamb finishing is 11.2% (Table 21).

Table 21: Annual EBIT for the 60-ha barley and lamb finishing models (dryland and irrigated), additional capital expenditure required, and the return on additional investment assuming no irrigation water charge.

	Arable and lamb finishing base ($/ha)	Arable and lamb finishing - irrigated ($/ha)	Variance
EBITDA ($/ha)	$1,278	$2,380	$1,102
Depreciation/Annual Capex offset	$108	$399	$291
EBIT ($/ha)	$1,170	$1,981	$811
Total Additional Capex	$0	$7,267	$7,267
Return on Investment (Additional EBIT/Capex)			**11.2%**

In order for farmers to invest in irrigation equipment, we would anticipate they would require a return on the additional capital of at least 10-12%. In the absence of water charges, investing in irrigation appears to be feasible.

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5.2.2 Dryland barley and lamb finishing return on additional investment

Table 22 highlights the additional returns on the 60 ha dryland and lamb finishing units assuming total charges of $0.10/m³ for irrigation water at the average expected annual water use of 4,940m³. A charge of $0.10/m³ for irrigation water provides a return of only 4.4% on the additional capital expenditure. It is unlikely that there would be appetite to install irrigation infrastructure at this level of return.

Table 22: Annual EBIT for the 60 ha dryland and irrigated barley and lamb finishing models, additional capital expenditure required and the return on additional investment assuming total charges of $0.10/m³ for irrigation water at the average expected annual water use of 4,940m³.

	Dryland barley and lamb finishing	Arable and lamb finishing - irrigated ($/ha)	Variance
EBITDA ($/ha)	$1,278	$2,380	$1,102
Depreciation/Annual Capex offset	$108	$399	$291
Average annual irrrigation water use (m3/ha/yr)		*4,940*	
Irrigation water rate ($/m³)		***$0.1000***	
Irrigation water charge ($/ha)	**$0**	**$494**	**$494**
EBIT ($/ha)	$1,170	$1,487	$317
Total Additional Capex	$0	$7,267	$7,267
Return on Investment (Additional EBIT/Capex)			**4.4%**

Table 23 further illustrates that the addition of any water charge is likely to be unpalatable to arable farmers running a barley and lamb finishing operation at a scale of 60 hectares.

Table 23: Return on additional capital investment sensitised to water use (m³/yr) and irrigation water cost.

Annual water use (m³/ha)	Irrigation water cost ($/m³)				
	$ -	$ 0.0500	**$ 0.1000**	$ 0.1500	$ 0.2000
average **4,940**	11.2%	7.8%	**4.4%**	1.0%	-2.4%

5.3 Viticulture

5.3.1 Dryland sheep and beef to viticulture, return on additional investment - no water charge

As discussed in Section 3.3.2 the returns from viticulture in the Wairarapa are relatively low compared to viticulture in other regions. While the EBITDA is significantly higher than dryland sheep and beef the capital cost of a greenfield conversion mean the returns on investment are very low (3%) and unlikely enough to see many people undertake such a conversion unless they are able to significantly reduce these capital costs. This is shown in Table 24.

Table 24. Dryland sheep and beef to Viticulture. Return on additional investment from converting to Viticulture

	Sheep and beef ($/ha)	Viticulture ($/ha)	Variance
EBITDA ($/ha)	$617	$5,099	$4,482
Annual Capex (Depreciation offset)	$ 108	$ 1,660	$ 1,552
EBIT ($/ha)	$509	$3,439	$2,930
Total Additional Capex	$0	$ 97,000	$97,000
Return on Investment (Additional EBIT/Capex)			**3.0%**

5.3.2 Dryland sheep and beef to viticulture, return on additional investment with water charge

Table 25 highlights the additional returns on the 10-ha irrigated vineyard assuming total charges of $0.30/m³ (for consistency with the dairy model) for irrigation water at the average expected annual water use of 1,150 m³. Given there was a very low return on investment from converting dryland sheep and beef to irrigated viticulture it is unlikely that this would occur with or without a water charge. Given that water use in irrigated viticulture is low (due to crop needs and the irrigation system) the impact of including a water charge on irrigated viticulture is very low when accounting for a water charge. The low water use does mean that a price of $0.30/m³ for irrigation water is likely acceptable however, it is unlikely many landowners will make this change given the returns from the capital investment required.

Table 26 provides a sensitivity analysis for the cost of irrigation water and it makes very little difference to the returns. If vineyards in Wairarapa had the same profitability as Marlborough, then arguably vineyard owners could pay a lot more for water (given low use) than a dairy farm. But while the viticulture returns are so low (given the combination of lower yield and higher costs) this is not the case in the target irrigation area.

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Table 25. Dryland sheep and beef to viticulture. Return on additional investment from converting to viticulture after paying for irrigation water

	Sheep and beef ($/ha)	Viticulture ($/ha)	Variance
EBITDA ($/ha)	$617	$5,099	$4,482
Depreciation/Annual Capex offset	$108	$1,660	$1,552
Average annual irrrigation water use (m3/ha/yr)		*1,150*	
Irrigation water rate ($/m^3)		***$0.3000***	
Irrigation water charge ($/ha)	**$0**	**$345**	**$345**
EBIT ($/ha)	$509	$3,094	$2,585
Total Additional Capex	$0	$ 97,000	$97,000
Return on Investment (Additional EBIT/Capex)			**2.7%**

Table 26. Return on additional capital investment sensitised to water use (m³/yr) and irrigation water cost.

			Irrigation water cost ($/m^3)				
Annual water use (m^3/ha)			$ 0.2000	$ 0.2500	**$ 0.3000**	$ 0.3500	$ 0.4000
	Avg.	**1,150**	2.8%	2.7%	**2.7%**	2.6%	2.5%

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6 Impact of irrigation requirements into the future

IrriCalc, the model used to estimate irrigation demand, is based on historical climate and rainfall data, which means it may either overestimate or underestimate future irrigation needs in a climate change-affected environment. While estimating irrigation demand under future climate scenarios is beyond the scope of this initial assessment, some initial high level conclusions can be drawn which are useful context for decision making.

The Ministry for the Environment's climate change projections[8] outline how New Zealand's climate is expected to evolve under various future scenarios. These projections are based on emissions scenarios developed by the Intergovernmental Panel on Climate Change (IPCC), known as Shared Socioeconomic Pathways (SSPs). These scenarios consider factors like economic growth, population changes, and technological advancements to estimate future greenhouse gas emissions and their impact on the climate.

The climate projections outline various variables measured, including the number of frost days, the number of growing degree days, changes in average temperature, and alterations in rainfall patterns to name a few. Some of the key impacts of climate change are summarised in Table 27. These results are based on a base period of 1995-2014 and a Climate Change Scenario of SSP 2-4.5.

Table 27: Estimated annual impact of climate change (SS2-4.5) compared to a baseline period of 1995-2014

	2021-40	2041-60
Number of hot days (>25°C)	+9.8 days	+20.9 days
Number of frost days (<0°C)	-4.4 days	-9.9 days
Average daily air temperature	+0.6°C	+1.1°C
Average daily minimum air temperature	+0.5°C	+1.1°C
Average daily maximum air temperature	+0.6°C	+1.2°C
Average solar radiation	-	+0.1 watts/m^2
Growing degree days (base 10°C)[9]	+162 GDD	+315.5 GDD
Total rainfall	-2%	-4.3%
Drought exposure (expressed as PED)	+22.5 mm	+34.7 mm
Number of rainy days (>=1mm)	+0.4 days	-0.9 days
Number of very rainy days (>25mm)	-0.1 days	-0.2 days
Heavy rainfall (99th percentile)	-0.2%	-1.2%
Number of dry days (<1mm)	-0.4 days	+0.9 days
Average relative humidity	-0.1%	-0.2%
Number of windy days (>10m/s)	+0.3 days	+2 days

Of key interest is the timing and volume of rainfall changes. The seasonal variation in rainfall is summarised in Table 28. The data indicates that while rainfall variability is expected throughout the season, the most significant change is anticipated in autumn, with rainfall projected to be approximately 9% lower than current. This will mean more irrigation is needed in Autumn in the future.

[8] https://map.climatedata.environment.govt.nz/

[9] GDDs are a temperature index, calculated by taking the average of the daily high and low temperatures compared with a baseline (10°C).

Currently summer is peak demand so the increase in demand from less rainfall in Autumn may be covered under the existing capacity, however this is not explicitly calculated here. It may also mean farms irrigate later in the year than currently in the future.

Table 28: Anticipated change in seasonal rainfall from the 1995-2014 base period

	2021-40	2041-60
Total rainfall	-2%	-4.3%
Spring	-2%	-3.4%
Summer	+1.3%	-2.1%
Autumn	-9.4%	-8.8%
Winter	-1.6%	-2.3%

Viticulture is particularly sensitive to climate variation and will need careful consideration before expansion to ensure the future climate is suitable for growing grapes, the irrigation required, and the varieties planted. Currently in the Wairarapa windy and cool flowering conditions constrain yields below other regions in most years (MPI, 2016[10]). Although the results above are not all presented seasonally, the region is expected to get warmer and windier annually which may impact on flowering.

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[10] Viticulture-Gross-Margin-Benchmarking-report-2016-web.pdf

7 Key limitations and assumptions

This report is an initial business case and as such there are a number of assumptions that have been made in its preparation that should be noted. These are areas that may need further consideration from the client if this work proceeds and are detailed below:

- This report assessed the irrigation demand for the various land use change scenarios described in Section 2. However, irrigation supply and availability assumptions were provided by Vitruvius. This report does not alter any of the assumptions made around water supply, other water uses or water losses. It simply takes the monthly water supply provided by Vitruvius and assess that against the monthly water demand in a water balance model provided by Vitruvius. Any changes to the water balance model will change the area of land that is able to be irrigated.
- The National Environmental Standards for Freshwater (NES-f) are a set of regulations aimed at protecting the health of freshwater ecosystems. These standards regulate activities that pose risks to freshwater and freshwater ecosystems, such as intensive winter grazing, land use change, and the use of synthetic nitrogen fertiliser. The NES-f is currently under review as is a number of regional plans, and with ongoing reforms it could impact the ability for land use change and intensification. It is worth noting that the impact of this legislation, or any legislation, has not been considered in the preparation of this report. Further work and analysis should be undertaken before proceeding with this project to assess the potential regulatory barriers to the land use changes explored in this work.
- Climate change is expected to alter both the distribution and overall volume of rainfall throughout the year, with drier autumns becoming increasingly likely in the future (summarised in Section 6, with more detail in Table 28). The modelling across all scenarios presented in this report do not account for the potential impacts of climate change. This will most likely mean the demand for water will change per hectare both in quantity and timing. Farmers may also be more inclined to invest in irrigation infrastructure as a means of mitigating climate-related risk in the future. This potential benefit of climate risk mitigation, through irrigation, has not been factored into the analysis provided in this report.
- The profitability of adopting irrigation is significantly impacted by seasonal variability. In wetter years, the return on investment from irrigation tends to be lower, while in drier years, the return is higher. Essentially, the gap between the dryland system and irrigated land becomes more pronounced in drier years. For the purposes of this analysis, we have not broken down the return on the additional capital invested under various scenarios, but have instead focused on an 'average year'.
- Our analysis has focused on a single horticultural land-use change. Horticulture is generally intensive and some horticulture land uses have the potential to be profitable under irrigation. Some horticulture land uses have the potential to be profitable under irrigation. However, because of the small existing footprint of horticulture in the target area this land use change will also require significant capital development which may impact returns (as seen in the viticulture example). While the region's soil type may limit certain types of horticulture, alternative horticulture scenarios could be assessed. This would involve more detailed assessment of likely crops under the specific climate and soil combination in the target area. Additional horticultural land uses, such as pipfruit, could be investigated in a ‘stage 2’ analysis, should further exploration be necessary. This would likely involve engaging with horticulturists and landowners in the region.

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8 Appendix

Appendix 1. Dryland Dairy scenario profit and loss

FARMAX **Forecast Profit and Loss for Dairy Scenario**
Jun 25 - May 26

			$ Total	$/Farm ha	$/cow	$/kg MS
Revenue	Stock	Net Milk Sales - this season	1,276,373	8,509	2,955	8.59
		Net Livestock Sales	73,307	489	170	0.49
		Total	1,349,680	8,998	3,124	9.09
	Crop & Feed	Capital Value Change	-4	0	0	0.00
		Total	-4	0	0	0.00
	Total Revenue		**1,349,675**	**8,998**	**3,124**	**9.09**
Expenses	Wages	Wages	151,200	1,008	350	1.02
		Management Wage	86,400	576	200	0.58
	Stock	Animal Health	43,200	288	100	0.29
		Breeding	36,720	245	85	0.25
		Farm Dairy	6,228	42	14	0.04
		Electricity	19,440	130	45	0.13
	Feed/Crop	Pasture Conserved	50,083	334	116	0.34
		Bought Feed	111,296	742	258	0.75
		Calf Feed	8,640	58	20	0.06
	Grazing	Grazing	180,791	1,205	418	1.22
	Other Farm Working	Fertiliser (Excl. N)	46,913	313	109	0.32
		Nitrogen	39,602	264	92	0.27
		Regrassing	9,000	60	21	0.06
		Weed & Pest Control	8,000	53	19	0.05
		Vehicle Expenses	25,000	167	58	0.17
		Fuel	15,000	100	35	0.10
		R&M Land/Buildings	25,000	167	58	0.17
		R&M Plant/Equipment	35,000	233	81	0.24
		Freight & Cartage	17,500	117	41	0.12
		Other Expenses	15,000	100	35	0.10
	Overheads	Administration Expenses	20,000	133	46	0.13
		Insurance	22,000	147	51	0.15
		ACC Levies	6,480	43	15	0.04
		Rates	18,000	120	42	0.12
	Total Farm Working Expenses		**996,493**	**6,643**	**2,307**	**6.71**
	Depreciation		74,000	493	171	0.50
	Total Farm Expenses		**1,070,493**	**7,137**	**2,478**	**7.21**
Economic Farm Surplus (EFS)			**279,182**	**1,861**	**646**	**1.88**
Farm Profit before Tax			**279,182**	**1,861**	**646**	**1.88**

EFS is a measure of farm business profitability independent of ownership or funding, used to compare performance between farms.
EFS should include an adjustment for unpaid family labour and management. This can be added to the expense database as management wage.

Farmax Dairy 8.3.4.17

Appendix 2. Irrigated Dairy scenario profit and loss

FARMAX

Forecast Profit and Loss for Dairy Scenario

Jun 25 - May 26

			$ Total	$/Farm ha	$/cow	$/kg MS
Revenue	Stock	Net Milk Sales - this season	1,604,019	10,693	3,442	8.61
		Net Livestock Sales	81,098	541	174	0.44
		Total	1,685,117	11,234	3,616	9.05
	Crop & Feed	Capital Value Change	-1	0	0	0.00
		Total	-1	0	0	0.00
	Total Revenue		**1,685,116**	**11,234**	**3,616**	**9.05**
Expenses	Wages	Wages	163,100	1,087	350	0.88
		Management Wage	93,200	621	200	0.50
	Stock	Animal Health	46,600	311	100	0.25
		Breeding	39,610	264	85	0.21
		Farm Dairy	6,838	46	15	0.04
		Electricity	20,970	140	45	0.11
	Feed/Crop	Pasture Conserved	12,054	80	26	0.06
		Bought Feed	82,383	549	177	0.44
		Calf Feed	9,320	62	20	0.05
	Grazing	Grazing	195,177	1,301	419	1.05
	Other Farm Working	Fertiliser (Excl. N)	63,593	424	136	0.34
		Nitrogen	40,617	271	87	0.22
		Irrigation	45,000	300	97	0.24
		Regrassing	9,000	60	19	0.05
		Weed & Pest Control	8,000	53	17	0.04
		Vehicle Expenses	25,000	167	54	0.13
		Fuel	15,000	100	32	0.08
		R&M Land/Buildings	25,000	167	54	0.13
		R&M Plant/Equipment	35,000	233	75	0.19
		Freight & Cartage	17,500	117	38	0.09
		Other Expenses	15,000	100	32	0.08
	Overheads	Administration Expenses	20,000	133	43	0.11
		Insurance	22,000	147	47	0.12
		ACC Levies	6,990	47	15	0.04
		Rates	18,000	120	39	0.10
	Total Farm Working Expenses		**1,034,953**	**6,900**	**2,221**	**5.56**
	Depreciation		114,577	764	246	0.62
	Total Farm Expenses		**1,149,530**	**7,664**	**2,467**	**6.17**
Economic Farm Surplus (EFS)			**535,586**	**3,571**	**1,149**	**2.87**
Farm Profit before Tax			**535,586**	**3,571**	**1,149**	**2.87**

EFS is a measure of farm business profitability independent of ownership or funding, used to compare performance between farms.
EFS should include an adjustment for unpaid family labour and management. This can be added to the expense database as management wage.

Farmax Dairy 8.3.4.17

Appendix 3. Dryland barley gross margin

	Total ($/ha/yr)
Revenue	
Grain	
Yield (t DM)	5.5
Price per tonne	520
Forage	
Yield (t DM)	1.0
Price per tonne	116
Total gross revenue	**$2,981**
Expenditure	
Cultivation - light cultivation	40
Sowing - disc seeder	125
Fertiliser application - spreader topdressing	30
Spraying - Boomspray (self propelled) 3 applications	80
Fertiliser application - spreader topdressing	19
Grain harvest - conventional harvester	390
Forage harvest - large square baler	160
Fertiliser	295
Seed	221
Herbicide	122
Insecticide	15
Irrigation	0
Fungicide	103
Growth regulator	36
Total working expenses ($/ha)	**$1,637**
Gross Margin ($/ha)	**$1,343**

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Appendix 4. Dryland lamb finishing gross margin

	Total ($/ha/yr)
Revenue	
Lamb Sales	
No. lambs	26
Carcass weight (kg)	21
Price ($/kg CWT)	8
Survival through to sale	97%
	$4,236.96
Less purchases	
No. lambs	26
Liveweight	34
Purchase price ($/kg LWT)	3.25
	$2,873.00
Net lamb sales	**$1,364**
Wool	
No. lambs	26
kg wool per head	1.5
Price of wool ($/kg)	1.3
	$49
Gross revenue ($/ha)	**$1,413**
Expenditure	
Spray out (glyphosate + contractor)	100
Power harrow + airseeder	280
Seed	150
DAP at sowing	200
Urea (one application @ 54 kg/ha)	62
Freight	78
Animal health	62
Killing charge	52
Shearing / crutching	104
Labour	128
Total Expenses	**$1,216**
Gross Margin ($/ha)	**$196**

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Appendix 5. Irrigated barley gross margin

	Total ($/ha/yr)
Revenue	
Grain	
Yield (t DM)	9.0
Price per tonne	520
Forage	
Yield (t DM)	1.7
Price per tonne	116
Total gross revenue	**$4,878**
Expenditure	
Cultivation - light cultivation	40
Sowing - disc seeder	125
Fertiliser application - spreader topdressing	30
Spraying - Boomspray (self propelled) 3 applications	80
Fertiliser application - spreader topdressing	19.31
Grain harvest - conventional harvester	390
Forage harvest - large square baler	160
Fertiliser	483
Seed	221
Herbicide	122
Insecticide	15
Irrigation	430
Fungicide	103
Growth regulator	36
Total working expenses ($/ha)	**$2,255**
Gross Margin	**$2,622**

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Appendix 6. Irrigated lamb finishing gross margin

	Total ($/ha/yr)
Revenue	
Lamb Sales	
No. lambs	26
Carcass weight (kg)	21
Price ($/kg CWT)	8
Survival through to sale	97%
	$4,236.96
Less purchases	
No. lambs	26
Liveweight	30
Purchase price ($/kg LWT)	3.25
	$2,535.00
Net lamb sales	**$1,702**
Wool	0
No. lambs	26
kg wool per head	1.5
Price of wool ($/kg)	1.3
	$49
Gross revenue ($/ha)	**$1,751**
	0
Expenditure	0
Spray out (glyphosate + contractor)	100
Power harrow + airseeder	280
Seed	150
DAP at sowing	200
Urea (one application @ 54 kg/ha)	62
Freight	78
Animal health	62
Killing charge	52
Shearing / crutching	104
Labour	160
Total Expenses	**$1,248**
Gross Margin ($/ha)	**$502**

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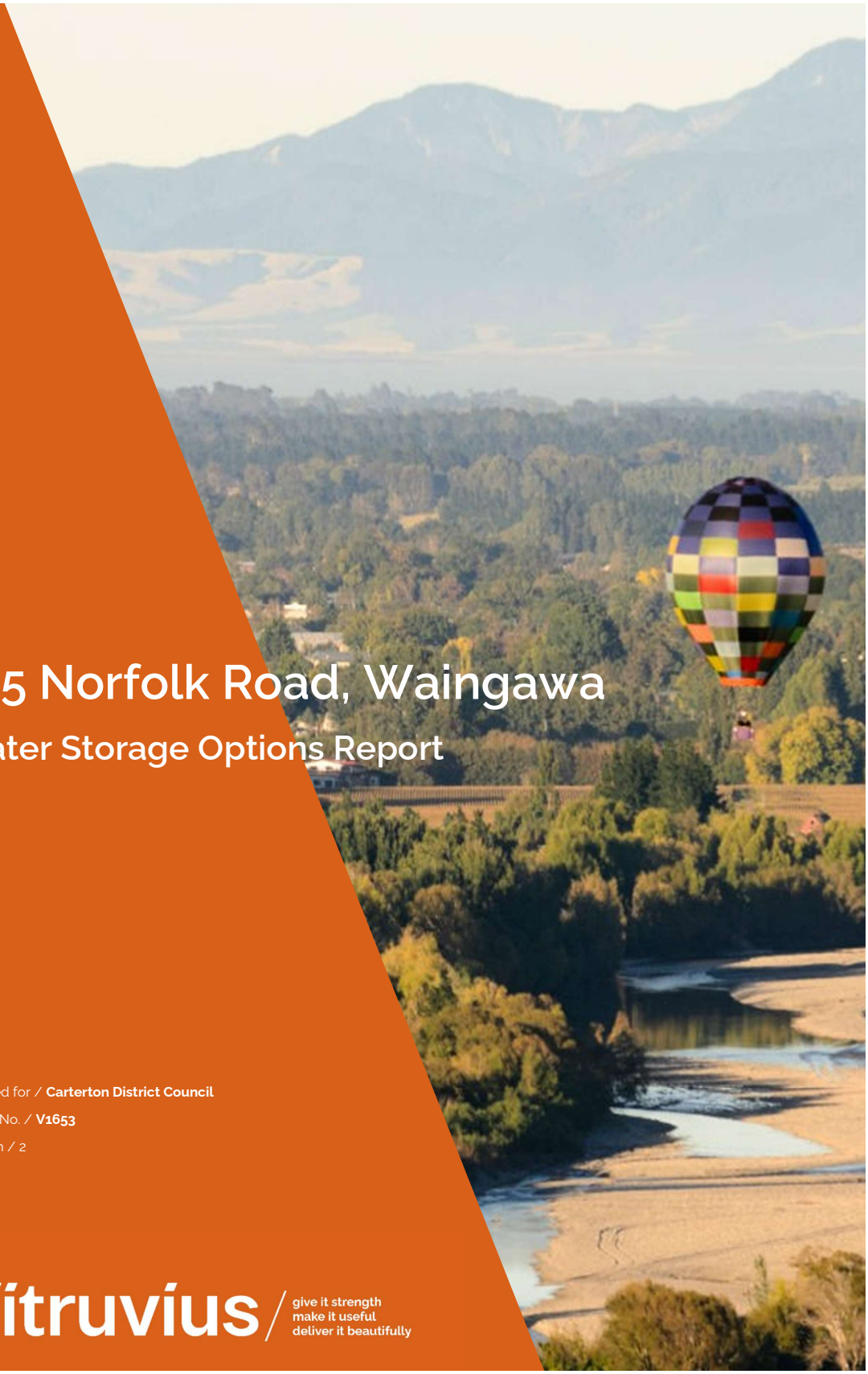
28 February 2025



145 Norfolk Road, Waingawa

Water Storage Options Report

Prepared for / **Carterton District Council**

Project No. / **V1653**

Revision / 2

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[1] Comment, Review, Draft, Approval, Final, As Requested, Copies for Distribution

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1 Executive Summary

Carterton District Council (CDC) is considering water storage opportunities at 145 Norfolk Road, Waingawa, Carterton.

CDC has engaged Vitruvius Limited (Vitruvius) to determine what feasible water storage options might exist at this site, to assess the likely high-level costs and benefits (qualitative) of these options and to recommend next step investigations.

Options eligible for the Regional Infrastructure Fund are preferred, as co-investment will be necessary. For clarity, these options are those that:

'Contribute to improving regional resilience and/or productivity.' (Ministry of Business Innovation and Employment, 2025).

The Site provides the following opportunities by virtue of the Site's features and location:

- The Site contains a length of water race that is supplied by a water take, with an estimated 10,000,000 m^3 excess water available.
- The Site is in a rural area, and adjacent to an industrial zone, therefore, water storage is considered in keeping with the environment, and unlikely to trigger strong community opposition.
- The Site is underlain by alluvial gravels, and it is considered that material onsite could be crushed and/or sieved and re-used onsite for the construction of the storage lagoon and sale.
- The storage can be positioned 'off-line' from the water race and any watercourse. This is expected to trigger less resource consent requirements and be less complex to consent overall.

The Site also has some issues, that could result in more expensive infrastructure being need, as follows::

- Irrigation storage is often constructed cost-effectively where a small bund can flood a stream or overland flow path that is then bounded by topography. The site is flat and will therefore need additional earthworks.
- The underlying gravel permeability indicates poor suitability for natural water retention. A waterproof liner (i.e., high density polyethylene (HDPE)) will be required to prevent excessive seepage losses.
- Pumping may be required to overcome the limited potential hydraulic grade across the site – in other words the Site elevation may not allow for gravity fed water supply.

Five options were considered for the site as follows:

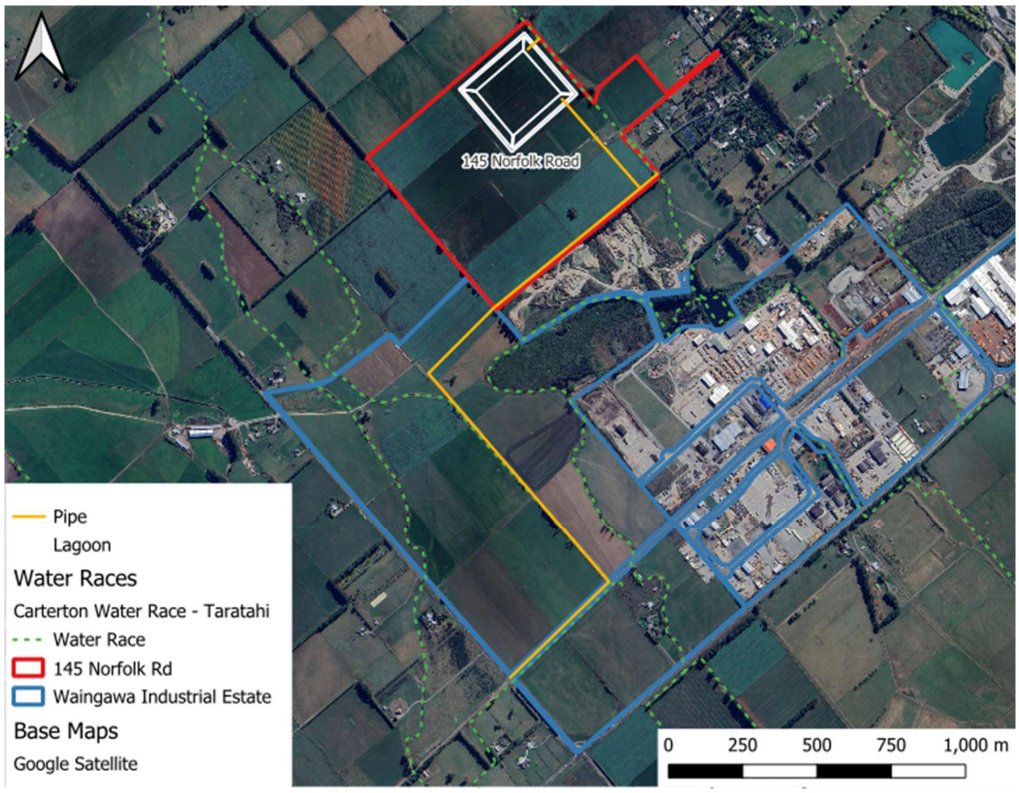
- A 1,200,000 m^3 seasonal irrigation water storage to supplement the Taratahi Water Race Scheme in summer (Option 1).
- A 28,800 m^3 process water storage to supply the remaining 120 ha of undeveloped industrial zoned land at Waingawa Industrial Estate to a level that would support very heavy water use industries. (option 2)
- A 270,000 m^3 combination of the above two water systems. (option 3)
- Municipal water storage to support the Carterton, (option 4) and Masterton (option 5) urban networks.

A summary of the options, cost estimates, and key differentiating risks and opportunities, are identified below. Ultimately, the preferred option was agreed with CDC to be Option 3.

Option	Class 4 Cost Estimate2	Benefits and Opportunities	Risks
Option 1: Taratahi Water Races Irrigation Water Storage 1,200,000 m³	$45,167,000	*Irrigation and increased productivity/land use change of up to 1,875 ha land.* *Efficient water use, reuse of existing infrastructure.* *Potential added value to construct using onsite quarry operations.*	*Consenting likely triggered by earthworks and dam creation.* *Security of ongoing take under s124* *Algal bloom risk.*
Option 2: Waingawa Industrial Estate Process Water Storage 28,800 m³	$6,015,000	*Enable heavy water industry of 120 ha industrial zoned land.* *Efficient water use, reuse of existing infrastructure.*	*Consenting likely triggered by earthworks and dam creation.* *Pressure on existing take consent and no security of ongoing take under s124*
Option 3: Combined Process Water and Irrigation Water Storage 270,000 m³	$14,892,000	*Enable heavy water industry of 120 ha industrial zoned land.* *Irrigation and increased productivity/land use change of up to 450 ha land.* *Efficient water use, reuse of existing infrastructure.* *Potential added value to construct using onsite quarry operations.*	*Consenting likely triggered by earthworks and dam creation.* *Pressure on existing take consent and no security of ongoing take under s124*
Option 4: Carterton Municipal Water Storage	*Option not considered further.*		
Option 5: Masterton Municipal Water Storage	*Option not considered further.*		

The assessment of water storage options at 145 Norfolk Road, Waingawa, highlights a preferred option for combined irrigation water storage for the Taratahi Water Race and process water storage for the Waingawa Industrial Estate. This offers tangible benefits for agricultural resilience and industrial growth. A basic layout is provided below:

[2] AACEI Class 4 cost estimate is suitable for a study or feasibility assessment, is based on a rough cost breakdown of critical items. It includes a 50% contingency.



To advance Option 3 the following steps/actions will need to be considered:

1. Investigate the co-investment funding requirements under the Regional Infrastructure Fund, i.e., would the provision of the land, or private farmers building their own intake and irrigation infrastructure be considered. Confirmation of who the co-investment partners are is needed.
2. Gathering of site data to inform design and confirm options and costing assumptions, including:
   a) Survey of the water race fall across the Site.
   b) Geotechnical investigations to determine winter peak groundwater level and presence of gravels for gravel extraction.
   c) Water balance assessment of the races.
3. Progressively develop the design of the preferred option, with standard hold points, to confirm technical feasibility, potential impact classification (PIC), and further refine costs and benefits.
4. Complete a planning assessment and consent strategy based on the developed concept design.
5. Apply for all necessary consents.
6. Procurement strategy to support accelerated construction timelines.

A rough and indicative programme to implement Option 3 is provided below, this programme should be expected to adjust as more information, including risks and dependencies, are identified:

Task	Duration	Start	End
Planning assessment and strategy (including investment requirements)	3 weeks	17 Mar 25	5 Apr 25
Site investigations	6 weeks	7 Apr 25	25 Apr 25
30% Design	5 weeks	14 Apr 25	16 May 2025
Hold Point 1 Client Review and Project Confirmation	2 weeks	19 May 25	30 May 25
100% Design	8 weeks	2 Jun 25	25 Jul 25
Hold Point 2 Client Review and Approval to proceed Resource Consent	2 weeks	28 Jul 25	8 Aug 25
Resource Consent Application and Processing	12 weeks	2 Jun 25	22 Aug 25
Hold Point 3 to Review Consent Conditions and proceed to Tender and Building Consent	2 weeks	25 Aug 25	5 Sept 25
Building Consent Application	1 week	25 Aug 25	1 Sept 25
Building Consent Processing	4 weeks	1 Sept Aug 25	26 Sep 25
Tender and contract award	6 weeks	25 Aug 25	3 Oct 25
Quarrying/construction/commissioning could start from early October 2025 within the earthworks season targeting the water storage lagoon and system to be in service by Winter 2026.			

This combined water storage solution supports both agricultural resilience and industrial expansion while leveraging available water allocations. It aligns with CDC's strategic vision and ensures long-term economic benefits for the region. The next steps involve feasibility validation, detailed design development, and securing final regulatory approvals. (No delays are anticipated due to funding or property acquisition) The project will proceed under the assumption that all required land and funding approvals have been considered.

2 Introduction

Carterton District Council (CDC) is considering water storage opportunities at 145 Norfolk Road, Waingawa, Carterton ("the Site"). CDC identified five systems that could benefit from additional storage including:

- Process water for the Waingawa Industrial Estate.
- Water races for stock water and irrigation supply.
- A combination of irrigation supply and process water
- Carterton municipal drinking water and fire water supply.
- Masterton municipal drinking water and fire water supply.

CDC has engaged Vitruvius Limited (Vitruvius) to determine what feasible water storage options might exist at the Site, to assess the likely high-level costs and benefits of these options, and to recommend a pathway forward.

Options eligible for the Regional Infrastructure Fund are preferred, as co-investment will be necessary. For clarity, these options are those that:

'Contribute to improving regional resilience and/or productivity.' (Ministry of Business Innovation and Employment, 2025).

2.1 PURPOSE

The purpose of this report is to determine if there is a viable water storage option at the Site that warrants further investigation, and that may be eligible for co-investment from the Regional Infrastructure Fund.

2.2 OBJECTIVE

To define feasible water storage options for the Site that align with CDCs objectives. To estimate high-level costs and identify risks and benefits (qualitative) for these water storage options and recommend the most viable option and pathway forward.

2.3 SCOPE

This technical report covers the following assessment to achieve the above objective:

- Contextual review of:
  - The Site.
  - Taratahi Water Race Scheme.
- Identify existing Issues.
- Investigate concept Water storage options assessment, including:
  - Feasibility.
  - Concept description.
  - Cost estimate.
  - Risks and opportunities.
- Options assessment and a pathway forward.

3 Background/Context

3.1 SITE DESCRIPTION

The Site is at 145 Norfolk Road (LOTS 3-6 DP 340153) and is in the Carterton District. The location and extents of the Site are shown in Figure 1. It is to the southwest of the Waingawa River and the northwest of the Waingawa Industrial Estate. The Site covers 51 ha and the current land use is arable. Based on Wellington Region LiDAR (2013-2014) the site is generally flat, with elevation between 125 – 131 m relative level (RL) (NZVD2016).

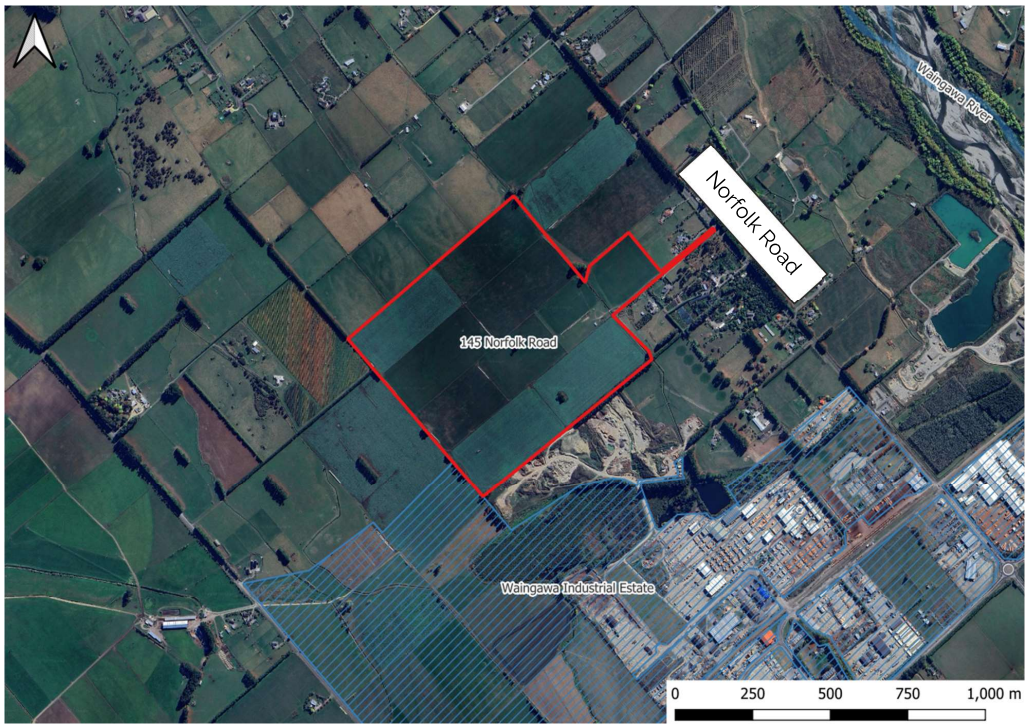


Figure 1: Site location

We have reviewed six borelogs accessed by the New Zealand Geotechnical Database (26 February 2025). The boreholes were located outside of the Site, but near the northeast and southeast boundaries.

These demonstrate that the area is underlain by alluvium, and described as variable layers of gravels and boulders, some bound in clays or containing sands and silts. Four of these borelogs identify groundwater level between 4.0 – 5.2 m below ground level (BGL), and 2.8m below the casing. The clearest to interpret of these borelogs states the groundwater level at 4.0 – 4.2 mBGL in November 2008. This may not reflect the worst-case (highest) groundwater level as worst-case groundwater levels typically occur in late winter, and 2008 was considered to be a dry year.

3.2 TARATAHI WATER RACE

A water race runs through the Site, which forms part of the Taratahi Water Race Scheme. The Taratahi Water Race Scheme comprises of a network of earthen channels, and some pipe connections. These use gravity to convey water abstracted from the Waingawa River out to approximately 9,500 ha of agricultural land, where it can be used for stock water and irrigation.

The water race enters the Site at the northern corner at approximately 134 mRL and exits the eastern corner at 130 mRL (Wellington Region LiDAR, 2013-2014). This assessment is based on using the existing water take consent and existing water race for conveyance to the Site.

CDC hold the consent to take water, manage the operation of the water races, and the stock water and irrigation connection permits. The water races are owned by the landowners of the property that they pass through. They are funded via targeted rates to the water race owners and managed by a committee that comprises of property owners and CDC (Carterton District Council, 2023).

3.2.1 Water Race Network

The Taratahi Water Race Scheme covers a large agricultural area generally east of Carterton and bounded by the Waingawa River to the northeast, and the Ruamahanga River to the southwest. A layout plan of the water races is provided in Figure 2.

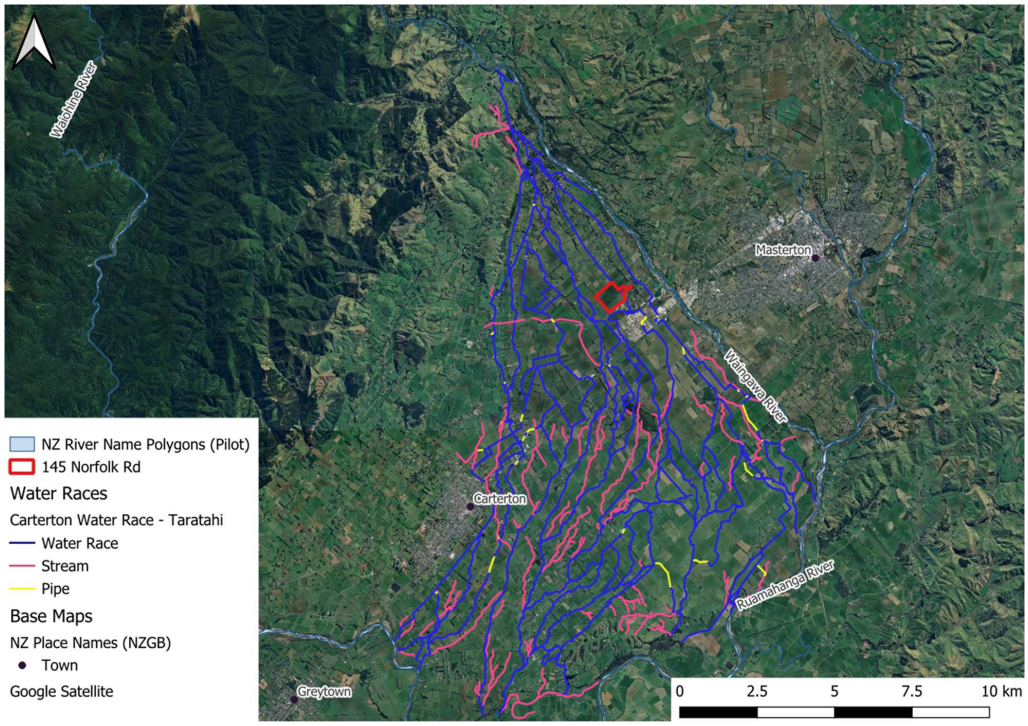


Figure 2: Taratahi Water Race Scheme layout plan

3.2.2 Water Take

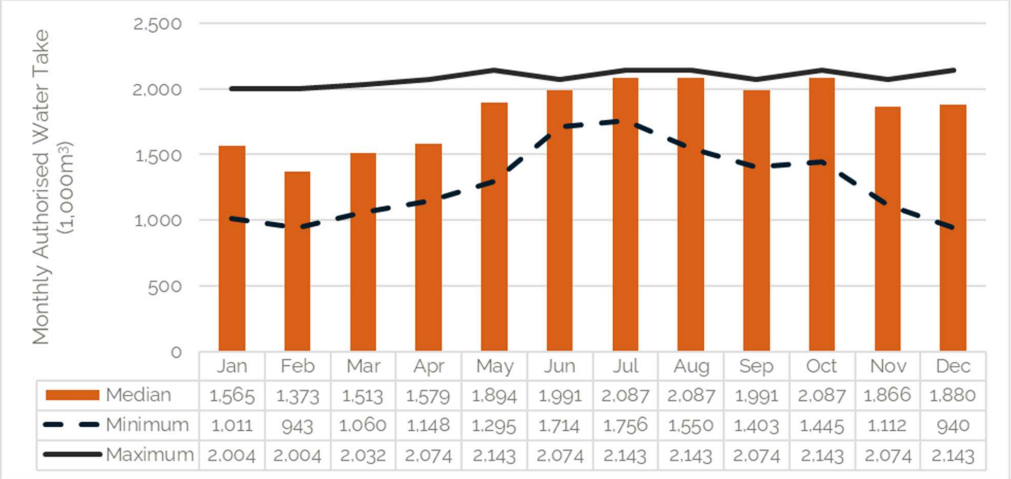
CDC hold a resource consent (WAR010227 V3A) with Greater Wellington Regional Council (GWRC) to take water from the Waingawa River into the Taratahi Water Race Scheme. The consent has lapsed, as of 28/06/2023, and CDC is operating legally under section 124 of the Resource Management Act (RMA). CDC have applied for a new consent (WAR230259) - this is currently on hold for further information under section 92 of the RMA.

The maximum water take is dictated by the Waingawa River flow at Kaituna Monitoring Station, located at the foothills of the Tararua Ranges, and accessed via Blakes Road. The water take limits, based on this flow gauge, are shown in Table 1 as follows:

Table 1: Taratahi Water Race Scheme Water Take Limits

Waingawa River Flow (L/s)	Take Limit (L/s)	Take Limit (m³/d)
> 3,500	800	69,100
1,900 - 3,500	480	41,500
1,700 - 1,900	410	35,400
< 1,700	337	29,100

We have used the Waingawa River Flow at Kaituna Monitoring Station daily flow rates from 1 January 1995 to 11 February 2025 (30 years), to assess the maximum water take across a range of climatic conditions. A summary of this assessment is provided in Figure 3 and in the below text.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Median	1,565	1,373	1,513	1,579	1,894	1,991	2,087	2,087	1,991	2,087	1,866	1,880
Minimum	1,011	943	1,060	1,148	1,295	1,714	1,756	1,550	1,403	1,445	1,112	940
Maximum	2,004	2,004	2,032	2,074	2,143	2,074	2,143	2,143	2,074	2,143	2,074	2,143

Figure 3: Graph of median, minimum and maximum authorised monthly water take

The data suggests that while the Taratahi Water Race Scheme has the potential to take up to 800 L/s, actual abstraction is often limited by river conditions and consent-imposed restrictions, meaning the available water supply fluctuates seasonally and in response to natural variations in river flow and the climate. The ability to take water is most constrained between January and April (inclusive).

The total annual authorised water take can be summarised as follows:

- Median of 21,387,000 m³/yr.
- Average of 21,579,000 m³/yr.
- Range of 19,848,000 – 23,542,000 m³/yr.

3.2.3 Water Quality

The water quality present in the Taratahi Water Race Scheme has not been assessed as part of this scope of works. The raw water quality is expected to reflect the surrounding agricultural land use. Typically, in agricultural catchments, surface water quality may have faecal contamination, elevated suspended solids and nutrients.

3.3 REGIONAL INFRSTRUCTURE FUND

The Regional Infrastructure Fund as a New Zealand Government allocation of $1.2 billion over three years to support regional infrastructure, primarily through loan and equity investments. Criteria relevant at this stage of screening are outlined below:

Eligibility requirements:

- Tangible or built asset, or physical works to protect an existing asset.
- Contribute to improving regional resilience and/or productivity, and alignment with the regional priorities, which in the Wairarapa include:
  - Water resilience.
  - Food and fibre.
- Co-investment from private sector, iwi or other non-government entity.

Exclusions:

- Potable water, except for community owned schemes.
- Purchase of land, except where essential to the project.

4 Site Issues and Opportunities

The Site has been identified based on land availability, rather than technical considerations. This section highlights the specific issues and opportunities with water storage, at this property, from a technical standpoint.

4.1 ISSUES

The Site's features present some significant cost acceleration issues:

- Irrigation storage is often constructed cost-effectively where a small bund can flood a stream or overland flow path, otherwise bounded by topography, i.e., surrounding higher land (hills). The Site is flat and doesn't offer this advantage.
- The underlying gravel permeability indicate poor suitability for natural water retention. A waterproof liner (i.e., HDPE) will be required to prevent excessive seepage losses.
- As the Site is flat, hydraulic grades of the Water Race System across the site are expected to be very flat. It is reasonable to expect that initial design identifies pumping is required to make this irrigation storage feasible. This is currently not allowed for in the cost estimate.

4.2 OPPORTUNITIES

The Site features provide the following opportunities/advantages:

- The Site is in a rural area, near an industrial park, with no identified environmental, archaeological or hazard layers. It is away from natural watercourses and wetlands. These features mean that a water storage lagoon is in keeping with the surrounding environment, and unlikely to influence any critical receptors based on its location.
- The Site is underlain by alluvial gravels, that are quarried by neighbours. Based on nearby quarries in similar materials, it is considered that material onsite could be crushed and/or sieved and re-used onsite for the construction of the storage lagoon. There may be an opportunity to position the storage lagoon to maximise cut material for crushing and/or sieving, and sale.
- At the Site, the storage can be positioned 'off-line' from the water race and any watercourse. This is expected to trigger less resource consent requirements and be less complex to consent overall.
- The Site is flat, and earthworks are expected to be cut/fill balanced or maximising cut material to support gravel extraction. Because of this, the required construction will result in a low embankment height (<4m), avoiding classification as a large dam.

5 Water Storage Options

The following water storage options were considered at the Site, focusing on CDC's water systems that will benefit from water storage, and those that align with the Regional Infrastructure Fund:

- Option 1: Taratahi Water Race Scheme Irrigation Water Storage
- Option 2: Waingawa Industrial Estate Process Water Storage
- Option 3: Combined Purpose Water Storage
- Option 4: Carterton municipal drinking water and fire water supply.
- Option 5: Masterton municipal drinking water and fire water supply.

5.1 OPTION 1: TARATAHI WATER RACE SCHEME IRRIGATION WATER STORAGE

This water storage option will capture and hold excess water in winter, for irrigation purposes in summer. This will act to balance the supply and demand of water, increasing the water available for irrigation, without putting additional pressure on the Waingawa River water take allocation. The increase in irrigation water will support increased farm productivity, and land use change to high water demand agriculture.

A photograph of an irrigation storage lagoon is included in Figure 4 below.



Figure 4: Photograph showing a lined earthen irrigation lagoon (Viking Containment , 2025)

5.1.1 Option 1: Feasibility

This option is feasible. Several water races within the Taratahi Water Race Scheme pass through the Site or nearby (Figure 5). The proximity means that the storage can take excess water from the existing race via a short run of pipe. Water supply back into the water race scheme in summer can also be achieved via a short run of pipe. These water races service approximately 9,500 ha of agricultural land, which can all benefit from the additional water availability for irrigation via the established water race network.

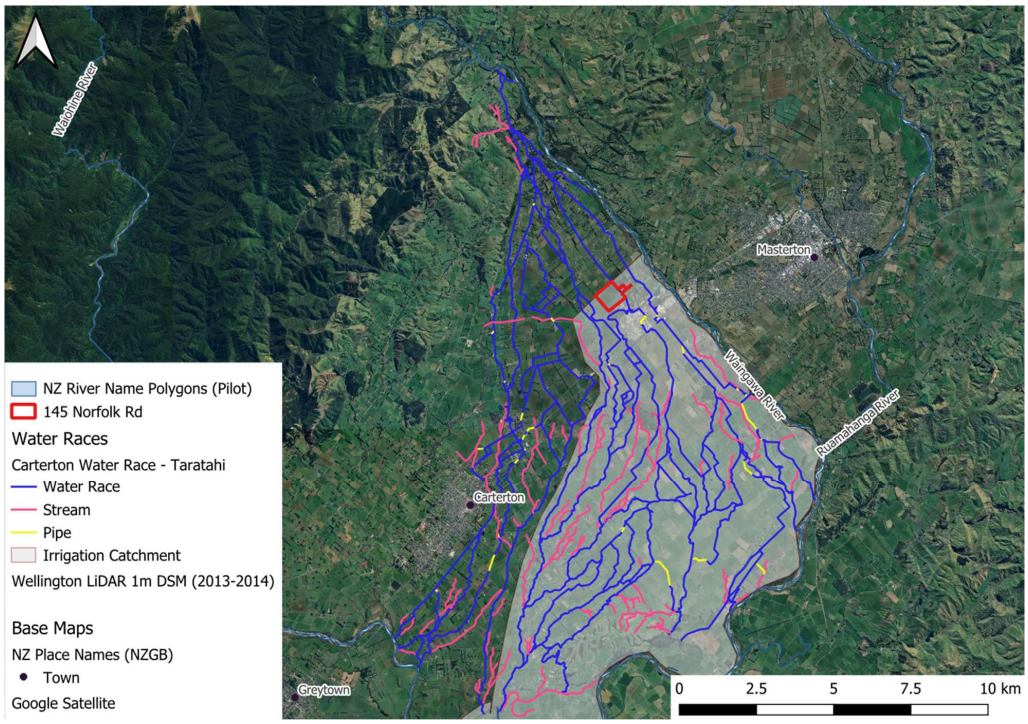


Figure 5: Potential irrigation water storage supply area that would be supported by Option 2

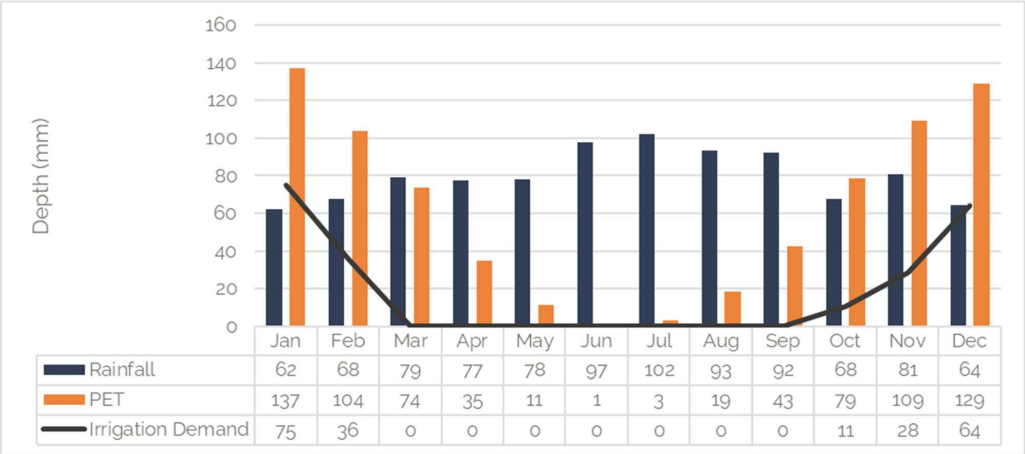
The water race network does not require substantial pressures, and it may be achievable to have inlet and outlet pipework to be gravity fed, controlled by automated valves. Irrigation and stock water does not need to meet the stringent quality requirements set out in the New Zealand Drinking Water Standards (Parlimentary Counsel Office, 2022).The raw water quality doesn't have to be monitored and managed via treatment, reducing capital and operational costs.

5.1.2 Option 1: Sizing

5.1.2.1 Irrigation Demand

Annual average irrigation demand has been approximated using a monthly water balance, summarised in Figure 6[3].

[3] Assessment based on rainfall and PET data at Masterton Automatic Weather Station (AWS) between April 2009 and November 2024, inclusive (National Institute of Water and Atmospheric Research, 2024). There were 81 days of rainfall data missing, gaps were populated based on the average daily rainfall depth for that month based on the remaining rainfall record. There were 144 days of PET data missing, gaps were populated based on the average daily PET depth for that month based on the remaining PET record



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	62	68	79	77	78	97	102	93	92	68	81	64
PET	137	104	74	35	11	1	3	19	43	79	109	129
Irrigation Demand	75	36	0	0	0	0	0	0	0	11	28	64

Figure 6: Monthly average rainfall, Potential Evapotranspiration (PET) and estimated irrigation demand

The above graph demonstrates that the agricultural demand for irrigation increases between the months of October to February (inclusive). This may shift forward to November to March following a more detailed soil moisture-based irrigation demand assessment. As expected, irrigation demand is highest in Summer (December – February, inclusive).

5.1.2.2 Storage Balance

The optimal irrigation storage volume is highly dependent on how many farmers choose to irrigate their properties once the water is available. The following assumptions have been made for the purposes of this report:

- 90% of the area is technically and financially feasible to irrigate
- 50% of the farms in the 9,500 ha service area use the water for irrigation purposes.
- Stock water use of 120 L/ha/day (Hall, 2012)
- 30% of the water take is lost via seepage and evapotranspiration (Greater Wellington Regional Council, 2003).

Based on these assumptions, an optimal storage volume would be approximately 2,700,000 m^3. This is based on a monthly average water balance, and is governed by irrigation demand (i.e., residual water take may be available for alternate uses). The storage basis set out in Table 2.

Table 2: Average monthly water balance storage calculation

Month	Average Water Take (m^3/month)	Stock Water (m^3/month)	Estimated Losses (m^3/month)	Average Irrigation Demand (m^3/month)	Excess Water Take (m^3/month)	Excess Irrigation Demand (m^3/month)
January	1,555,000	4,000	467,000	3,211,000	0	1,656,000
February	1,366,000	3,000	410,000	1,549,000	0	183,000
March	1,529,000	4,000	459,000	0	1,066,000	0
April	1,597,000	3,000	479,000	0	1,115,000	0
May	1,853,000	4,000	556,000	0	1,293,000	0
June	1,952,000	3,000	586,000	0	1,363,000	0
July	2,046,000	4,000	614,000	0	1,428,000	0
August	2,058,000	4,000	617,000	0	1,437,000	0
September	1,935,000	3,000	581,000	0	1,351,000	0
October	2,038,000	4,000	611,000	457,000	966,000	0
November	1,803,000	3,000	541,000	1,203,000	56,000	0
December	1,834,000	4,000	550,000	2,731,000	0	897,000
Total	**21,566,000**	**43,000**	**6,471,000**	**9,151,000**	**10,075,000**	**2,736,000**

5.1.3 Option 1: Storage Volume

The optimum storage volume will not be accommodated within the 55 ha site boundaries, therefore this optioneering assessment is based on a storage volume of 1,200,000 m^3 that can reasonably be accommodated within the Site boundaries. This will provide supplementary water to support summer irrigation for approximately 1,875 ha. This option can be scaled to any storage volume, to match available capital, but would be able to service a lesser irrigation area.

5.1.4 Option 1: Concept Description

To implement Option 1 at the Site, the following solution is recommended:

- Inlet works that gravity intercept the water race near the northern site boundary.
- 1,200,000 m^3 HDPE lined earthen lagoon within the site boundary.
- Outlet works to gravity connect to the four closest downstream water races.
- Level sensors that connect to automated controls in the inlet and outlet valves.

The above solution excludes the following elements:

- On-farm intake, distribution, and irrigation infrastructure is not included in this assessment, as it assumes this will be constructed owned and operated by farmers, a farm scale.
- Any upgrades required for the Taratahi Water Race Scheme to maximise water take. This is because the infrastructure condition and capacity has not been assessed within this scope of work, and the requirements, if any, to upgrade the system are undefined.

5.1.5 Option 1: Cost Estimate

We have prepared a rough order cost estimate for this irrigation water storage option. It is based on several high-level assumptions as follows:

- No allowance has been made for:
  - User end infrastructure, i.e. irrigation, water intake, conveyance.
  - Any infrastructure upgrades required for the Taratahi Water Race Scheme to maximise water take.
  - Operational costs.
  - Property purchase.
  - Staging capital works to align with growth in water demand is not considered.
- Other cost assumptions include:
  - All costs in New Zealand Dollars
- Design assumptions include:
  - An HDPE lined lagoon provides storage.
  - Cut to fill balance over the site.
- Costs are based on:
  - QV cost builder, and
  - Inflation-adjusted tender rates to December 2024.

The cost estimate breakdown is provided in Table 3. A more detailed breakdown is in Appendix A

Table 3: Cost estimate breakdown for irrigation water storage (Option 1)

Item	Description	Amount
e	Preliminary and General (15%)	$3,415,000
2	Inlet works	$21,000
3	Storage Lagoon	$22,228,000
2	Outlet works	$73,000
4	Electrical and Control (2%)	$446,000
5	Professional Services (15%)	$3,928,000
6	Contingency (50%)	$15,056,000
	Class 4[4] Cost Estimate	**$45,167,000**

5.1.6 Option 1: Risks and Mitigations

The following high-level risks have been identified with Option 1, and potential mitigations considered.

- Earthen lagoon construction will trigger earthworks consents, and possibly other consents. A planning assessment and consent strategy will better define and mitigate this risk.
- The lagoon construction will create a dam to be classified under the New Zealand Building Code and consented, monitored and managed according to its classification. During design, a

[4] AACEI Class 4 cost estimate is suitable for a study or feasibility assessment, is based on a rough cost breakdown of critical items. It includes a 50% contingency.

PIC should be carried out to define the likely consent, management and monitoring requirements.

- Increasing water take for irrigation purposes may reduce water availability for stock water use in the Taratahi Water Race Scheme or necessitate changes to consent limits and/or additional water takes. A full assessment of total water demand and losses could better define water take capacity issues.
- The water demand is dependent on irrigation uptake, and if uptake is poor the storage may go underutilised. Staging of the water storage could provide the benefit and mitigate the risk of underused storage capacity.
- Grades through the Taratahi Water Race Scheme at the Site are limited, and groundwater may be shallow. Site survey, ground investigations and concept design will be needed to confirm achievable storage depths.
- Eutrophication and algal bloom risk in the storage lagoon. To mitigate this risk would require aeration installation. This item is not allowed for in the above cost estimate.
- Unknown ground conditions at time of development may be encountered. This reduce this risk ground investigations would be required.

5.1.7 Option 1: Opportunities

The following opportunities for value added and broader outcomes have been identified with Option 1:

- Excellent alignment with the Regional Infrastructure Fund to improve water supply resilience, and increase farm productivity, and therefore productivity in primary food production.
- Depending on local groundwater conditions and geology present, the lagoon earthworks could be designed to maximise cut material, to be sold/exported to provide additional revenue. Quarry consents may be required.
- Seasonal water storage will allow for more efficient water use, taking water in the wet season when water is abundant, for use in the dry season when water is scarce.
- Large lagoon offers potential for water recreational uses, for example Lake Breamore, Whareama (Lake Braemore Owners, 2025). The impact on design lagoon design and recreational water quality requirements are not assessed in this report.

5.2 OPTION 2: WAINGAWA INDUSTRIAL ESTATE PROCESS WATER STORAGE

To the immediate east of the site, is the Waingawa Industrial Estate zone (Figure 7). This zone is approximately 250 ha, with approximately 130 ha developed and connected with potable water supply (via Masterton Municipal Water Network) and process water supply (via Taratahi Water Race Scheme). There is 120 ha of undeveloped agricultural land available for future industrial use.

This option proposes a water storage solution at the Site to supply the remaining 120 ha of undeveloped industrial zoned land with untreated process water. The water storage could support very heavy water use industries with a Peak Daily Demand (PDF) of 12 L/d/m^2 (Watercare, 2021).

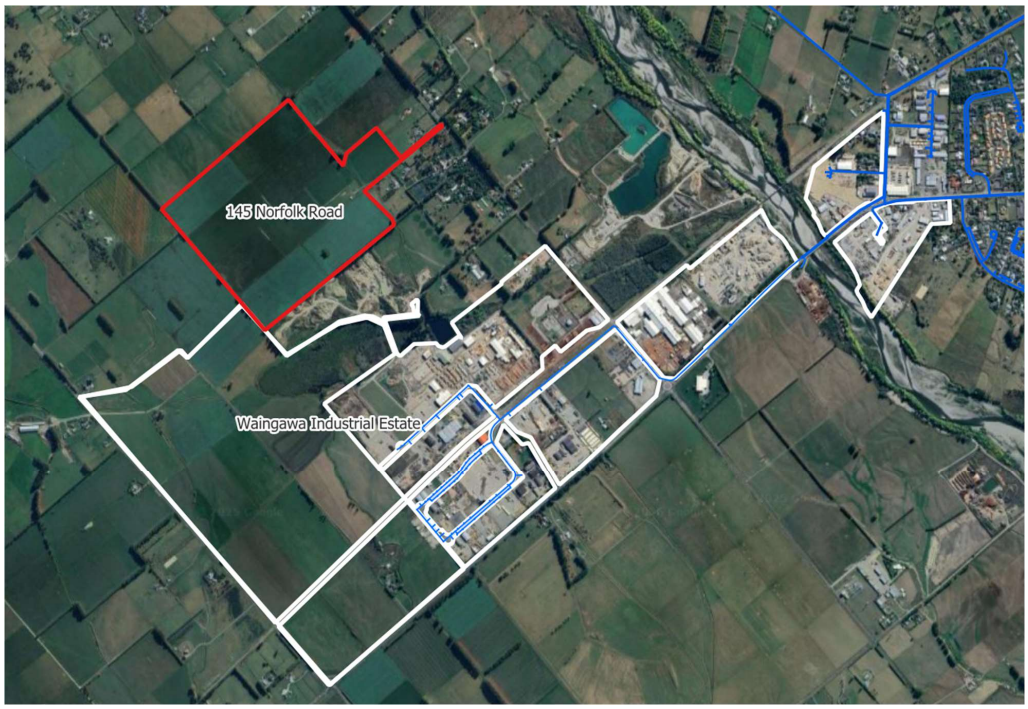


Figure 7: Waingawa Industrial Estate zone (white).

5.2.1 Option 2: Feasibility

The Site's proximity and elevation support a low-pressure high-volume process water supply, refer to Table 4 below.

Table 4: Process water storage potential elevation head and conveyance distance

Area Description	Elevation (NZVD, 2016)	Potential Elevation Head	Distance from the Site
145 Norfolk Road ("The Site")	125 – 134 mRL	-	-
Waingawa Industrial Estate – Greenfield	114 – 125 mRL	0 – 20 m	0.2 -2.0 km

Depending on its ultimate use, process water may not need to meet the stringent quality requirements set out in the New Zealand Drinking Water Standards (Parliamentary Counsel Office, 2022). Therefore, the raw water quality doesn't have to be monitored and managed via treatment, with specific industries providing onsite treatment, appropriate to the intended use.

5.2.2 Option 2: Sizing

To support wet industry in the 120 ha of undeveloped Waingawa Industrial Estate, we propose a storage volume of ~28,800 m^3. The basis for this volume is provided in Table 5 below.

Table 5: Process water storage sizing

Parameter	Value	Unit	Source
Waingawa Industrial Estate Area (Undeveloped)	120	ha	Wairarapa Proposed District Plan zones
Wet Industry Peak Daily Usage	12	L/d/m²	Watercare (2021)
Waingawa Industrial Estate Peak Daily Demand (PDD)	14,400	m³/d	Area x Usage
Minimum Daily Take	29,117	m³/d	Consent limits
Storage Resilience	2.0	x PDF	Assumed (will need confirmation with CDC)
Proposed Storage Volume	**28,800**	**m³**	

5.2.3 Option 2: Concept Description

To implement Option 2 at the Site, the following solution is recommended:

- Inlet works that gravity intercept the water race near the northern site boundary.
- 28,800 m³ HDPE lined earthen lagoon within the site boundary.
- Level sensors that connect to automated controls in the inlet and outlet valves.
- Reticulation network for the Waingawa Industrial Estate.

5.2.4 Option 2: Cost Estimate

We have prepared a rough order cost estimate for the process water storage option based on several high-level assumptions. Key assumptions include:

- No allowance for:
  - Any infrastructure upgrades required for the Taratahi Water Race Scheme to maximise water take.
  - Operational costs.
  - Property purchase.
  - Staging capital costs to align with growth in water demand is not considered.
- Other cost assumptions include:
  - All costs in New Zealand Dollars and Goods and Services Tax (GST) is excluded.
- Design assumptions include:
  - Storage is provided by an HDPE lined lagoon.
  - Cut to fill balance over the site.
- Costs are based on:
  - QV cost builder.
  - CDC figure for Waingawa Industrial Estate Reticulation of $3M including contingency (See Items 4, outlet works and reticulation and 7 Contingency).
  - Inflation-adjusted tender rates to December 2024.

The cost estimate breakdown is provided in Table 6, more detailed breakdown is in Appendix A

Table 6: Cost estimate breakdown for process water storage (Option 2)

Item	Description	Amount
1	Preliminary and General (20%)	$581,000
2	Inlet works	$21,000
3	Water Storage works	$733,000
4	Outlet Works and Reticulation	$1,667,000
5	Electrical and Control (20%)	$484,000
6	Professional Services (15%)	$523,000
7	Contingency (50%)	$2,005,000
	Cost Estimate	**$6,015,000**

5.2.5 Option 2: Risks and Mitigations

The following high-level risks and potential mitigations have been identified with Option 2:

- Earthen lagoon construction will trigger earthworks consents, and possibly other consents. A planning assessment and consent strategy will better define and mitigate this risk.
- The lagoon construction will create a dam to be classified under the New Zealand Building Code and monitored/managed according to its classification. During design, complete a PIC of a dam at the site to define the likely consent, management and monitoring requirements.
- When flows in the Waingawa River are low, the peak process demand represents 50% of the authorised water take, this may reduce water availability to other users in the Taratahi Water Race Scheme or necessitate changes to consent limits and/or additional water takes. A full assessment of total water demand could better define water take capacity issues.
- Change in water take purpose may not be covered under the existing consent, and this could trigger a variation or new water take consent. A planning assessment and consent strategy will better define and mitigate this risk.
- The water demand is dependent on the industrial sites that occupy the undeveloped part of the Waingawa industrial area. Staging of the water storage could provide the benefit and mitigate the risk of underused storage capacity.
- Grades through the Taratahi Water Race Scheme at the Site are limited, and groundwater may be shallow. Site survey, ground investigations and concept design are recommended to confirm achievable storage depths.
- Unknown ground conditions may be encountered during construction. To reduce this risk and inform design, ground investigations would be required.

5.2.6 Option 2: Opportunities

The following opportunities for value added and broader outcomes have been identified with Option 2:

- Good alignment with the Regional Infrastructure Fund to improve water supply resilience, and potential to support food and fibre processing industries.
- Depending on local groundwater conditions and geology present, the lagoon earthworks could be designed to maximise cut material, to be sold/exported to provide additional revenue. Quarry consents may be required.

- Integrating water race systems into the process water network could promote more efficient water use and management within the district.
- Repurposing existing water infrastructure aligns with sustainable practices, potentially reducing the need for developing new water infrastructure.
- A reliable and efficient water supply is crucial for industrial operations. Increased water supply in this area could attract wet industries to the Waingawa Industrial Estate, fostering economic development.
- Lagoon could be integrated with surrounding greenspace at the site that could be developed for land-based recreational uses.
- Lagoon will only occupy a small area of the site (~0.5 ha), leaving the remaining area available for other uses, including other water storage uses assessed above.

5.3 OPTION 3: COMBINED IRRIGATION AND PROCESS WATER STORAGE

Option 3 considers a dual-purpose water storage lagoon. To seasonally store water for irrigation (described in Option 1), and to supply the undeveloped industrial zoned land with untreated process water to support very heavy water use industries (Option 2). This option targets a $15M capital cost, as an expected budget from CDC. See Figure 8 below for an indicative layout.

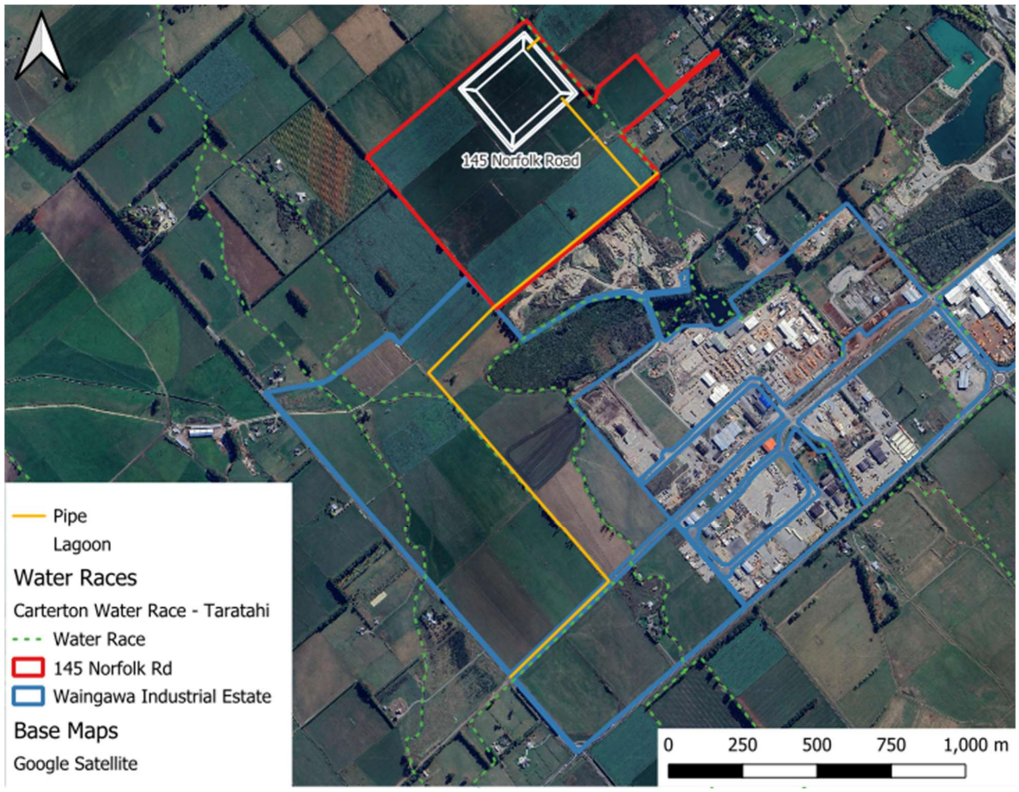


Figure 8: Option 3 indicative layout

5.3.1 Option 3: Feasibility

As for the above options, this would be feasible at the site. Consideration would need to be given to water supply priorities and outlet arrangement to achieve the priorities,

5.3.2 Option 3: Sizing

This option proposed construction of a 270,000 m^3 storage lagoon to target a $15M capital cost, with allowances for ancillary works. The breakdown of storage elements is provided in Table 7.

Table 7: Combined water storage sizing

Parameter	Value	Unit	Source
Process Water Storage Volume	28,800	m^3	See Table 5.
Irrigation Water Storage Volume	231,200	m^3	Suitable for 350-450 ha irrigation.
Total Water Storage Volume	260,000	m^3	

5.3.3 Option 3: Concept Description

To implement Option 3 at the Site, the following solution is recommended:

- Inlet works that gravity intercept the water race near the northern site boundary.
- 260,000 m^3 HDPE lined earthen lagoon within the site boundary.
- Level sensors that connect to automated controls in the inlet and outlet valves.
- Outlet works to gravity connect to the four closest downstream water races.
- Reticulation network for the Waingawa Industrial Estate.

The above solution excludes the following elements:

- On-farm intake, distribution, and irrigation infrastructure is not included in this assessment, as it assumes this will be constructed owned and operated by farmers, a farm scale.
- Any upgrades required for the Taratahi Water Race Scheme to maximise water take. This is because the infrastructure condition and capacity has not been assessed within this scope of work, and the requirements, if any, to upgrade the system are undefined.

5.3.4 Option 3: Cost Estimate

We have prepared a rough order cost estimate for the process water storage option based on several high-level assumptions. Key assumptions include:

- No allowance for:
  - Any infrastructure upgrades required for the Taratahi Water Race Scheme to maximise water take.
  - Operational costs.
  - Property purchase.
  - Staging capital costs to align with growth in water demand is not considered.
- Other cost assumptions include:
  - All costs in New Zealand Dollars and Goods and Services Tax (GST) is excluded.
- Design assumptions include:
  - Storage is provided by an HDPE lined lagoon.
  - Cut to fill balance over the site.

- Costs are based on:
  - QV cost builder.
  - CDC figure for Waingawa Industrial Estate Reticulation of $3M including contingency (See Item 4, Outlet works and reticulation and 7 contingency).
  - Inflation-adjusted tender rates to December 2024.

The cost estimate breakdown is provided in Table 8, more detailed breakdown is in Appendix A

Table 8: Cost estimate breakdown for combined water storage (Option 3)

Item	Description	Amount
1	Preliminary and General (15%)	$1,132,000
2	Inlet works	$21,000
3	Storage Lagoon	$5,127,000
4	Outlet works and reticulation	$1,667,000
5	Electrical and Control (10%)	$686,000
6	Professional Services (15%)	$1,295,000
7	Contingency (50%)	$4,964,000
	Cost Estimate	**$14,892,000**

5.3.5 Option 3: Risks and Mitigations

The following high-level risks and potential mitigations have been identified with Option 2:

- Earthen lagoon construction will trigger earthworks consents, and possibly other consents. A planning assessment and consent strategy will better define and mitigate this risk.
- The lagoon construction will create a dam to be classified under the New Zealand Building Code and monitored/managed according to its classification. During design, complete a PIC of a dam at the site to define the likely consent, management and monitoring requirements.
- The water storage supports additional water users that may reduce water availability to other users in the Taratahi Water Race Scheme or necessitate changes to consent limits and/or additional water takes. A full assessment of total water demand could better define water take capacity issues.
- Change in water take purpose may not be covered under the existing consent, and this could trigger a variation or new water take consent. A planning assessment and consent strategy will better define and mitigate this risk.
- Grades through the Taratahi Water Race Scheme at the Site are limited, and groundwater may be shallow. Site survey, ground investigations and concept design are recommended to confirm achievable storage depths.
- Eutrophication and algal bloom risk in the storage lagoon. To mitigate this risk would require aeration installation. This item is not allowed for in the above cost estimate.

- Unknown ground conditions at time of development may be encountered. This reduce this risk ground investigations would be required.

5.3.6 Option 3: Opportunities

The following opportunities for value added and broader outcomes have been identified with Option 2:

- Excellent alignment with the Regional Infrastructure Fund to improve water supply resilience, and support food and fibre processing industries.
- Depending on local groundwater conditions and geology present, the lagoon earthworks could be designed to maximise cut material, to be sold/exported to provide additional revenue. Quarry consents may be required.
- Integrating water race systems into the process water network could promote more efficient water use and management within the district.
- Seasonal water storage will allow for more efficient water use, taking water in the wet season when water is abundant, for use in the dry season when water is scarce.
- Repurposing existing water infrastructure aligns with sustainable practices, potentially reducing the need for developing new water infrastructure.
- A reliable and efficient water supply is crucial for industrial operations. Increased water supply in this area could attract wet industries to the Waingawa Industrial Estate, fostering economic development.
- Lagoon will only occupy a small area of the site (6 ha), leaving the remaining area available for other uses, including land-based recreational uses.
- Lagoon may offer potential for water recreational uses, for example Lake Breamore, Whareama (Lake Braemore Owners, 2025). The impact on design lagoon design and recreational water quality requirements are not assessed in this report.

6 Option Summary

Table 9:: Options assessment summary

Option	Class 4 Cost Estimate	Risks	Opportunities
Option 1: Taratahi Water Races Irrigation Water Storage **1,200,000 m³** ***Optimum 2,700,000 m³***	$45,167,000	– Earthen lagoon construction will trigger earthworks consents. – The lagoon construction will create a dam to be classified under the New Zealand Building Code. – Increasing water take for irrigation purposes may reduce water availability for stock water use in the Taratahi Water Race Scheme or necessitate changes to consent limits and/or additional water takes. – The water demand is dependent on irrigation uptake, and if uptake is poor the storage may go underutilised. – Grades through the Taratahi Water Race Scheme at the Site are limited, and groundwater may be shallow, impacting feasible vertical storage limits. – Eutrophication and algal bloom risk in the storage lagoon. – Unknown ground conditions at time of development may be encountered.	– Excellent alignment with the Regional Infrastructure Fund. – Improve farm resilience to extreme weather events and climate change and increase farm productivity. – Depending on local groundwater conditions and geology present, the lagoon earthworks could be designed to maximise cut material, to be sold/exported to provide additional revenue. Quarry consents may be required. – Seasonal water storage will allow for more efficient water use, taking water in the wet season when water is abundant, for use in the dry season when water is scarce. – Large lagoon offers potential for water recreational uses, for example Lake Breamore, Whareama (Lake Breamore Owners, 2025). The impact on design lagoon design and recreational water quality requirements are not assessed in this report.
Option 2: Waingawa Industrial Estate Process Water Storage **28,800 m³**	$6,015,000	– Earthen lagoon construction will trigger earthworks consents. – The lagoon construction will create a dam to be classified under the New Zealand Building Code. – When flows in the Waingawa River are low, the peak process demand represents 50% of the authorised water take, this may reduce water availability to other users in the Taratahi Water Race Scheme or necessitate changes to consent limits and/or additional water takes. – Change in water take purpose may not be covered under the existing consent, and this could trigger a variation or new water take consent. – The water demand is dependent on the industrial sites that occupy the undeveloped part of the Waingawa industrial area. – Grades through the Taratahi Water Race Scheme at the Site are limited, and groundwater may be shallow, impacting feasible vertical storage limits. – Unknown ground conditions at time of development may be encountered.	– Good alignment with the Regional Infrastructure Fund – Improve process water supply and resilience, and potential to support food and fibre processing industries. – Integrating water race systems into the process water network could promote more efficient water use and management within the district. – Depending on local groundwater conditions and geology present, the lagoon earthworks could be designed to maximise cut material, to be sold/exported to provide additional revenue. Quarry consents may be required. – Repurposing existing water infrastructure aligns with sustainable practices, potentially reducing the need for developing new water infrastructure. – A reliable and efficient water supply is crucial for industrial operations. Increased water supply in this area could attract wet industries to the Waingawa Industrial Estate, fostering economic development. – Lagoon could be integrated with surrounding greenspace at the site that could be developed for land-based recreational uses. – Lagoon will only occupy a small area of the site (~0.5 ha), leaving the remaining area available for other uses, including other water storage uses assessed above.
Option 3: Combined Process Water and Irrigation Water Storage **270,000 m³**	$14,892,000	– Earthen lagoon construction will trigger earthworks consents, and possibly other consents. A planning assessment and consent strategy will better define and mitigate this risk. – The lagoon construction will create a dam to be classified under the New Zealand Building Code and monitored/managed according to its classification. – The water storage supports additional water users that may reduce water availability to other users in the Taratahi Water Race Scheme or necessitate changes to consent limits and/or additional water takes. – Change in water take purpose may not be covered under the existing consent, and this could trigger a variation or new water take consent. – Grades through the Taratahi Water Race Scheme at the Site are limited, and groundwater may be shallow. – Eutrophication and algal bloom risk in the storage lagoon. – Unknown ground conditions at time of development may be encountered.	– Excellent alignment with the Regional Infrastructure Fund to improve water supply resilience, and support food and fibre processing industries. – Depending on local groundwater conditions and geology present, the lagoon earthworks could be designed to maximise cut material, to be sold/exported to provide additional revenue. Quarry consents may be required. – Integrating water race systems into the process water network could promote more efficient water use and management within the district. – Seasonal water storage will allow for more efficient water use, taking water in the wet season when water is abundant, for use in the dry season when water is scarce. – Repurposing existing water infrastructure aligns with sustainable practices, potentially reducing the need for developing new water infrastructure.

Option	Class 4 Cost Estimate	Risks	Opportunities
			– A reliable and efficient water supply is crucial for industrial operations. Increased water supply in this area could attract wet industries to the Waingawa Industrial Estate, fostering economic development. – Lagoon will only occupy a small area of the site (6 ha), leaving the remaining area available for other uses, including land-based recreational uses. – Lagoon may offer potential for water recreational uses, for example Lake Breamore, Whareama (Lake Braemore Owners, 2025). The impact on design lagoon design and recreational water quality requirements are not assessed in this report.
Option 4: Carterton Municipal Water Storage	*Option not considered further.*		
Option 5: Masterton Municipal Water Storage	*Option not considered further.*		

7 Recommendation and Pathway Forward

The assessment of water storage options at 145 Norfolk Road, Waingawa, highlights a combined irrigation water storage for the Taratahi Water Race and process water storage for the Waingawa Industrial Estate (Option 3) as the most viable solutions, offering tangible benefits for agricultural resilience and industrial growth.

To advance Option 3, further feasibility and regulatory assessment are required. It would also be recommended that funding requirements for the Regional Infrastructure Fund be further defined to help shape this further assessment work.

To advance Option 3 the following steps/actions will need to be considered:

1. Investigate the co-investment funding requirements under the Regional Infrastructure Fund, i.e., would the provision of the land, or private farmers building their own intake and irrigation infrastructure be considered. Confirmation of who the co-investment partners are is needed.
2. Gathering of site data to inform design and confirm options and costing assumptions, including:
   a) Survey of the water race fall across the Site.
   b) Geotechnical investigations to determine winter peak groundwater level and presence of gravels for gravel extraction.
   c) Water balance assessment of the races.
3. Progressively develop the design of the preferred option, with standard hold points, to confirm technical feasibility, potential impact classification (PIC), and further refine costs and benefits.
4. Complete a planning assessment and consent strategy based on the developed concept design.
5. Apply for all necessary consents.
6. Procurement strategy to support accelerated construction timelines.

A rough and indicative programme to implement Option 3 is provided below, this programme should be expected to adjust as more information, including risks and dependencies, is identified :

Table 10:: high level implementation programme

Task	Duration	Start	End
Planning assessment and strategy (including investment requirements)	3 weeks	17 Mar 25	5 Apr 25
Site investigations	6 weeks	7 Apr 25	25 Apr 25
30% Design	5 weeks	14 Apr 25	16 May 2025
Hold Point 1 Client Review and Project Confirmation	2 weeks	19 May 25	30 May 25
100% Design	8 weeks	2 Jun 25	25 Jul 25
Hold Point 2 Client Review and Approval to proceed Resource Consent	2 weeks	28 Jul 25	8 Aug 25
Resource Consent Application and Processing	12 weeks	2 Jun 25	22 Aug 25
Hold Point 3 to Review Consent Conditions and proceed to Tender and Building Consent	2 weeks	25 Aug 25	5 Sept 25
Building Consent Application	1 week	25 Aug 25	1 Sept 25

Building Consent Processing	4 weeks	1 Sept Aug 25	26 Sep 25
Tender and contract award	6 weeks	25 Aug 25	3 Oct 25
Quarrying/construction/commissioning could start from early October 2025 within the earthworks season targeting the water storage lagoon and system to be in service by Winter 2026.			

Resource consenting timeframes (application, pre-app meeting, processing timeframes) could be in the order of 3 months, assuming that the application is non-notified, that there are no substantive requests for further information, no substantive engagement required. Early planning assessment and strategy would work to reduce these timeframes where practicable.

This combined water storage solution supports both agricultural resilience and industrial expansion while leveraging available water allocations. It aligns with CDC's strategic vision and ensures long-term economic benefits for the region. The next steps involve feasibility validation, detailed design development, and securing final regulatory approvals. (No delays are anticipated due to funding or property acquisition) The project will proceed under the assumption that all required land and funding approvals have been considered.

8 References

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9 Appendices

Appendix

A

Costing PDFs

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A.1 Costing PDFs

Cost Estimate

Waingawa Water Storage - Lagoon Storage

ITEM	DESCRIPTION	UNIT	QTY	Rate	Amount
1.0	**Preliminary and General**				
1.01	Preliminary and General	%	15	$22,768,521	$3,415,278
				Sub Total	$3,415,278
2.0	**Inlet works**				
2.01	DN 525 intake pipe	m	10	$874	$8,742
2.02	DN 525 intake structure	ea	1	$2,622	$2,622
2.03	DN 525 valve and manhole	ea	1	$9,882	$9,882
				Sub Total	$21,246
3.0	**Storage Lagoon**				
3.01	Cut to Fill	m3	271,000	$10	$2,710,000
3.02	Cut unsuitable material and dispose of nearby	m3	13,550	$20	$271,000
3.03	Underdrains	m	19,500	$70	$1,365,000
3.04	Geotextile	m2	290,000	$4	$1,160,000
3.05	Gas strips	m	36,563	$3	$109,688
3.06	Sand blinding	m2	290,000	$25	$7,250,000
3.07	1.5mm HDPE liner	m2	290,000	$25	$7,250,000
3.08	Anchor trench	m	2,280	$125	$285,000
3.09	Stripping top soil to stockpile to sell, give away or disperse	m3	87,000	$10	$870,000
3.10	Stripping topsoil to stockpile and reuse	m3	16,800	$7	$117,600
3.11	Topsoil and regrassing the outer slopes	m2	56,000	$15	$840,000
				Sub Total	$22,228,288
4.0	**Outlet works**				
4.01	DN 750 outlet pipe	m	30	$1,100	$33,000
4.02	DN 750 outlet structure	ea	3	$3,300	$9,900
4.03	DN 750 valve and manhole	ea	3	$9,882	$29,646
				Sub Total	$72,546
5.0	**Electrical and control**				
5.01	Electrical and control	%	2	$22,322,080	$446,442
				Sub Total	$446,442
	Cost Estimate (Class 4 -30%/+50%)			**Total**	**$26,111,253**

Cost Estimate

Waingawa Water Storage - Lagoon Storage

ITEM	DESCRIPTION	UNIT	QTY	Rate	Amount
1.0	**Preliminary and General**				
1.01	Preliminary and General	%	15	$7,544,429	$1,131,664
				Sub Total	$1,131,664
2.0	**Inlet works**				
2.01	DN 525 intake pipe	m	10	$874	$8,742
2.02	DN 525 intake structure	ea	1	$2,622	$2,622
2.03	DN 525 valve and manhole	ea	1	$9,882	$9,882
				Sub Total	$21,246
3.0	**Storage Lagoon**				
3.01	Cut to Fill	m3	62,651	$10	$626,506
3.02	Cut unsuitable material and dispose of nearby	m3	3,133	$20	$62,651
3.03	Underdrains	m	4,333	$70	$303,333
3.04	Geotextile	m2	65,000	$4	$260,000
3.05	Gas strips	m	8,125	$3	$24,375
3.06	Sand blinding	m2	65,000	$25	$1,625,000
3.07	1.5mm HDPE liner	m2	65,000	$25	$1,625,000
3.08	Anchor trench	m	1,020	$125	$127,475
3.09	Stripping top soil to stockpile to sell, give away or disperse	m3	19,500	$10	$195,000
3.10	Stripping topsoil to stockpile and reuse	m3	4,875	$7	$34,125
3.11	Topsoil and regrassing the outer slopes	m2	16,250	$15	$243,750
				Sub Total	$5,127,215
4.0	**Outlet works to water races**				
4.01	Reticulation works	PS	1	$1,667,000	$1,667,000
				Sub Total	$1,667,000
4.0	**Outlet works to water races**				
4.01	DN 750 outlet pipe	m	30	$1,100	$33,000
4.02	DN 750 outlet structure	ea	3	$3,300	$9,900
4.03	DN 750 valve and manhole	ea	3	$70	$210
				Sub Total	$43,110
5.0	**Electrical and control**				
5.01	Electrical and control	%	10	$6,858,572	$685,857
				Sub Total	$685,857
	Cost Estimate (Class 4 -30%/+50%)			**Total**	**$8,676,093**

Cost Estimate

Process Water Storage Option

ITEM	DESCRIPTION	UNIT	QTY	Rate	Amount
1.0	**Preliminary and General**				
1.01	Preliminary and General	%	20	$2,905,563	$581,113
				Sub Total	$581,113
2.0	**Inlet works**				
2.01	DN 525 intake pipe	m	10	$874	$8,742
2.02	DN 525 intake structure	ea	1	$2,622	$2,622
2.03	DN 525 valve and manhole	ea	1	$9,882	$9,882
				Sub Total	$21,246
3.0	**Water Storage works**				
3.01	Cut to Fill	m3	12,000	$10	$120,000
3.02	Cut unsuitable material and dispose of nearby	m3	1,200	$20	$24,000
3.03	Underdrains	m	320	$70	$22,400
3.04	Geotextile	m2	8,400	$4	$33,600
3.05	Gas strips	m	610	$3	$1,830
3.06	Sand blinding	m2	8,400	$25	$210,000
3.07	1.5mm HDPE liner	m2	8,400	$25	$210,000
3.08	Anchor trench	m	280	$125	$35,000
3.09	Stripping top soil to stockpile to sell, give away or disperse	m3	2,520	$10	$25,200
3.10	Stripping topsoil to stockpile and reuse	m3	480	$7	$3,360
3.11	Topsoil and regrassing the outer slopes	m2	3,200	$15	$48,000
				Sub Total	$733,390
4.0	**Outlet Works and Reticulation**				
4.01	Outlet Works and Reticulation	LS	1	$1,666,667	$1,666,667
				Sub Total	$1,666,667
5.0	**Electrical and control**				
5.01	Electrical and control	%	20	$2,421,303	$484,261
				Sub Total	$484,261
	Cost Estimate (Class 4 -30%/+50%)			**Total**	**$3,486,676**

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5 KARAKIA WHAKAMUTUNGA

Kia whakairia te tapu

Kia wātea ai te ara

Kia turuki whakataha ai

Kia turuki whakataha ai

Haumi ē, hui ē, taiki ē