Lyford Lane

Wastewater Feasibility Options Study

Mackenzie District Council

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Executive Summary

Lyford Lane is a private road located to the north-west of the Twizel township. There are currently several properties located on Lyford Lane which discharge partially treated domestic wastewater to ground through onsite septic systems. A number of these properties are located over Twizel's Drinking Water Protection Zone (DWPZ) and all the properties are located within Twizel's Source Water Risk Management Area (SWRMA) Zone 2. All properties on Lyford Lane are within the Source Water Risk Management Areas (SWRMA) Zone 2 for Twizel's drinking water supply. The DWPZ was developed in 2008 by hydrogeological studies. The SWRMA Zone 2 was determined in 2022 in the development of Twizel's Drinking Water Safety Plan.

Domestic wastewater discharges to ground within the DWPZ or the SWRMA Zone 2 have the potential to introduce direct contamination at source and therefore undermines the safety of the aquifer for drinking water, albeit that discharges into the DWPS are considered to have a higher likelihood of contaminating the drinking water source than discharges outside of the DWPS but within the SWRMA.

The Water Services Act (2021) dictates that drinking water providers must implement a high standard of care with regards to the protection of source water. In this context MDC must investigate options for eliminating the discharge of domestic wastewater above a protected water source. The water source in this case is the aquifer beneath the town. Therefore, in order to protect the town supply from contamination, the aquifer requires protection from any potential contamination.

GHD undertook a site visit on the 15th of September 2022 to understand site characteristics and identify design constraints that may impact the potential design solutions. Key site features included the Frasers Stream bridge crossing and the Dry Stream bridge crossing.

High level desktop reviews were undertaken to provide insight to the site characteristics within the project area. The outcomes of the reviews were as follows:

- Several geotechnical hazards were identified which provide additional difficulties and risk with construction:
    - Course alluvial deposits are located in the ground below the project area. This makes directional drilling very difficult as larger rocks will damage drill equipment.
    - The site is extremely flat. The entrance to Lyford Lane where the nearest council service is located is approximately 480 mRL. Most of the dwelling on Lyford Lane are at approximately 470 mRL.
    - Erosion risks may be present within 10 m of waterways.
- The groundwater table is likely to be shallow and within 1 – 2 m of the ground surface.
- The flood risk review found that all identified routes could have flood risk issues based on waterway flows. This is particularly of concern for the Frasers and Dry Stream bridge crossings.
- The ecological review identified the project area to be a spawning habitat for the Canterbury Galaxias in the Frasers Stream and tributaries, as well as providing habitat to other freshwater species. Consideration in both the construction phase and permanent solutions will be required to ensure there are no adverse environmental impacts on the waterways and local aquatic life.

Gravity systems were not considered as the site is located on very flat ground, which would require deep sewers and/or numerous network pump stations. The site is located above rocky ground, making excavation difficult and/or expensive. The high groundwater table also introduces a risk of infiltration to pipework.

Improving onsite treatment systems were not considered for a several reasons, mainly:

- High groundwater table – introduces complexities and costs with disposal systems,
- Inadequately treated discharge – systems will be self-managed by the property owner. Failure to adequately maintain systems will result in contaminated discharge,
- Depth and proximity of existing drinking water supply wells – there are several existing domestic supply wells within the DWPZ and SWRMA. Depth and proximity of existing drinking water supply wells – there are several existing domestic supply wells within the DWPZ (and therefore within the SWRMA Zone 2). These are relatively shallow (10 – 17 m deep) and there is risk of hydraulic connection between discharges and well points.

- Storage of blackwater – There is inherent risk of storing between 10 – 20,000 L of domestic waste at each property within the DWPZ or the SWRMA Zone 2. Failure events will result in discharge of contaminants within the DWPZ or the SWRMA Zone 2.

Two main options for the installation of low-pressure reticulation systems were investigated as part of this feasibility study: connection of all properties within the DWPZ to the wastewater network (Option 1), or connection of all properties on Lyford Lane (ie all Lyford Lane properties within the SWRMA Zone 2) to the wastewater network (Option 2). The former requires the connection of seven existing dwellings whereas the latter requires the connection of 13. Consideration has been given to future development in both cases in line with MDC growth projections and district plan. A sub-option to Option 2, Option 2.1, was investigated where the cost of the pressure sewer system for the 13 existing dwellings is covered by MDC, and cost for future dwellings is covered by the future property owner.

Option 1 requires the installation of a DN50 pipe for 1.2 km along Lyford Lane to connect all properties within the DWPZ. Option 2 requires the installation of a DN63 for 1.4 km along Lyford Lane to connect all properties on Lyford Lane. Option 2 also requires two additional pipes to account for the delineation in development along Lyford Lane, where the road splits into two. This requires the installation of a further 600 m of DN50 pipe. A number of additional non-return valves and flushing valves will be required as part of Option 2. Both options will need to navigate the river crossings by fixing pipeline to the bridges. Odour control units will also be required at the downstream location due to odour/septicity issues. The main differences between the two options are:

- Cost – Option 1 is expected to cost around $ 628,000, Option 2 is expected to cost approximately $ 1,416,000 and Option 2.1. expected to cost $ 1,028,000 (all excluding GST). The current assumption is that MDC will own and operate the pump system. Careful consideration and consultation will be required with property owners to determine the best ownership model for this area. This has the potential to significantly impact costs. For Option 2.1, the cost of the pressure sewer system for the existing 13 dwellings is covered by MDC, and cost for future dwellings is covered by the future property owner.
- Complexity – Option 2 requires the installation of 800 m of additional pipeline. The pressure systems become more difficult to operate within the intended design parameters (sufficient head, sufficient self-cleansing velocities) with increased pipe length and size. As such, the design may require further regular maintenance requirements such as flushing of lines. The length and diameter also increase odour and septicity concerns which are difficult to avoid due to the length requirement of the solution.
- Public buy-in – Option 2 will require greater buy-in from the affected residents. Some residents may see it as unnecessary to install reticulation when they are both not over the DWPZ, and already have a functioning and consenting onsite septic system. This is less relevant with the ownership model of Option 2.1 (refer Section 4.3).

An unweighted criteria analysis was undertaken to evaluate the suitability of the options with the criteria agreed by MDC. The complexities of operation associated with Option 2 reduced both the level of service and reliability. However, Option 2 had the greatest environmental and ecological benefit, whereas Option 1 was only considered satisfactory in this case, as discharge of domestic waste to ground continues within the SWRMA Zone 2.

Deliverability and operational risks inherently increase with the additional complexities in the design for Option 2.

Cost uncertainty was considered high in both cases due to the unknowns around the ownership model for the pressure sewer system, however, the smaller Option 1 capital cost would lessen the extent of cost uncertainty for this option.

	Option 1	Option 2	Option 2.1.
Capital Costs (excluding GST)	$ 628,000	$ 1,416,000	$ 1,028,000
Life Cycle Operating Costs (excluding GST)	$ 1,400	$ 3,400	$ 3,400

While Option 1 potentially offers some cost and project benefits, it still presents a potential risk to the Twizel drinking water supply. Option 2.1 however presents a lower risk in this respect and is therefore is recommended as the preferred solution.

However, it is recommended that consultation is undertaken with the residents of Lyford Lane to understand their position as this may impact both the ownership model and the extent of the network. These factors may alter the basis for the recommendations made in this report.

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1. Introduction

There are currently several properties located on Lyford Lane, Twizel, which discharge partially treated domestic wastewater to ground. Most of the properties on Lyford Lane are located within Twizel's Drinking Water Protection Zone (DWPZ – refer to Figure 1 below). All properties on Lyford Lane are located within Twizel's Source Water Risk Management Area (SWRMA) Zone 2 (refer to Figure 18 in Appendix A). The DWPZ was developed in 2008 by hydrogeological studies. The SWRMA Zone 2 was determined in 2022 in the development of Twizel's Drinking Water Safety Plan.

Domestic wastewater discharges to ground within the DWPZ or the SWRMA Zone 2 have the potential to introduce direct contamination at source, and therefore undermines the safety of the aquifer for drinking water.

The Water Services Act (2021) dictates that drinking water providers must implement a high standard of care with regards to the protection of source water. In this context, the Mackenzie District Council (MDC) must protect the supply aquifer from becoming contaminated. As a result, MDC must investigate options to eliminate the discharge of partially treated domestic wastewater on Lyford Lane within the DWPZ and the SWRMA Zone 2.

1.1 Purpose of this report

The purpose of this report is to investigate and recommend options for eliminating the discharge of partially treated domestic wastewater to ground on Lyford Lane, Twizel. This report considers options for Lyford Lane properties within the DWPZ and within the SWRMA Zone 2.

1.2 Scope and limitations

This report: has been prepared by GHD for Mackenzie District Council and may only be used and relied on by Mackenzie District Council for the purpose agreed between GHD and Mackenzie District Council as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Mackenzie District Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.3 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

GHD has prepared the preliminary high level budgetary cost estimate set out in section 4.1.2 & 4.2.2 of this report using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD to cover construction risk and inflation.

The Cost Estimate has been prepared for the purpose of option review and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the project can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

GHD has prepared this report on the basis of information provided by Mackenzie District Council and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.3 Assumptions

The following assumptions have been made in the preparation of this report:

- Properties whose boundaries intersect the DWPZ are considered 'partially' within the DWPZ. For the purpose of analysis this will be included in the 'only properties within the DWPZ' group.
- In lieu of specific information for Lyford Lane, growth projections for Twizel (percentage population growth) are representative of growth projections for Lyford Lane (see Section 2.3).
- As Lyford Lane is a private road (i.e. not a public road), it is assumed that easements will be able to be obtained for installation of pipe alignments.
- The existing wastewater gravity main on Lyford Lane is in good condition, is able to be connected to, and has sufficient capacity for flows from the Lyford Lane catchment.
- The existing private pressure sewer connection (48 Lyford Lane) is to be abandoned and the property will be included in design options for Lyford Lane.

1.4 Standards and Codes

Lyford Lane is located within the Mackenzie District (MDC) and as such is governed by Mackenzie District Council (MDC). MDC use the national standard NZ4404:2010 (Land development and subdivision infrastructure) as their Engineering Code of Practice. This includes provision for wastewater design and development. Note that there is a concurrent project underway to develop an MDC specific Code of Practice.

1.5 Source information

- Canterbury Land and Water Regional Plan
- Canterbury Maps
- GNS Science Geology of the Aoraki area. Institute of Geological and Nuclear Sciences 1:250
- Mackenzie District Plan, Section 8 (2011)
- Mackenzie District Growth Projections (2020)
- Mackenzie Spatial Plans (2021)
- MDC Wastewater Activity Management Plan (2018 – 2028)
- MDC Activity Management Plan for Foul Sewer (2015 – 2025)
- MDC Water Supply, Wastewater and Stormwater Bylaw (2021)
- National Institute of Water and Atmospheric Research (NIWA) Flood Frequency Tool
- New Zealand Geotechnical Database
- New Zealand Threat Classification System Database
- Twizel Wastewater Network Hydraulic Model Development, Calibration and System Performance
- Water New Zealand Pressure Sewer National Guidelines

2. Background

2.1 Site characteristics

2.1.1 Project location

Lyford Lane is a private road located to the north of Twizel, off Glen Lyon Rd. There are 13 existing dwellings on Lyford Lane. Five of which are located within the DWPZ, two are partially[1] within the DWPZ, and the other six are not located within the DWPZ. An overview of the project is shown in Figure 1. Details of the individual properties are provided in Table 2 in Section 2.1.4.

The project objectives include providing wastewater solutions to either all properties along Lyford Lane (blue shaded area in Figure 1), or just the properties along Lyford Lane that are within the DWPZ (where the red border overlaps the blue shaded area in Figure 1).

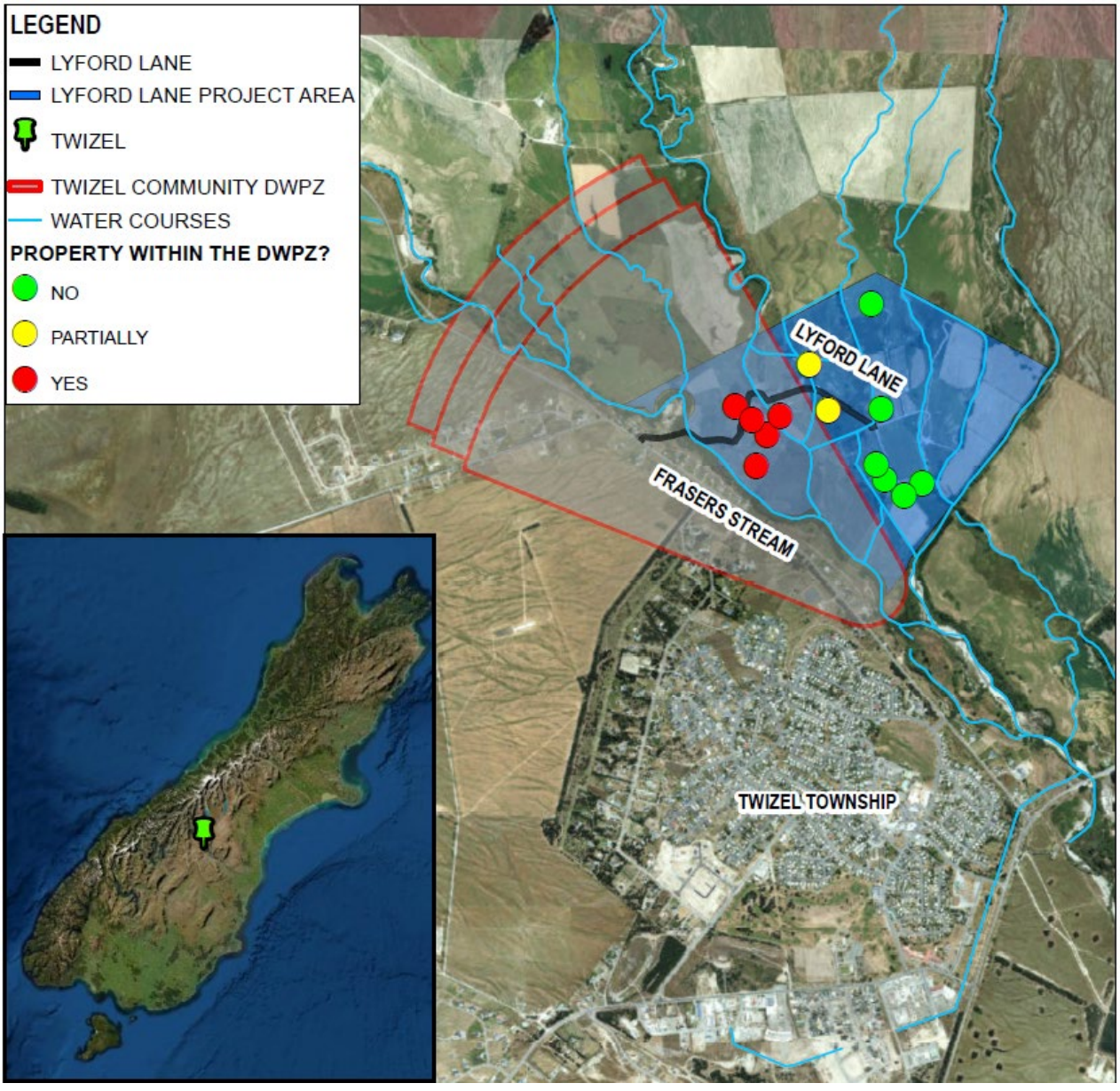


Figure 1 Lyford Lane Wastewater Investigation Overview

[1] Defined as a portion of the property to the boundary being above the DWPZ.

2.1.2 Site visit

A site visit was conducted by GHD on the 15th of September 2022 as part of this assessment. The purpose of the visit was to understand the site characteristics and to identify any design constraints that may be present. The following was observed during the site visit:

- There were several water crossings across site.
    - Two bridges (refer Figure 2 and Figure 3), and five culverts were noted along the Lyford Lane alignment. An additional culvert was noted at the entrance to 107 Lyford Lane.
    - A PVC pipe was used as a conduit for the private pressure sewer to cross Frasers Stream (refer Figure 2).
- There were a significant number of large trees either side of Lyford Lane, with little to no space available in the berm for services (refer Figure 4). Tree roots are expected to be prevalent along the Lyford Lane alignment.
- Roadside drainage in the form of swales was noted for the majority of Lyford Lane. There is little space available between the carriageway and the swale.

Figure 2 PVC pipe conduit used to carry the private pressure sewer across Frasers Stream (Bridge 1)

Figure 3 Dry Stream crossing (Bridge 2)

Figure 4 Large trees along Lyford Lane

2.1.3 Desktop review summary

Several desktop reviews have been undertaken for the site to give an indication of the site constraints. The reviews are summarised in this section. Further detail from each desktop review can be found in Appendix A.

2.1.3.1 Geotechnical review

The geotechnical review highlighted the following:

- The presence of coarse alluvial deposits below the project area. This is a result of the proximity to the source (mountain range), and that the site is a former riverbed.
- The site is flat with elevations between 480 m and 460 m RL. The nearest council wastewater service is at the entrance to Lyford Lane at approximately 480 m RL. The majority of dwelling are at approximately 470 m RL.
- There are several waterways throughout the project area:
    - Erosion risks may be present within 10 m of waterways.
    - This indicates the groundwater table is likely relatively high, and the pipe trenches may act as preferential pathways depending on pipe depth. The implementation of trench stops can effectively mitigate this risk.
- The site is near a number of active faults. There is no known data on recurrence intervals however earthquake risk should be considered.

2.1.3.2 Groundwater

The groundwater review highlighted the following:

- Groundwater is likely to be shallow, within 1-2 m of ground surface and potentially shallower.
- Springs may be present in low lying areas.
- The shallow aquifer is utilised for domestic and public water supply.
- The site intersects the community DWPZ for the Twizel supply wells. Some on-site septic systems dispose domestic waste to ground within this zone.
- The entirety of the site is within the Source Water Risk Management Areas (SWRMA) Zone 2, and by MfE's guidance all discharges introduce risk to the towns source water.

2.1.3.3 Flood risk

No detailed topographic information has been sighted to inform an understanding of peak waterway flood levels and velocities. However, the desktop review indicates that, based on waterway flows, there is potentially a significant flood risk to proposed project infrastructure where this infrastructure crosses Fraser Stream. There is also potentially a flood risk in the vicinity of the Dry Stream crossing.

2.1.3.4 Ecology

The assessment identified the presence of three fish species as shown in Table 1.

Table 1 Fish species present in the Lyford Lane area

Species Name (Common Name)	Conservation Status[2]
Salmo trutta (Brown trout)	Introduced and Naturalised
Anguilla dieffenbachii (New Zealand longfin eel)	Declining
Galaxias macronasus (Bignose galaxias)	Nationally Vulnerable

[2] Retrieved from the New Zealand Threat Classification System (NZTCS) on 30th September 2022.

The presence of these fish species requires the allowance for fish passages in both construction and in final design solutions. This also reinforces the need to safeguard the freshwater course from harmful discharges in both construction (sediment discharge) and operation (pipe failure or leakage).

In the Canterbury Land and Water Regional Plan, the Water Quality Management Units and Classes for Rivers defines the Frasers Stream (refer Figure 5) as an Alpine Upland/Spring Fed Upland water course. This classification is more relevant for the protection of the water quality of water courses and is not expected to impact the applicability of design options.

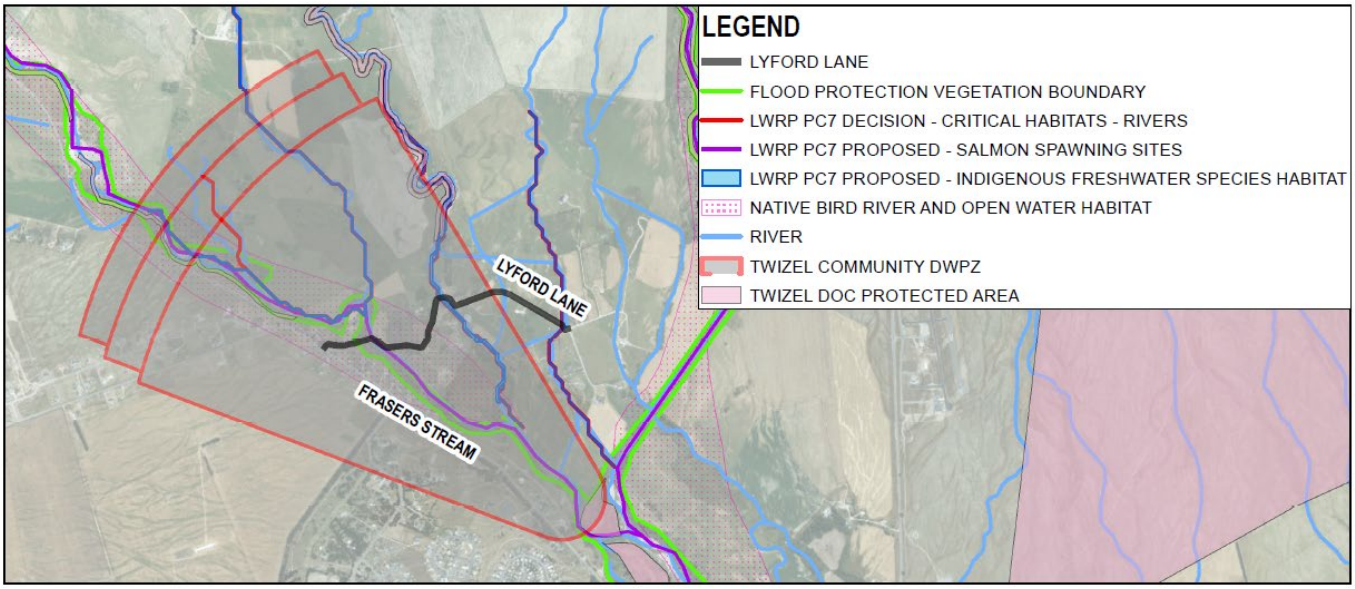


Figure 5 Ecological desktop study detail

Note that this review has not been summarised in Appendix A and is included above in full.

2.1.4 Existing infrastructure

Most of the existing properties currently operate either:

- Greywater treatment and discharge to ground, with onsite blackwater storage before transportation to the wastewater network,
- Onsite primary and secondary treatment and discharge to ground.

A summary of the wastewater infrastructure for the properties along Lyford Lane is included below in Table 2 and illustrated in Figure 6.

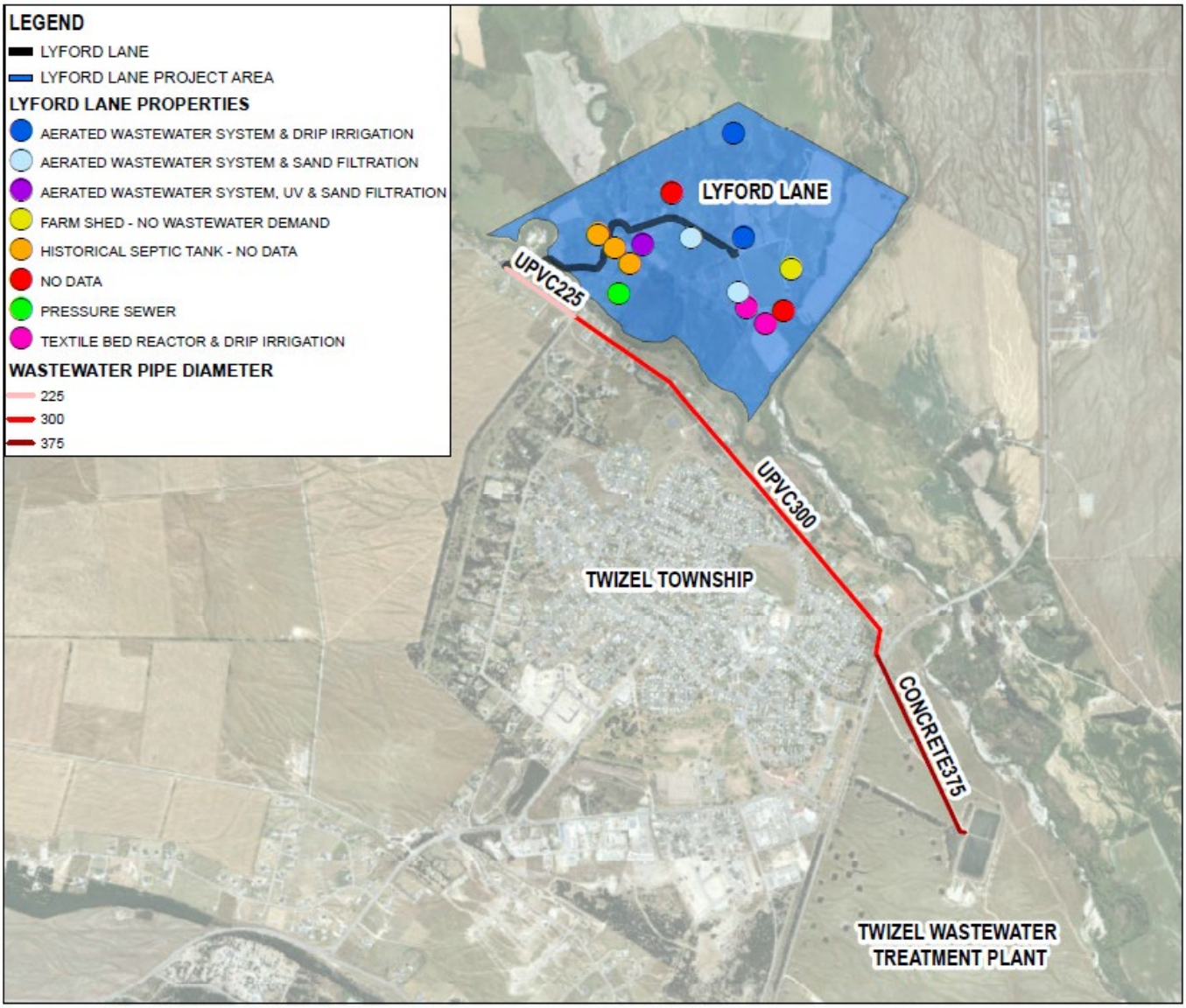


Figure 6 *Overview of Twizel WW network relevant to the Lyford Lane feasibility study*

Table 2 *Lyford Lane existing wastewater infrastructure*

Location	Located within DWPZ?	Consent No.	Existing Treatment	Existing Disposal
48 Lyford Lane	Yes	N/A	Private pressure sewer (discharges to the Twizel wastewater network on Lyford Lane)	
58 Lyford Lane	Yes	N/A	Historical septic tank – no data	
65 Lyford Lane	Yes	N/A	Historical septic tank – no data	
66 Lyford Lane	Yes	N/A	Historical septic tank – no data	
86 Lyford Lane	Yes	CRC201075	i. Aerated wastewater system ii. Proprietary effluent filter iii. UV treatment system	Land via sand filtration

107 Lyford Lane	Partially	N/A	No data	
108 Lyford Lane	Partially	CRC183805	i. Aerated wastewater system ii. Proprietary effluent filter	Land via drip irrigation
140a Lyford Lane	No	CRC181861	i. Aerated wastewater system	Land via drip irrigation
140b Lyford Lane	No	CRC093870.1	i. Textile packed bed reactor ii. Proprietary effluent filter	Land via drip irrigation
140c Lyford Lane	No	CRC133981	i. Textile packed bed reactor ii. Proprietary effluent filter	Land via drip irrigation
140d Lyford Lane	No	N/A	No data	
147 Lyford Lane	No	CRC194681	i. Aerated wastewater system ii. Proprietary effluent filter	Land via drip irrigation
158 Lyford Lane	No	N/A	This property is not a dwelling and is used for storage of farm equipment.	
187 Lyford Lane	No	CRC224578	i. Aerated wastewater system ii. Proprietary effluent filter	Land via drip irrigation

Note that it has been assumed that the existing private pressure sewer (48 Lyford Lane) will be connected to the proposed pressure system for Lyford Lane (i.e., existing connection abandoned). Note also that 158 Lyford Lane is not a dwelling and therefore won't be considered further in this report. This leaves a total number of 13 properties to consider for the concept design.

One property (48 Lyford Lane) has an Ecoflow pressure sewer installed from the property to the DN225 uPVC gravity main located on Glen Lyon Rd. The gravity main is assumed to be in good condition as it was installed in 2006. The Ecoflow system is comprised of a DN40 PE pipe which follows the alignment shown in Figure 7. The pipeline is installed as per AS/NZS 2033:2008: Installation of Polyethylene Pipe Systems. PVC conduits are used to cross the bridge over Frasers Stream (refer Figure 2).

For this property a pressure sewer was adopted over the use of a gravity sewer for a number of reasons (Pressure Sewer National Guidelines, Water NZ 2020):

i. The site is located on very flat ground, requiring deep sewers and/or numerous network pump stations (i.e. more than 1 network pump station / 100 properties), and

ii. Rocky ground, making excavation difficult and/or expensive, and

iii. High groundwater table (risk of infiltration).

There are currently no land parcels associated with the carriageway for Lyford Lane. Easements have been obtained to allow for the installation of the pressure sewer on Lyford Lane. Easements will need to be obtained for future use of this lane.

The DN225 gravity main runs along Glen Lyon Rd to the Twizel Wastewater Treatment Plant (WWTP), as shown in Figure 6. There is approximately 400 metres of DN225 main before the line widens to a DN300 main. There is an additional 2.6 km of pipe work before discharge to the Twizel WWTP.

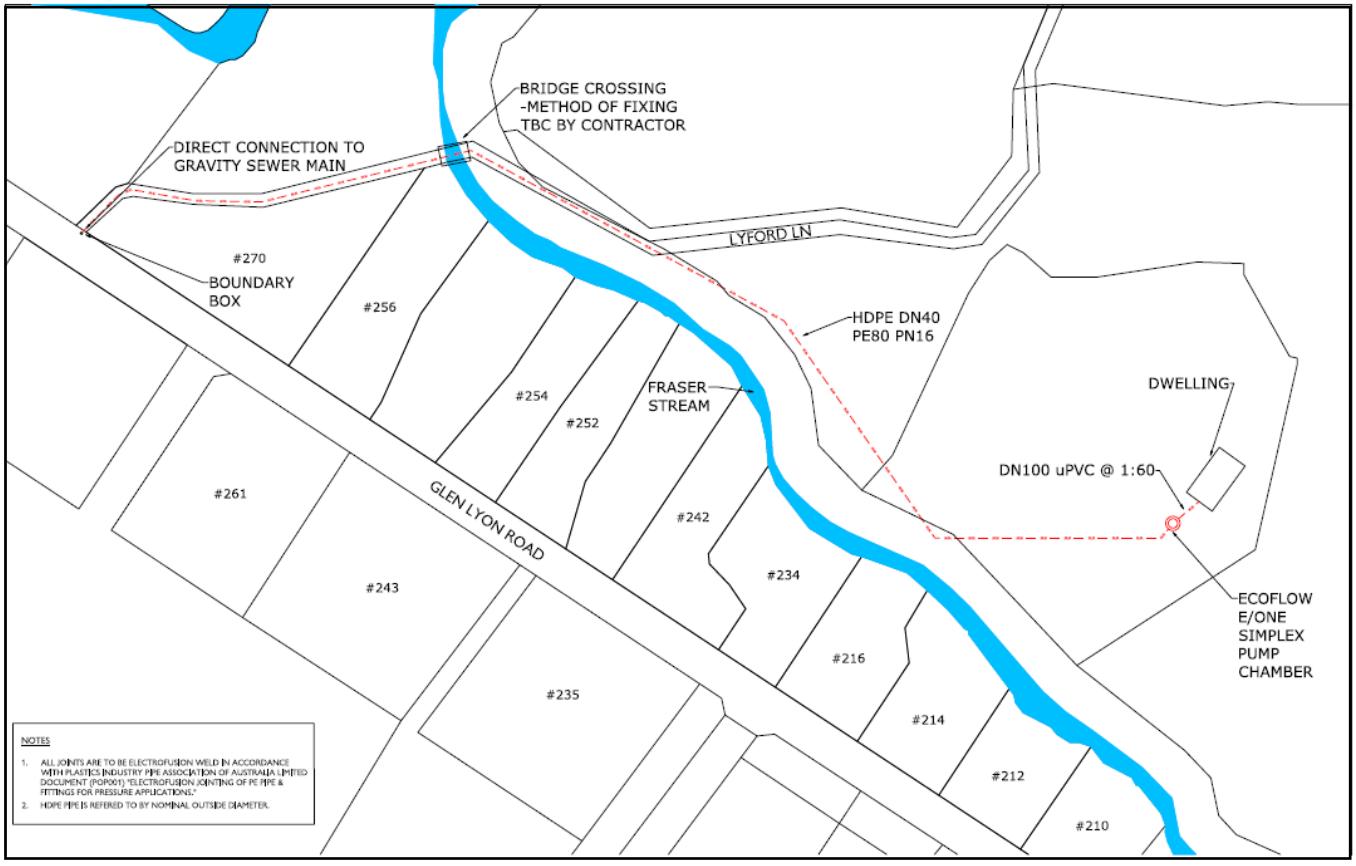


Figure 7 *Low pressure sewer detail from 48 Lyford Lane*

There have been previous attempts at drilling under Frasers stream for pipe installation, in favour of fixing a conduit to the bridge (see supporting documents to consent number CRC191394 associated 48 Lyford Lane). However, due to the nature of ground material (course alluvial deposits), drilling equipment was unable to work through the ground without damage to equipment. It may be possible to drill under the stream using another contractor or another method of installation (i.e., potentially drilling deeper). However, as the piped conduit was accepted by MDC it will be assumed viable for this project.

2.2 Stakeholders

2.2.1 Iwi/Māori interests

The project area and DWPZ are in an area governed by Te Runanga o Ngai Tahu. Te rūnanga o Arowhenua and Te rūnanga o Waihao hold mana whenua rights and interests over the lands and waters within their respective takiwa.

Water is central to Māori life and is considered a taonga. It is essential from a Māori viewpoint to take all reasonable steps to safeguard the health and waterways and waterbodies. It is therefore important to actively engage Māori in decision making for any activities involving interaction with water.

Te Runanga o Ngai Tahu have a Freshwater Policy guiding the management of freshwater within their area of jurisdiction. The three core values associated with Ngai Tahu's Freshwater Policy are:[3]

i. **Mauri** – to restore, maintain and protect the Mauri of freshwater resources.

[3] Paraphrased from Te Runanga o Ngai Tahu's Freshwater Policy

ii. **Mahinga Kai** – to maintain vital, healthy mahinga kai populations and habitats capable of sustaining harvesting activities.

iii. **Kaitiakitanga** – to promote collaborative management initiatives that enable the active participation of Ngai Tahu in freshwater management.

It is noted that the existing management method of discharging treated domestic wastewater to ground (in most cases) goes against the key principle of maintaining and protecting water bodies, because, in this case, there is likely a direct hydraulic connection between the aquifers and surrounding streams (Section 2.1.3.2).

It is understood that for the one pressure sewer installed on Lyford Lane, consultation was undertaken with Te rūnanga o Arowhenua and Te rūnanga o Waihao who both approved the system as it aligned with their core interests of eliminating the discharge of treated domestic wastewater to ground. The Aoraki Environmental Consultancy is an agency owned by Te rūnanga o Arowhenua and typically facilitates consultation between rūnanga and government processes.

2.2.2 Current and future drinking water management

The current management of the Twizel DWPZ is split between MDC and ECAN. In this context MDC manage the allocation of the DWPZ, and the utilities and infrastructure above which including Twizel's drinking water supply. ECAN manage environmental activities such as discharge of contaminants to air, land and water and in this context, discharge of treated domestic wastewater to land.

Recent legislation for the Drinking Water Standards for New Zealand was updated to improve the quality of drinking water. One of the objectives of the Water Services Act 2021 is to "…enable risks to source water to be properly identified, managed, and monitored". This report seeks to identify the extent of the risk to drinking water and provide solutions for ongoing management of domestic wastewater discharges for Lyford Lane. This feasibility study can be used to inform required capital works under the proposed Three Waters Reform.

2.3 Growth projections

The magnitude and location of growth projections for Twizel will impact the applicability of design options for Lyford Lane, particularly for:

i. Connection to the reticulation network from Lyford Lane, and

ii. Conveyance to the wastewater treatment plant.

This section will discuss the growth projection parameters relevant to the Lyford Lane wastewater feasibility study. This feasibility study will not investigate the impact on Twizel's wastewater treatment plant.

MDC have determined spatial plans (Mackenzie District Council, 2021) for the development of its settlements. For Twizel, this has been set out as displayed in Figure 8.

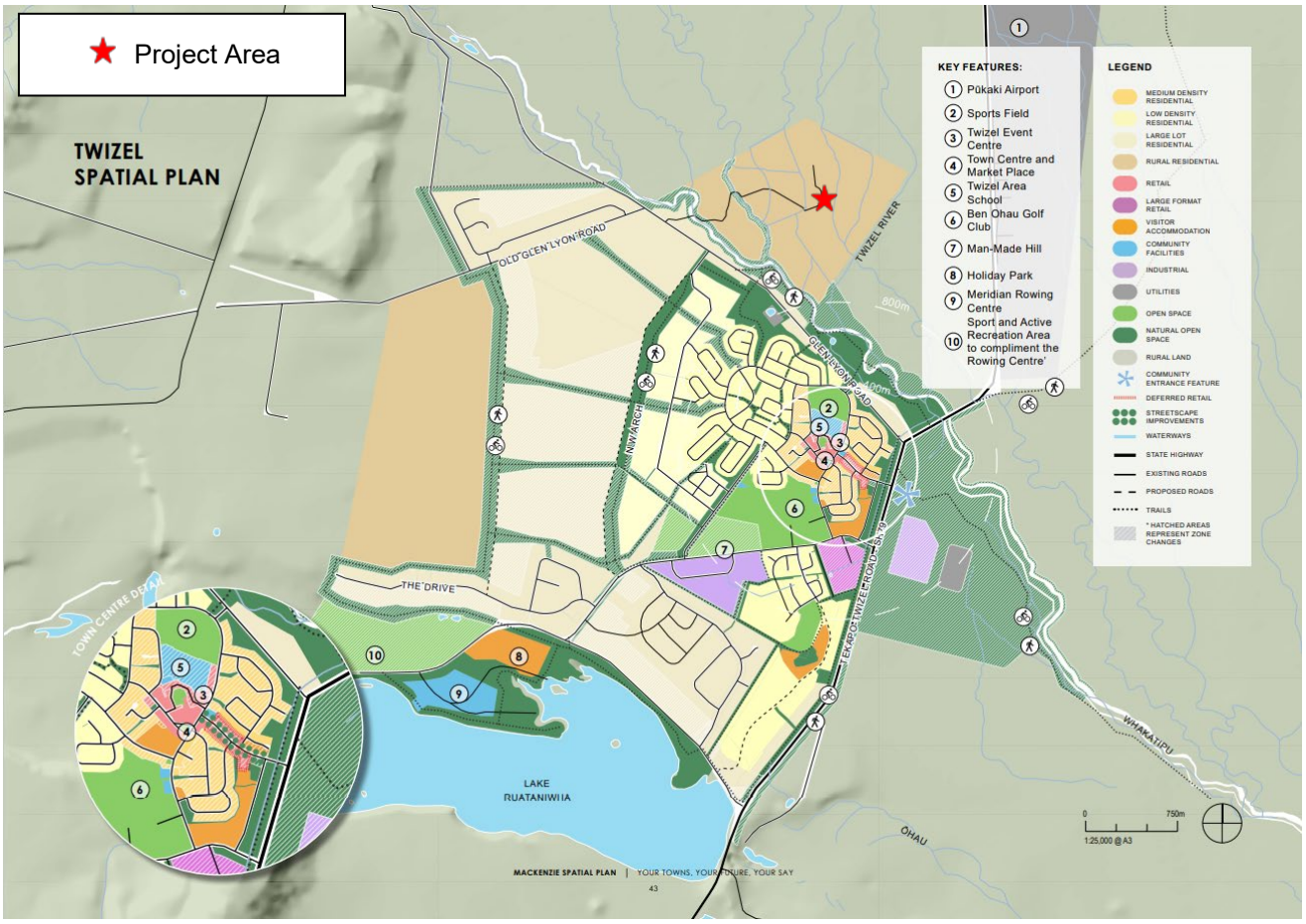


Figure 8 *Twizel Spatial Plan*

The project area for this feasibility study, Lyford Lane, is located north of Twizel in a 'Rural Residential' zone. This category is defined by having 0.5 – 2 dwellings per hectare. The total area of properties within Lyford Lane assigned as 'Rural Residential' is approximately 150 hectares. This equates to an expected capacity of between 75 – 300 dwellings. The area of 'Rural Residential' land which overlaps the DWPZ is approximately 50 ha. This reduces the expected capacity to between 25 – 100 dwellings. These estimations have however been calculated based solely on the zoned area and district plan detail. There are currently only 19 sections with a total of 13 dwellings. This equates to approximately 0.09 dwellings per hectare which is significantly less than the district plan guidelines of 0.5 – 2 dwellings per hectare. Basing future network demand on the district plan guidelines is expected to significantly overestimate the design requirement.

Twizel's future population growth projections are detailed in Figure 9 (Mackenzie District Council, 2020). With reference to Figure 9, by 2050 the projected population is expected to increase to between approximately 2,900 and 3,700. The recommended value as defined by MDC is 3,395 at 2050. This equates to an average increase in population size of 3 % per year (231 % increase to 2050 based on the 2022 population).

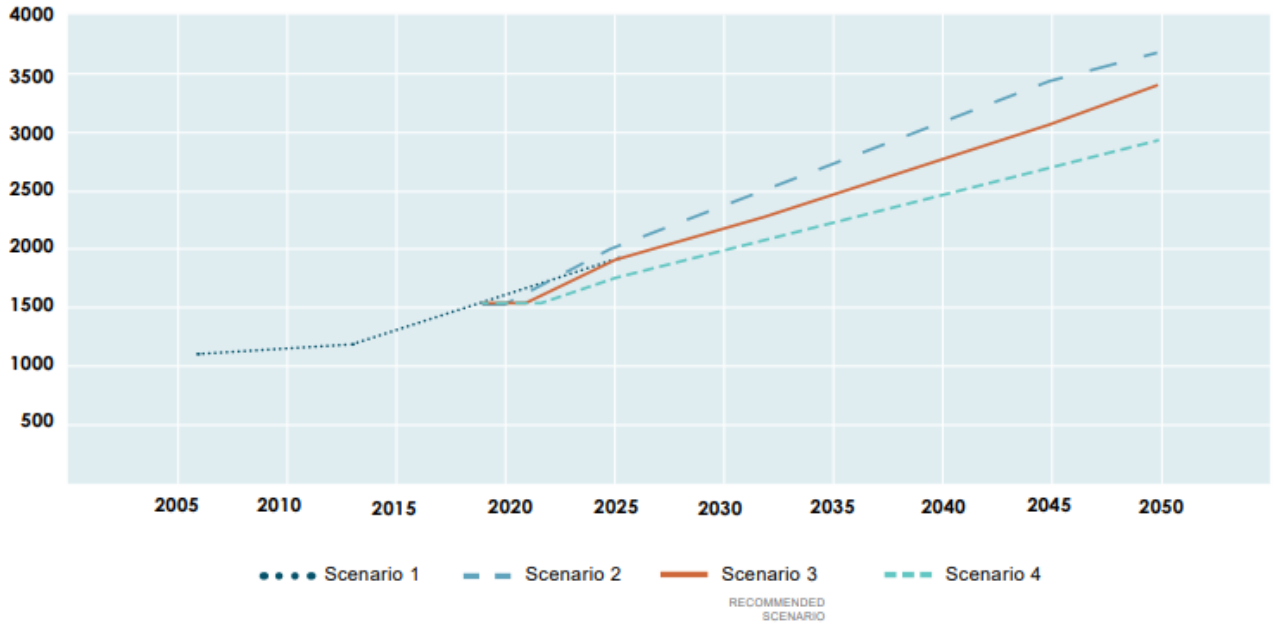


Figure 9 Twizel Population Growth Projections

There are clear differences between estimating future population based on the district plan and based on growth projections. The district plan alone overestimates population increase and therefore network requirements, where the growth projections provide a more modest estimation. However, the number of dwellings forecasted through growth projections are greater than what would be expected through reasonable subdivision of the lots based on existing property sizes. Therefore, a reduction[4] will be applied to the growth projections to reach the design demand.

Table 3 details the population projections using the different methods, including the adopted design populations. Although a typical design life for wastewater systems would be 100 years, projections are only accurate to 2050 and extrapolating beyond this would be unreliable. The design life will therefore only assess projected demands to 2050. Note that the population size is estimated as per NZS4404:2010 (2.5 – 3.5 people per dwelling).

Table 3 Estimated projected dwellings number for Lyford Lane

Design Solution	Existing Population (Dwellings)	Design Population Based on Growth Projections (Dwellings)	Design Population Based on the District Plan (Dwellings)	Adopted Design Population (Dwellings)
All properties in Lyford Lane	39 (13)	96 (32)	225 (75)	78 (26)
Only properties within the DWPZ	21 (7)	63 (21)	75 (25)	30 (10)

[4] This is based on a reasonable expectation of subdivision within the area. A reasonable expectation has been defined as a majority of land parcels above 4 ha being subdivided into multiple parcels with a minimum area of 2 ha each.

2.4 Planning and consenting

A planning and consenting assessment was undertaken based on two potential design options;

1. a pipeline to the gravity main along Glen Lyon Rd, and
2. onsite treatment with continued discharge to ground.

The Lyford Lane project is located in the following Mackenzie District Plan Overlays

i. Hocken (Lyford) Lane Rural Residential Zone

ii. Twizel Water Supply Protection Area

The planning requirements for Option 1 (wastewater pipe connection to existing pipe on Glen Lyon Road) are:

- As the proposed alignment crosses a number of rivers, the installation of wastewater pipes requires resource consent as a discretionary activity under Rule 1.5a of Section 16 of the Mackenzie District Plan (MDP). Specifically, proximity to (crossing of) the Dry Stream and Fraser Stream (and any other river) means Standard 1.2.l.iii cannot be met (no utility structures shall be located within 20 m of a river). In this context the MDC district plan defines a utility as any facility, structure and works necessary for the installation of wastewater reticulation systems, which would include bridge crossings.
- Earthworks within 10 m of the bank of Dry Stream or Fraser Stream (or any other river) requires resource consent as a discretionary activity under Rule 2.4.3 of Section 8 of the MDP. Any earthworks 10 m or further from any river are a permitted activity under Rule 2.3.9 of Section 8 of the MDP.
- As the proposed works would occur within a Community Drinking Water Protection Zone, construction-phase stormwater discharges require resource consent as a restricted discretionary activity under Rule 5.94B of the Canterbury Land and Water Regional Plan (LWRP). This is because Standard (6) of Rule 5.94A cannot be complied with.

Planning requirements for Option 2 (onsite treatment upgrade and discharge to ground)

- As the discharge would be located within a Community Drinking Water Protection Zone, the discharge does not meet permitted activity condition 3(g) of Rule 5.8 of the LWRP, and is therefore a restricted discretionary activity under Rule 5.9, requiring resource consent.
- As the proposed works would occur within a Community Drinking Water Protection Zone, any construction-phase stormwater discharges would require resource consent as a restricted discretionary activity under Rule 5.94B of the Canterbury Land and Water Regional Plan (LWRP). This is because Standard (6) of Rule 5.94A cannot be complied with.

3. Basis of design

3.1 Network extent

The existing network has been discussed in Section 2.1.4. The proposed management options are based off the following key findings:

i. The connection to the Twizel wastewater network will be at the DN225 uPVC pipe where it crosses the Lyford Lane entrance.
    a. The capacity of the transmission to the WWTP will be assessed based on the receiving DN225 pipe as this is the most constraining pipe size.
    b. Pipe sizes beyond this extent will not be considered as part of this analysis as this will predominantly be impacted by the wider Twizel network demand (i.e., where the DN300 uPVC pipe transitions to the DN375 concrete pipe prior to disposal to the treatment plant, refer Figure 6).

ii. Possible pipe alignments will assume that easements are able to be obtained for Lyford Lane. Pipe based solutions will assume that connection to the sewer from the individual properties will occur at the property boundary.

iii. The assessment therefore will consider the installation of a pressure sewer. Pipe alignments will be considered from the property boundaries to the connection with the DN225 uPVC pipe along Glen Lyon Rd.
    a. Options for either reticulation for all the properties along Lyford Lane, or only for the properties within the DWPZ will be investigated.
    b. Note that pressure sewers are being investigated due to the site constraints (see Section 2.1) excluding gravity sewers from being an applicable option.

3.1.1 Improved On-site Treatment

There was some initial consideration as part of this assessment to providing improved on-site treatment for each individual dwelling to allow for the continued discharge to ground. It is expected that any treatment systems will be owned and operated by the property owner. There are two possible means to this:

1. Discharge of treated greywater to ground, and onsite storage and collection of blackwater for disposal to the Twizel WWTP, or
2. Advanced treatment of all wastewater to allow for discharge to ground.

For Lyford Lane there are however several concerns associated with both treatment-based options:

i. **High Groundwater Table** (both) – The project area has a high groundwater table (Section 2.1.3.2) and as such introduces complexities and additional costs associated with the discharge design. Discharges may have to be managed through raised beds at the property owner's cost.

ii. **High Flood Risk Zone** (both) – The area is located within a flood risk zone (Section 2.1.3.3). Although septic treatment systems and storage tanks can be built to withstand flood events (i.e., above the 1 in 50-year flood event level), there is still risk of considerable asset failure under flood events.

iii. **Inadequately Treated Discharge** (both) – For this solution to be acceptable, all treatment systems within the DWPZ need to be technically advanced, fully functional, and well maintained. Equipment failure of one treatment system could introduce risk of contamination to the DWPZ. It is expected that treatment system maintenance and operation will be the responsibility of the property owner.

iv. **Depth and Proximity of Existing Wells** (both) – There are a number of existing domestic drinking water supply wells within the DWPZ, mainly the Twizel town supply of which the DWPZ was based. These wells are generally located between 10 – 17 metres deep. Due to the shallow depth, there is risk of hydraulic connectivity between septic discharges and domestic supply wells, risking contamination.

v. **Type of Contaminants** (both) – The high permeability of the coarse alluvial deposits reduces the available time for contaminants to die off as they travel through the aquifer before reaching supply wells. This increases the risk of contaminants being introduced to water supplies.

vi. **Intentional Non-Compliant Release** (Option 1) – To avoid the cost of emptying blackwater tanks, there is risk the property owners will discharge blackwater directly to ground. Although this is illegal it is very difficult to monitor.

vii. **Storage of Blackwater** (Option 1) – There is inherent risk with storage of blackwater above the DWPZ. It is expected that between 10 – 20,000 L of storage will be required at each property, with 13 existing dwellings located on Lyford Lane. Single failure events (individual storage tank) or mass natural disasters (all storage tanks) can damage storage tanks, resulting in discharge to ground of untreated domestic wastewater.

viii. **Māori Interests** (both) – The discharge of domestic wastewater occurs to ground before reaching the receiving aquifer in both solutions. There is also potential that discharges reach the streams (Frasers and Dry Streams) surrounding the project area due to likely hydraulic connection between the waterways and aquifer. This is option is not preferred as it results in the wastewater discharging to the local water bodies.

If this solution is chosen, this then sets a precedent that discharge to ground within the DWPZ is acceptable under certain conditions. However, with further development there are increased complexities with ensuring compliance and optimal operation, and therefore increased opportunities for failure and thus contamination of the drinking water supply. This is considered a poor long-term solution for wastewater management on Lyford Lane and will not be considered further.

3.2 Demand

Design of the pressure system is in accordance with Water New Zealand Pressure Sewer Guidelines, Part B. The rational method has been used to estimate the design demand for the system, as shown in Table 4.

Table 4 Estimated projected demand for Lyford Lane

Design Solution	Existing Population (Dwellings)	Design Population (Dwellings)	Existing Maximum Discharge (L/s)	Forecasted Maximum Discharge (L/s)
All properties in Lyford Lane	39 (13)	78 (26)	1.73	2.42
Only properties within the DWPZ	21 (7)	30 (10)	1.39	1.56

3.3 Water quality

There are no specific requirements on wastewater quality to be discharged to Twizel's wastewater network. The design will however need to consider the impacts of septicity and odour which are known risks to pressure networks. Odour and septicity issues are largely driven by retention times and flow velocity (ensuring self-cleansing flows are achieved)

3.4 Level of service

3.4.1 Design flow

As per the Water New Zealand Pressure Sewer Guidelines, a minimum design velocity of 0.6 m/s will need to be achieved daily for to achieve self-cleansing velocities.

The maximum design velocity is 2.5 m/s.

3.4.2 System pressure

A typical grinder pump performance curve is shown in Figure 10. The total dynamic head must be below 55 m at normal operation.

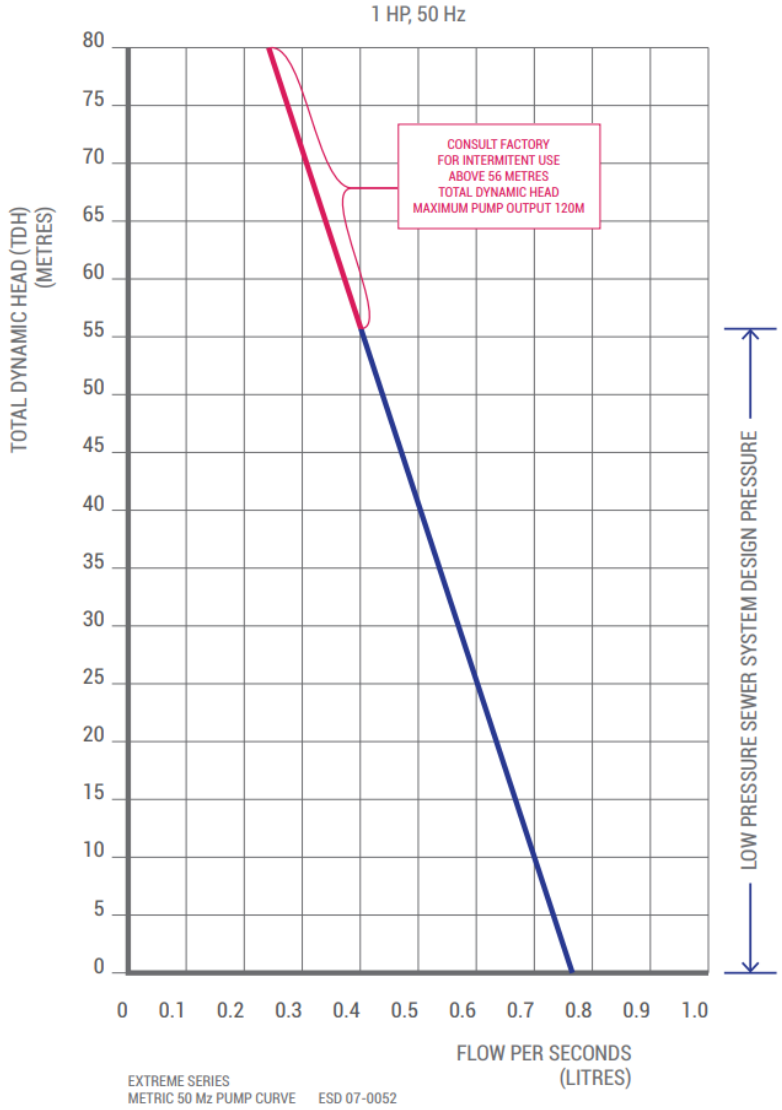


Figure 10 E/One Grinder Pump Curve

3.4.3 Design Parameters

Retention times must be managed to avoid issues with septicity and odour. Retention times ideally should be below 4 hours, but at worst case no more than 8 hours.

3.5 Service connections

A connection will be made to the MDC owned gravity main located on Glen Lyon Rd (refer Figure 6). There is an existing connection at this location from the existing private pressure sewer. It is assumed that the existing connection can be used for discharge.

Due to the expected low flow from Lyford Lane, it is assumed there is sufficient capacity in the DN225 main to allow for the additional flow from Lyford Lane.

4. Design Options

4.1 Option 1 – Reticulate only properties within the DWPZ

4.1.1 Description

This solution provides wastewater reticulation to only properties located within the DWPZ. Any existing properties whose boundaries intersect the DWPZ will be assumed to be within the DWPZ. Any future properties whose boundaries intersect the DWPZ will be assumed to be required to install septic systems in an area clear of the DWPZ.

An overview of the pipe alignment and key infrastructure is shown in Figure 11. Also shown are the assumptions of residential development for the Lyford Lane area (see Section 2.3).

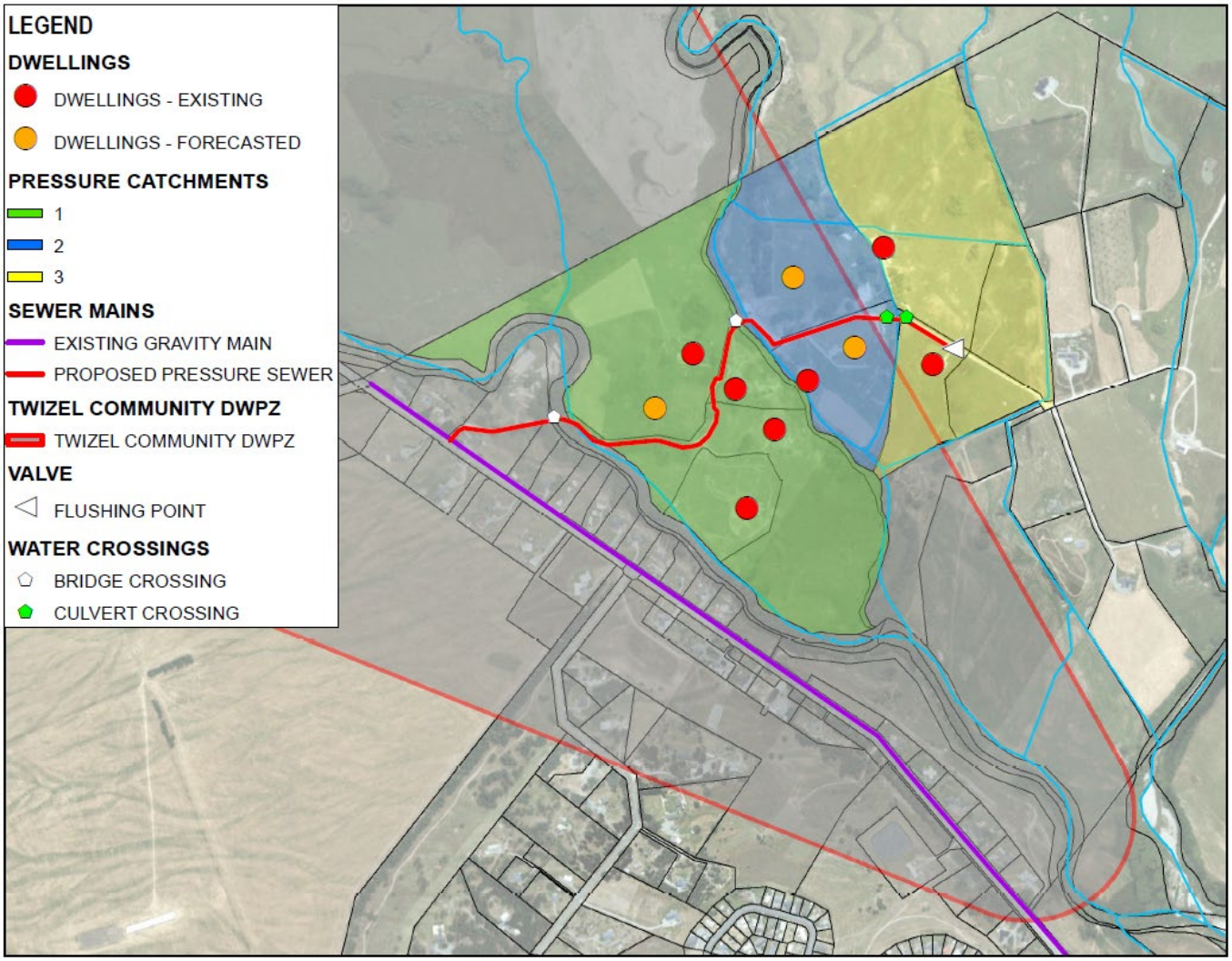


Figure 11 Option 1: Wastewater connection for only properties within the DWPZ

Refer to Appendix B for detailed overview drawings.

4.1.1.1 Pressure sewer system description

The system is designed with use of a grinder pump pressure system. The system is characterised by a sump/collection pit with a pump and control panel for each lot. A grinder pump macerates the sewage and pumps

it to a pressure main or gravity reticulation. Figure 12 shows a 718 L capacity Simplex unit from Ecoflow, a common supplier of pressure systems in New Zealand. The sump indicated is designed for one residential lot and has an emergency storage volume of 24 hours of wastewater.

Figure 12 E/One Simplex single pump and integrated sump.

A typical pressure system arrangement is shown in Figure 13 below. Note the requirement for boundary kits to eliminate backflow to the properties. The minimum main diameter is DN50 (40 mm ID). DN40 PE is typically used for the pressure lateral, and DN100 PVC is typically used to connect flows from the dwelling to the grinder pump.

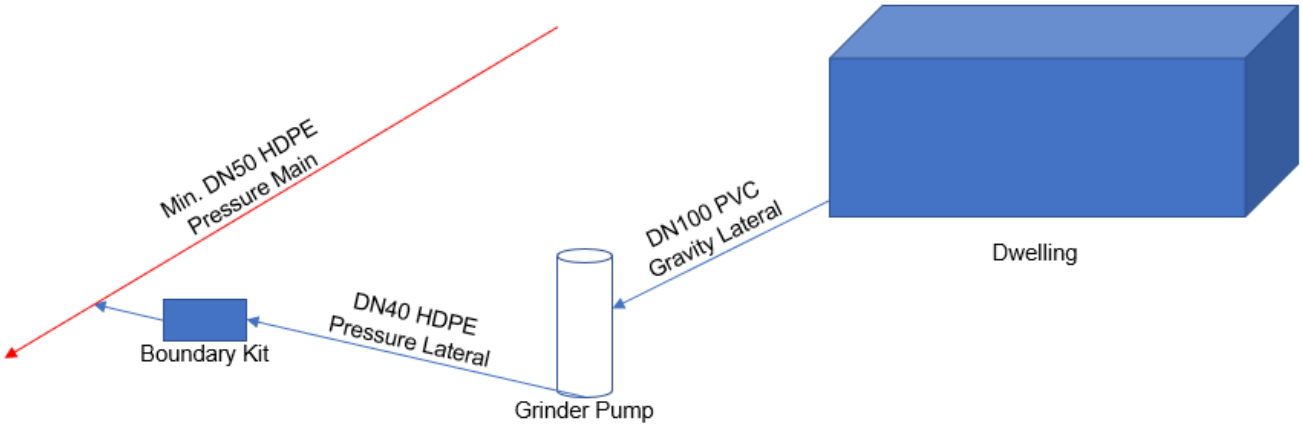


Figure 13 Typical pressure system arrangement.

Clear definition of the responsibilities is required for ownership, operation and maintenance of parts of the systems. Common models include:

- The property owner owns and operates the pump – potential issues with maintenance capacity in the market and with affordability (and a tight timeframe for action) when the pump requires replacement at the end of life or failure. Uncertainty with rental properties includes responsiveness by the property owner if maintenance or replacement is needed.
- The property owner owns the pump; Council offers maintenance services– potential issues with when the pump requires replacement at the end of life or failure. Uncertainty with rental properties includes responsiveness by the property owner if maintenance or replacement is needed.

- Council owns and operates the pump and has a right of access under the Local Government Act section 181.
- Council owns the pumps and contracts operation of the pumps and network to a 3rd party for a specified period.

Ownership related issues need further consideration once the technology recommendations are approved, with additional work required to identify Councils preferred commercial approach and model. For the purpose of this report and for cost estimation, it will be assumed the council own and operate the pumps.

4.1.1.2 Key Infrastructure

The area has been split up into three 'pressure catchments' (refer Figure 11) to allow for the correct sizing of pipe diameters along the length of the pipeline. This is essential as the number of contributing dwellings, and therefore the flow demand, reduces along the length of pipe. As a result, the optimal pipe diameter for each section will vary along the length of the pipe.

In this case it is suitable to have one DN50 HDPE pipe run for 1.2 km along Lyford Lane until 108 Lyford Lane. The pipe will be PE100 PN16 as per Water New Zealand Pressure Sewer Guidelines. The pipe will be installed as per AS/NZS 2033:2008: Installation of Polyethylene Pipe Systems.

E/One pump units will be required at each property (see Section 4.1.1.1). It is assumed that MDC will own and operate the pumps. With development, the performance of the system and pump units will need to be monitored to ensure that they maintain operation within the design parameters. Noting that the assumptions in this report will likely differ from actual development.

As the maximum elevation in the pipeline is at the discharge location, no air release valves are required. It is proposed to have one flushing point at the last property on Lyford Lane for maintenance.

Four water crossings will be required for this pipe alignment. Two bridge crossings will be required for the Frasers and Dry Streams. Two culvert crossing will be required, one of which will be to connect a private property to the network. The pipe will be fixed using stainless steel conduits on all bridges and culverts. Note that there is a considerable flood risk in the waterways throughout the project and a specific design may be required to allow for this.

Where possible the pipeline will be constructed parallel to Lyford Lane, however, there are instances where the pipe alignment needs to cross the road. Reinstatement of the pipeline will be assumed to be 20 % in the carriageway and 80 % in the berm to form a conservative estimate for reinstatement costs. Ideally a trenchless method of installation, such as mole ploughing, would be preferred however this is not expected to be viable given the presence of coarse alluvial deposits. Dewatering has been assumed to be required due to the high groundwater table.

Reinstatement will be undertaken as per MDC's 'Unsealed Road Carriageway Reinstatement' detail. Connection will be made with the manhole near Lyford Lane on Glen Lyon Rd (Asset ID: GLLYSM135). There will likely be issues with odour/septicity at the discharge location. It is recommended an odour control unit is installed. This has not been designed but rather an estimation of cost has been provided.

4.1.1.3 High Level Hydraulic Analysis

A high-level hydraulic analysis was undertaken to determine the hydraulic requirements for a pressurised sewer system for only properties on Lyford Lane above the DWPZ. The analysis was undertaken in accordance with the rational method detailed in Water New Zealand Pressure Sewer Guidelines, Part B.

Table 5 summarises the outcome of the analysis.

Table 5 Hydraulic Analysis Summary - Option 1

Eone Grinder Pump	Existing Demand	Future Demand
Average Retention Time at 660 L/day (hrs)	7.81	5.47
Max Velocity (m/s)	1.10	1.24
Min Velocity (m/s)	0.64	0.64
Max Static Head (m)	6.0	6.0
Min Static Head (m)	4.0	4.0
Max Total Dynamic Head (m)	40.2	53.1
Min Total Dynamic Head (m)	24.3	28.7
Range Total Dynamic Head (m)	15.9	24.4
Total Number of Pumps	7	10
Capacity of Network (L)	1,503	1,503
Total Length of Network (m)	1,196	1,196
Length of each Pipe (m)		
DN50	1,196	1,196

In both cases the minimum velocity (0.6 m/s) is achieved for self-cleansing. The total dynamic head remains in the bounds of the manufacturer's guidelines (less than 55 m head). The main concern however with the outcome of the analysis is the retention time. Retention times are impacted by pipe length, pipe diameter and system demand. With instances of low demand and large distances between dwellings and the connection point, such as Lyford Lane, it is difficult to satisfy all parameters. Considering this, as per Water New Zealand Pressure Sewer Guidelines, it is recommended that if this option is selected, efforts are undertaken to assess the impact of odour and mitigate it where required. An odour control design has not been undertaken as part of this assessment, however an indication of likely costs has been provided.

The analysis is shown in further detail in Appendix C.

4.1.2 Budgetary Cost Estimate

4.1.2.1 Capital Cost Estimate

Cost estimation has been undertaken in accordance with Estimate Class 4 (Feasibility Study) as per the Association for the Advancement of Cost Engineering (AACE) classification system. The intent with Class 4 estimates is to provide a high-level budgetary estimate (-30% to +50%). The capital cost estimate for Option 1 can be found in Table 6. Note it is assumed that MDC own and operate the pump systems (see 4.1.1.1). Further detail on the cost estimate can be found in Appendix D.

Table 6 Option 1 – Capital cost estimate

CAPEX	Cost	Comment
Preliminaries & General	$ 30,000	Based on previous tenders
Ground investigations	$ 1,000	Based on previous tenders
Wastewater main installation (Supply and install)	$ 88,000	Based on supplier information, rates from previous tenders (includes dewatering)
Pump systems	$ 230,000	Assumes one per property, owned and operated by MDC (see Section 4.1.1.1)
Testing	$ 1,000	Supplier information
Odour treatment	$ 6,000	Supplier information/previous tenders
Service connections	$ 2,000	Based on previous tenders

Reinstatement	$ 18,000	Assumed to be 30% in the road carriageway
Miscellaneous	$ 35,000	Allowance for miscellaneous small works
Base cost estimate	**$ 411,000**	
Design fee	$ 62,000	
Consenting	$ 50,000	
Contingency	$ 105,000	Assumed to be 20%
Total budgetary estimate	**$ 628,000**	**Excluding GST**

4.1.2.2 Operating Cost Estimate

The operating cost estimate for Option 1 can be found in Table 7. Maintenance requirements are minimal for the pressure sewer system so have been assumed based on worst case performance. The annual operating costs are estimated to be **$ 1,400 (excluding GST).**

Table 7 Option 1 - Operating cost estimate

OPEX	Annual Cost	Comment
Operator inspections and maintenance	$ 780	Operator cost provided by MDC. Misc. maintenance requiring 1 hours/month
Operator mileage	$ 430	Operator mileage assumed from Twizel township
Carbon replacement	$ 180	For the odour control unit. Material only.
Total annual cost	**$ 1,400**	**Excluding GST**

4.1.3 Maintenance Requirements

The pressure sewer system requires minimal maintenance. Maintenance only occurs when issues or alarms are noticed, in which case the manufacturers guidelines will be followed. Occasional flushing of the lines may also be required which will occur at the flushing point locations. It is assumed both responsibilities can be covered by the MDC maintenance contractor.

The pumps have an expected service life of 25 years until replacement is required. Further maintenance advice can be found in Water New Zealand Pressure Sewer Guidelines, Part D.

The odour control unit has been assumed to require one full replacement per year and is able to be done by the MDC maintenance contractor.

4.1.4 Benefits

This option can provide the following benefits:

- This is the lowest cost method of eliminating discharge of domestic wastewater to ground in the DWPZ.
- Maintenance requirements will likely be low. There are less concerns with the system operating within the design parameters in comparison to Option 2. This is due to the significantly shorter length of pressure main required.
- This option will require the least buy-in from residents on Lyford Lane. Some residents may see it as unnecessary to install reticulation when they are both not within the DWPZ, and already have a functioning and consented onsite septic system. This is particularly of note when referencing the potential ownership models (Section 4.1.1.1).

4.1.5 Challenges

The following challenges are associated with this option:

- For future development, this option relies on the installation of septic tanks and disposal systems for properties outside the DWPZ. There may be additional costs for MDC in consenting and regulation for these properties.
- This solution does not remove discharge of domestic waste within the SWRMA Zone 2 (refer Section 2.1.3.2).

4.2 Option 2 – Reticulate all properties on Lyford Lane

4.2.1 Description

This solution provides low pressure wastewater reticulation to all properties in Lyford Lane and therefore avoid wastewater discharges to ground within both the DWPS and the SWRMA from these properties. An overview of the pipe alignment and key infrastructure is shown in Figure 14. Also shown are the assumed future residential properties for the Lyford Lane area (see Section 2.3). The system is designed for use of a grinder pump pressure system as described in Section 4.1.1.1.

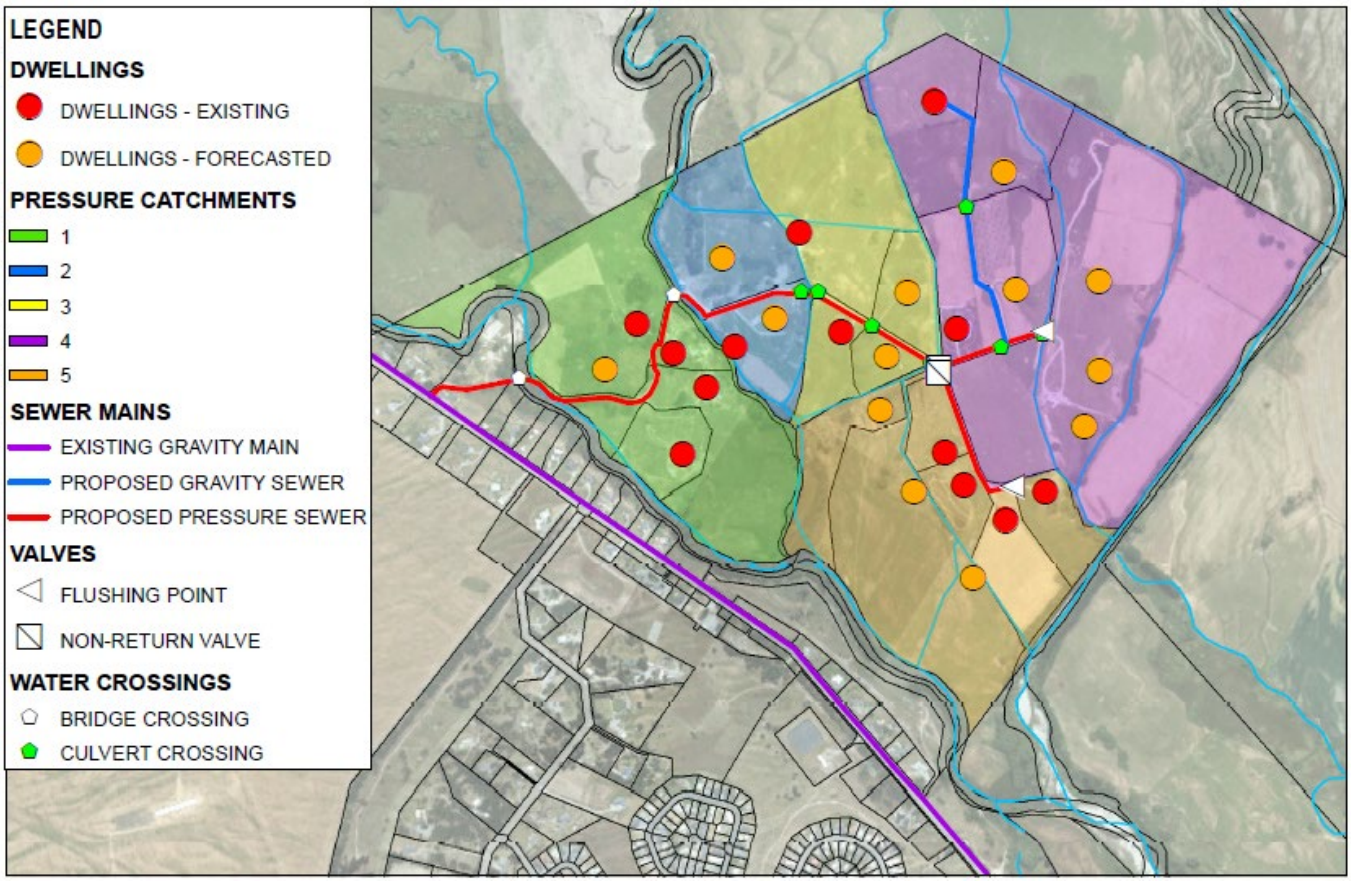


Figure 14 Option 2: Wastewater connection for all properties on Lyford Lane

Refer to Appendix B for detailed overview drawings.

4.2.1.1 Key Infrastructure

The area has been split up into five ‘pressure catchments’ (refer Figure 14). For Option 2, in addition to the reasons mentioned in Option 1, this was required to allow for the divergence of pipelines as the road diverges.

A DN63 HDPE pipe run for 1.4 km along Lyford Lane until the lane reaches a fork in the road. From this point, a DN50 HDPE pipe will be laid for 270 m until reaching the final existing land parcel for ‘Catchment 4’. A second DN50 HDPE pipe will be laid for 350 m until reaching the final land parcel for ‘Catchment 5’. All pipes will be PE100 PN16 as per Water New Zealand Pressure Sewer Guidelines. The pipe will be installed as per AS/NZS 2033:2008: Installation of Polyethylene Pipe Systems.

E/One pump units will be required at each property (see Section 4.1.1.1). It is assumed that MDC will own and operate the pumps. With development, the performance of the system and pump units will need to be monitored to ensure that they maintain operation within the design parameters. Noting that the assumptions in this report will likely differ from actual development.

Non-return valves will be required at the pipe junction to stop backflow to the different catchments. Note that non-return valves (boundary kits) will be required at each individual property as shown in Figure 13 but are not shown in overview drawings.

Note that in ‘Catchment 4’ there is considerable distance between the northern most dwelling (187 Lyford Lane) and the proposed pipe alignment. A pressure sewer system is likely to encounter issues with both septicity/odour and pump operation as a result. There is however sufficient fall in a southerly direction to allow for the installation of a gravity main to a receiving pump chamber near the proposed pipe alignment.

As the maximum elevation in the pipeline is at the discharge location, no air release valves are required. It is proposed to have flushing points at the end of each pipe alignment.

Nine water crossings will be required for this pipe alignment. Two bridge crossings will be required for the Frasers and Dry Streams. Seven culvert crossing will be required, two of which will be to connect private properties to the network. The pipe will be fixed using stainless steel conduits on all bridges and culverts. Note that there is a considerable flood risk in the waterways throughout the project area and a specific design may be required to allow for this.

Where possible the pipeline will be constructed parallel to Lyford Lane, however, there are instances where the pipe alignment needs to cross the road. Reinstatement of the pipeline will be assumed to be 20 % in the carriageway and 80 % in the berm to form a conservative estimate for reinstatement costs. Ideally a trenchless method of installation, such as mole ploughing, would be preferred however this is not expected to be viable given the presence of coarse alluvial deposits. Reinstatement will be undertaken as per MDC’s ‘Unsealed Road Carriageway Reinstatement’ detail. Connection will be made with the manhole near Lyford Lane on Glen Lyon Rd (Asset ID: GLLYSM135). There will likely be issues with odour/septicity at the discharge location. It is recommended an odour control unit is installed. This has not been designed but rather an estimation of cost has been provided.

4.2.1.2 High Level Hydraulic Analysis

A high-level hydraulic analysis was undertaken to determine the hydraulic requirements for a pressurised sewer system for all properties on Lyford Lane. The analysis was undertaken in accordance with the rational method detailed in Water New Zealand Pressure Sewer Guidelines, Part B. Table 8 summarises the outcome of the analysis.

Table 8 Hydraulic Analysis Summary - Option 2

Eone Grinder Pump	Existing Demand	Future Demand
Average Retention Time at 660 L/day (hrs)	10.20	5.10
Max Velocity (m/s)	0.96	1.18
Min Velocity (m/s)	0.59	0.79
Max Static Head (m)	10.0	10.0
Min Static Head (m)	4.0	4.0
Max Total Dynamic Head (m)	34.6	63.3
Min Total Dynamic Head (m)	17.0	28.2
Range Total Dynamic Head (m)	17.6	35.1
Total Number of Pumps	13	26
Capacity of Network (L)	3648	3648
Total Length of Network (m)	2023	2023
Length of each Pipe (m)		
DN50	617	617
DN63	1406	1406

For the existing demand the minimum velocity (0.6 m/s) is not achieved for self-cleansing. For the future demand, the maximum total dynamic head is greater than the manufacturers guidelines (greater than 55 m head). However, in both cases the parameter is only slightly not achieved. Increased flushing may result from not achieving the minimum velocity. The pumps can pump up to 120 m and the manufacturer should be consulted for intermittent use above 55 m head.

As with Option 1 there is concern with the retention time. With Option 2 however, the retention time for the initial demand is greater than 8 hours. Due to the characteristics of the site (large distances, low demand), there is little than can be done to resolve this in terms of system design.

Considering this, as per Water New Zealand Pressure Sewer Guidelines, it is recommended that if this option is selected, efforts are undertaken to assess the impact of odour and mitigate it where required. An odour control design has not been undertaken as part of this assessment, however an indication of likely costs has been provided.

The analysis is shown in further detail in Appendix C.

4.2.2 Budgetary Cost Estimate

4.2.2.1 Capital Cost Estimate

Cost estimation has been undertaken in accordance with Estimate Class 4 (Feasibility Study) as per the AACE classification system. The capital cost estimate for Option 2 can be found in Table 9. Further detail on the cost estimate can be found in Appendix D.

Table 9 Option 2 – Capital cost estimate

CAPEX	Cost	Comment
Preliminaries & General	$ 53,000	Based on previous tenders
Ground investigations	$ 5,000	Based on previous tenders
Wastewater main installation (Supply and install)	$ 222,000	Based on supplier information, rates from previous tenders (includes dewatering)
Pump systems	$ 598,000	Assumes one per property, owned and operated by MDC (see Section 4.1.1.1)
Testing	$ 2,000	Supplier information
Odour treatment	$ 6,000	Supplier information/previous tenders
Service connections	$ 2,000	Based on previous tenders
Reinstatement	$ 38,000	Assumed to be 30% in the road carriageway
Miscellaneous	$ 82,000	Allowance for miscellaneous small works
Base cost estimate	**$ 1,007,000**	
Design fee	$ 123,000	
Consenting	$ 50,000	
Contingency	$ 236,000	Assumed to be 20%
Total budgetary estimate	**$ 1,416,000**	**Excluding GST**

4.2.2.2 Operating Cost Estimate

The operating cost estimate for Option 2 can be found in Table 10. Maintenance requirements are minimal for the pressure sewer system so have been assumed based on worst case performance. The annual operating costs are estimated to be **$ 3,400 (excluding GST)**.

Table 10 Option 2 - Operating cost estimate

OPEX	Annual Cost	Comment
Operator inspections and maintenance	$ 2,340	Operator cost provided by MDC Misc. maintenance requiring 3 hours/month
Operator mileage	$ 520	Operator mileage assumed from Twizel township
Carbon replacement	$ 300	For the odour control unit. Material only.
Total Annual Cost	**$ 3,400**	**Excluding GST**

4.2.3 Maintenance Requirements

The pressure sewer system requires minimal maintenance. Maintenance only occurs when issues or alarms are noticed, in which case the manufacturers guidelines will be followed. Occasional flushing of the lines may also be required which will occur at the flushing point locations. It is assumed both responsibilities can be covered by the MDC maintenance contractor.

The pumps have an expected service life of 25 years until replacement is required

Further maintenance advice can be found in Water New Zealand Pressure Sewer Guidelines, Part D.

The odour control unit has been assumed to require one full replacement per year and is able to be done by the MDC maintenance contractor. This has been scaled to reflect the increased load for Option 2.

4.2.4 Benefits

This option can provide the following benefits:

- This option eliminates all discharge of domestic wastewater to ground in Lyford Lane for both the DWPZ and the SWRMA Zone 2:
    - This removes the use of septic tanks and thus the risk of contamination of the drinking water supply as a result of domestic discharge from properties on Lyford Lane.
    - This removes the consenting requirement (both from MDC and ECAN) for domestic discharge to ground for future developments.

4.2.5 Challenges

The following challenges are associated with this option:

- This option has the highest capital cost ($ 1,416,000 excluding GST, compared to $ 628,000 excluding GST). This assumes that MDC own and operate the pump systems. The assumption of the ownership model has potential to significantly impact the cost estimation and subsequently the preferred option. The ownership model will need consideration and consultation with effected residents to confirm this assumption.
- This option will require the most buy-in from residents in Lyford Lane. Some residents may see it as unnecessary to install reticulation when they are both not within the DWPZ, and already have a functioning and consented onsite septic system. This is particularly of note when referencing the potential ownership models (Section 4.1.1.1).
- As the rate and location of development may differ from the assumptions made in this report, managing optimal functionality of the system may prove difficult. This is exacerbated by the requirement of pressure zones and greater pipe lengths. Regular monitoring will be required to ensure that the system operates as intended.
- Self-cleansing velocities are only just achieved in both cases. Due to the complexities of the system and potential inaccuracies in the high-level analysis, maintenance requirements (manual flushing at the flushing points) may increase.
- Without mitigation, there will be greater odour and septicity issues when compared with Option 1. There will be further costs associated with this if installing odour treatment.

4.3 Option 2.1. – Reticulate all properties on Lyford Lane (Cost adaption)

Option 2 assumes that MDC pay for both existing and future pump systems. An alternative to Option 2 is that MDC does not fund the installation of the pressure sewer system for all future dwellings on Lyford Lane, but that future dwellings will need to meet the full cost of installing a pressure sewer system to gain consent approval. Note that detail of what properties are existing and what are forecasted are shown in Figure 14.

The difference between Option 2 and Option 2.1. is the exclusion of boundary kits and pump units for the latter option. Refer to Appendix D for the cost estimation for detail.

There is no difference to the design of the system with this sub option. This section therefore presents a comparison of costs between Option 2 (Section 4.2) and Option 2.1 (Section 4.3), as shown in Table 11.

Table 11 Option 2 – Capital cost estimate

CAPEX	Option 2	Option 2.1
Preliminaries & General	$ 53,000	$ 50,000
Ground investigations	$ 5,000	$ 4,000
Wastewater main installation (Supply and install)	$ 222,000	$ 206,000
Pump systems	$ 598,000	$ 299,000
Testing	$ 2,000	$ 2,000
Odour treatment	$ 6,000	$ 6,000
Service connections	$ 2,000	$ 2,000
Reinstatement	$ 38,000	$ 38,000
Miscellaneous	$ 82,000	$ 77,000
Base cost estimate	**$ 1,007,000**	**$ 684,000**
Professional fees	$ 123,000	$ 123,000
Consenting	$ 50,000	$ 50,000
Contingency	$ 236,000	$ 171,000
Total budgetary estimate	**$ 1,416,000**	**$ 1,028,000**

5. Options review

5.1 Key Criteria

The following items were identified in consultation with Mackenzie District Council as their key criteria in determining the shortlisting of options for further consideration.

Table 12 Key criteria for criteria analysis as identified by MDC

Criteria	Definition
Value for money	Criterion assessing the anticipated overall cost of the option, and therefore gives an indication for the impact on rates. Including assessed CAPEX costs, OPEX costs, depreciation, and holding costs. Options with lower cost are considered preferable than those with higher cost.
Level of service	Assessment of the supply type on offer for each option, and its ability cater for users usage requirements. On-demand (urban) usage preferred over restricted (rural) usage.
Reliability	Assessment of reliability of each option. Reliability is based on qualitative engineering judgement of treatment effectiveness and efficiency by assessing vendor provided information.
Environmental and ecological impact	Criterion assessing the potential impact of a particular option on the known existing environmental and ecological sites or features. Sites with the lowest amount of impact and less critical impacts are considered preferable.
Social impact	Assessment of the impact on local people and communities particularly during construction, but also any ongoing impacts if any. Options with the lowest impact are considered favourable.
Environmental Sustainability	Criterion assessing the enduring environmental sustainability for each option. For example, increased inspection requirements and therefore travel costs to site, ongoing power costs for pumping, requirements for generator use etc). Options with the lowest environmental footprint are considered preferable.

5.2 Key Risks

The following items were identified in consultation with Mackenzie District Council as their key risks to be considered whilst determining options for further consideration.

Table 13 Key risks for criteria analysis as identified by MDC

Risks	Definition
Deliverability	Risk associated with the ability to deliver the project. Covers design, consenting and construction risk.
Natural hazards	Risk from Natural Hazards such as earthquake fault lines and flood risk.
Operational	Selected option operational risk, including safety of personnel, reliability risk
Cost uncertainty/escalation	Risk related to uncertainties which have the potential to impact project cost.

5.3 Criteria Analysis

An unweighted criteria analysis was carried out for each option. Options were categorised based on their level of favourability with dark green representing the most favourable, green representing somewhat favourable, orange representing somewhat unfavourable, and red representing unfavourable. The result of the analysis is presented in Table 14 below.

Table 14 Criteria analysis

Criteria	Option 1	Option 2	Option 2.1
Value for money			
Level of service			
Reliability			
Environmental and ecological impact			
Social impact			
Environmental sustainability			
Risks	**Option 1**	**Option 2**	**Option 2.1**
Deliverability			
Natural hazards			
Operational			
Cost uncertainty/escalation			
Cost	**Option 1**	**Option 2**	**Option 2.1**
Capital cost	$ 628,000	$ 1,416,000	$ 1,028,000
Lifecycle cost	$ 83,500 – $111,300	$ 203,900 – $ 271,800	$ 203,900 - $271,800
Rank	**1**	**3**	**2**

5.4 Summary of Options

Option 1 provides a design solution which eliminates domestic wastewater discharge within the DWPZ, whereas Option 2 provides a design solution which eliminates domestic wastewater discharge for all properties in Lyford Lane (discharges are eliminated in both the DWPZ and SWRMA Zone 2). Option 2.1 provides an adaption to the ownership model shown in Option 2.

The key differences between the options from the criteria analysis are:

- There is a significantly greater capital cost associated with Option 2. This is largely due to the additional cost of pump units per property. The future demand (refer Section 3.2) was assumed as 10 dwellings (7 existing) for Option 1, and 26 (13 existing) for Option 2. Considerations to the ownership model may alter this value (refer Section 4.1.1.1).
    - The cost for Option 2 does reduce with the ownership model discussed in Option 2.1 (refer Section 4.3), where the cost of the pressure sewer system for the existing 13 dwellings is covered by MDC, and cost for future dwellings is covered by the future property owners.
- As Option 2 requires a significantly greater pipe distance for the network, and there are greater concerns around septicity and odour issues than for Option 1. Careful planning will be needed to mitigate this.
- Due to the complexities of the system, Option 2 will also require closer monitoring and optimisation as development occurs. This has not been included in operational costing.
- Option 2 will require greater buy-in from the affected residents. Some residents may see it as unnecessary to install reticulation when they are both not within the DWPZ, and already have a functioning and consented onsite septic system. This is less relevant with the ownership model discussed in Option 2.1 (refer Section 4.3).
- Option 1 does not fully eliminate the discharge of domestic wastewater to ground in Lyford Lane:
    - Although this option does remove discharge of domestic wastewater within the DWPZ, discharge still occurs within the SWRMA Zone 2. Therefore, there is still risk of contamination to the aquifer if Option 1 is chosen. The magnitude of this risk must be determined by the water service provider.
    - This would likely not completely satisfy Iwi/Māori interests and some other local stakeholders; however, it is recommended early consultation occurs to understand their exact perspective on the matter.
- Both options are considered environmentally sustainable from an operations perspective.
- The delivery of the project for Option 1 will be inherently simpler due to the simpler network, lower number of effected dwellings, shorter pipe lengths, and lower number of water crossings.

6. Recommendations

This study investigated the feasibility of wastewater pressure systems for Lyford Lane to minimise the risk of drinking water contamination from the discharge of domestic wastewater to ground. The unweighted criteria assessment carried out for each option indicated a favourable outcome for Option 1, due to it being the smallest extent and the lowest capital cost option.

The residual risk of contamination of the drinking water supply from wastewater discharges outside of the DWPZ, but within the SWRMA Zone 2, can be considered to outweigh the cost and project benefits offered by Option 1.

We therefore recommend that Option 2.1 be progressed as the preferred solution.

There remain uncertainties around the ownership model of the system, however, which may impact the option selection. It is recommended that consultation is firstly undertaken with affected residents.

Appendix A

Desktop reviews

A-1 Geotechnical Review

INITIAL DESKTOP STUDY	1258950

Site location	Site 4 – Lyford Lane, Twizel
Client name	Mackenzie District Council PM Rose Sullivan GHD
Report date	27/09/2022
Introduction	Mackenzie District Council (MDC) is looking to complete a range of feasibility studies and concept designs to connect remote water supplies and on-site wastewater systems to existing Council operated networks in the Mackenzie District. This initial desktop study outlines high level geological and geotechnical hazards identified at the site of the proposed wastewater pipeline extension, based on readily available desktop sources. This document is for internal use only and is to be used only for high-level understanding of geological/geotechnical conditions. It should not be consulted without a geotechnical engineer to explain the limitations of the sources. A full scope of geotechnical works (i.e. a ground investigation and subsequent interpretation of results) is required to confirm and quantify the hazards identified.
Site topography	The topographic layer of the Canterbury maps GIS indicates the proposed site area is a relatively flat riverbed with the entire site sitting between 460 m and 480 mRL (ECAN, 2022). Site topography and proposed alignment is included in Figure 15.
Geological setting	An extract of the geological map and legend is presented below in Figure 16. It shows the proposed site area is located within an alluvial plain.
Available NZGD geotechnical information: (New Zealand Geotechnical Database)	No relevant nearby ground investigation (GI) data was found on NZGD for this site. Due to the publish geology showing different units at this site to the nearby township of Twizel, GI data taken from those locations was deemed to be incompatible with this site's geology (NZGD, 2020).
Geomorphology	The pipe alignment is located along relatively flat plains feature. The site area sits nearby to many small stream channels with the geology dominated by alluvial deposits.
Faults and ground shaking	The proposed site area sits nearby (~3 km) to the active Ostler Fault Zone. The recurrence interval is stated as between 2000 and 3,500 with an unknown single event displacement (GNS Science, 2020).
Geotechnical hazards	The geotechnical hazards listed in Table 15 are based on readily available information only and will be required to be confirmed and quantified at later stages of design. It is important to note this is a high-level overview of the site with large amounts of uncertainties and may not capture all the hazards.
Construction hazards	Construction specific geotechnical hazards identified for this project are listed in Table 16. These hazards assume that the pipes will be shallow and installed via open trenching techniques. It is important to note this is a high-level overview of the site with large amounts of uncertainties and may not capture all the hazards especially given the method of construction has not been determined.

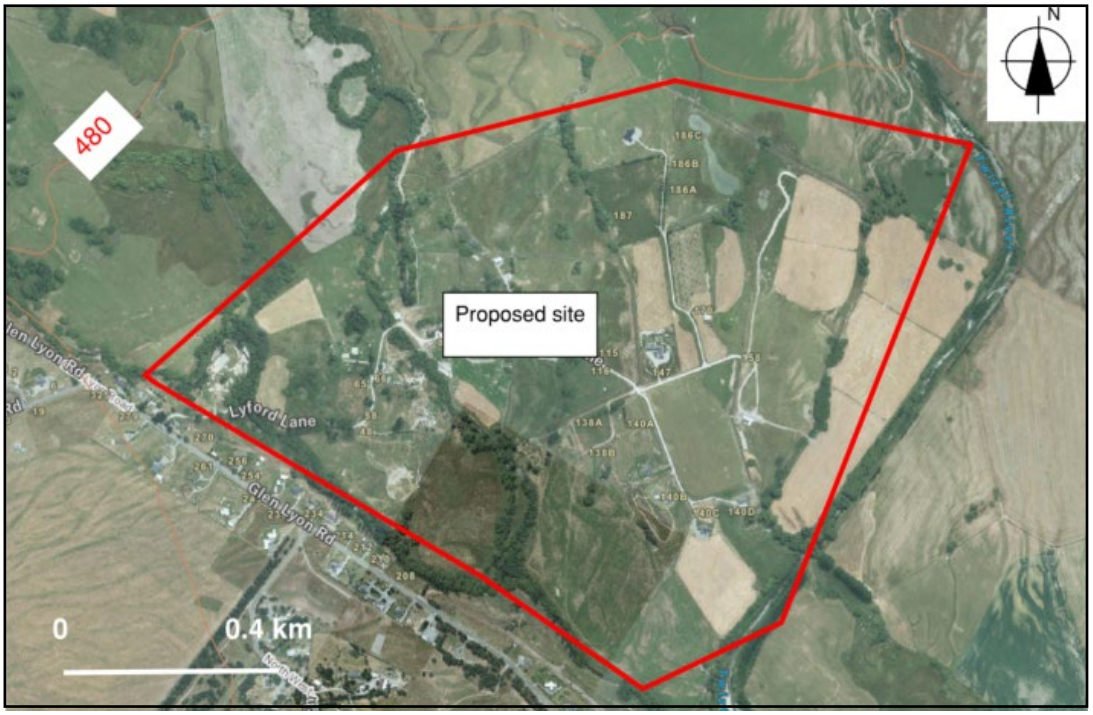


Figure 15 Extract from Canterbury Maps Site topography – 20 m contours (ECAN, 2022)

Table 15 Key hazards to proposed pipeline

Hazard	Description
Settlement	Settlement can be induced along the alignment due to the removal of in situ materials and replacement with heavier engineered granular fills. This hazard is proportional to the depth of pipe however it is expected the pipe will be within a few meters of ground level and as such settlement induced damage to existing infrastructure and structures is considered to be low.
Permanent groundwater drawdown	Permanent groundwater drawdown caused by the pipe trench acting as preferential pathway is possible. However, the implementation of trench stops can effectively mitigate this risk.
Erosion	The offset between the alignment and the stream is unknown. This should be assessed once the pipe location is known however where the pipe is within 10 m of the nearby rivers the hazard can be considered to be present.
Liquefaction Potential	The proposed pipeline and sit on predominantly gravels and coarse-grained soils, as such liquefaction is not considered a high risk for this site.
Slope Stability	A review of the available aerials does not show the alignment to cross any visually obvious areas of instability.
Rock Fall Hazard	No obvious rock out crops were identified on the aerial photographs therefore the hazard associated with rock hazard is considered low.

Table 16 Key hazards to the construction of the proposed pipeline

Hazard	Description
Trench stability	The alignment passes through alluvial soils in proximity to multiple water ways. This could result in excavations through saturated silts which may be prone to collapse. Similarly, due to the site's proximity to the source of its fluvial deposits, larger particles sizes, including up to boulders may be present near and on the soil surface. The presence of these boulders increases the risk of instability when excavating trenches. This results in an increased risk of trench collapse and may

	require additional consideration in construction methodology, such as benching of trench walls or additional shoring.
Construction dewatering settlement	The presence of waterways such as creeks or rivers in the proposed alignment present a significant disruption to construction. Specific design is required to address river crossings across a proposed alignment. Due to the proximity of this site to many small streams as well as the potential for a high groundwater level, any construction will require careful planning to best navigate across nearby waterways.

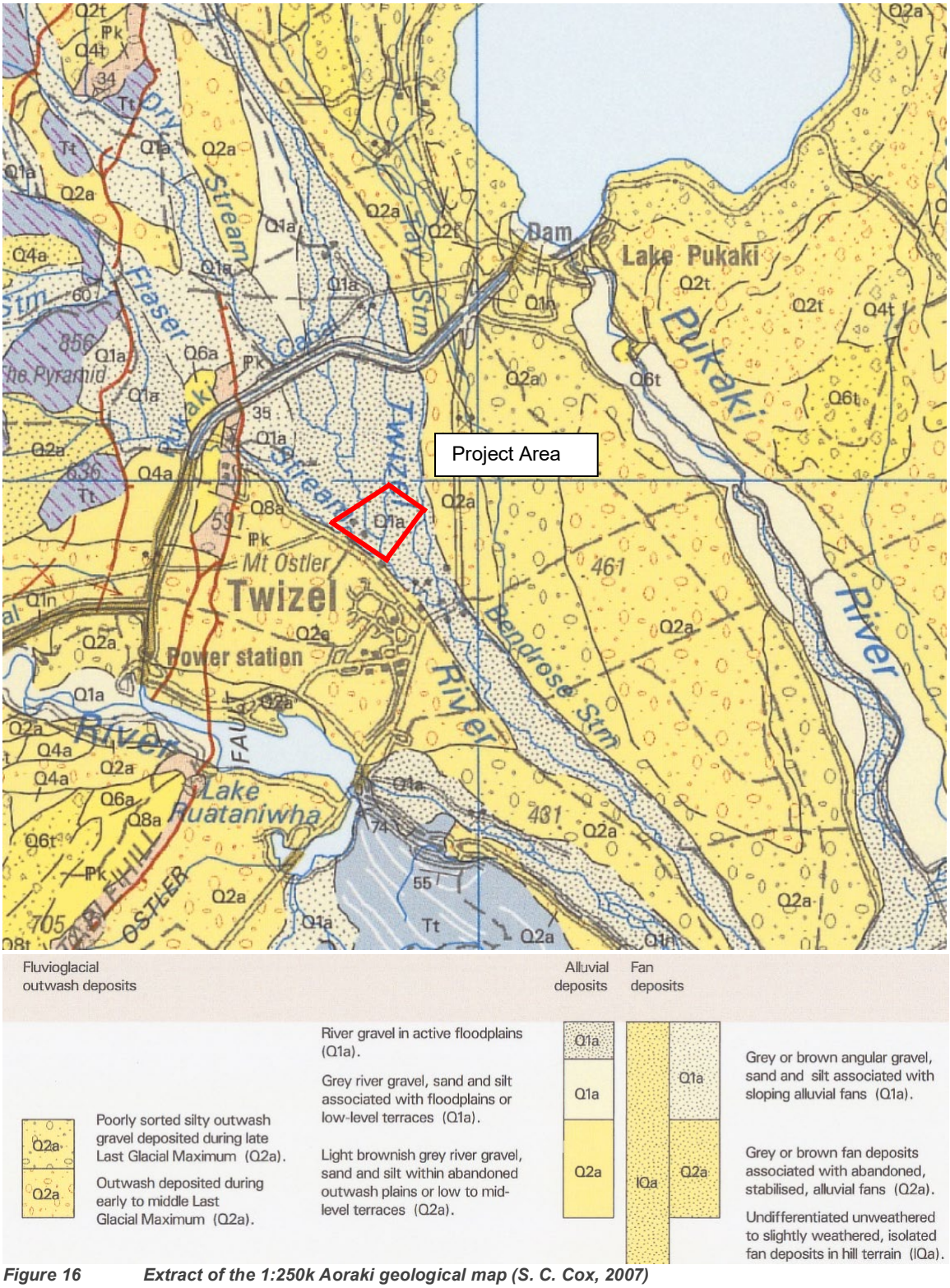


Figure 16 *Extract of the 1:250k Aoraki geological map (S. C. Cox, 2007)*

A-2 Groundwater review

A desktop review of publicly available information was undertaken to provide an overview of the groundwater setting. Information reviewed include geological and soil maps, Environment Canterbury (ECan) databases and GIS mapping platform (Canterbury Maps) and other technical reports. The desktop review is summarised in Table 17.

Table 17 Lyford Land, Twizel desktop review

Category	Description
Geology and soils	The site is located within the shallow Q1a river gravels associated with Twizel River and its tributaries. The gravels comprise unweathered sandy gravel with lenses of well sorted gravels and sands (Cooksey, 2008[5]). The river gravels have been incised into the older Q2 outwash gravels that form the terrace along the southeastern margin of the site (Cox et al, 2007[6]). S-Map indicates that soils within the area are well drained.
Springs and surface water interaction	Flow gauging presented in Cooksey (2008) indicates that the Twizel River both loses water to, and gains water from, the shallow groundwater system. Between the Pūkaki Canal and State Highway 8 (SH8), the river gains water by approximately 35% from groundwater. Cooksey (2008) notes that the groundwater contribution is from a number of depression springs[7] that emerge in the area. No springs are identified on ECan maps for the project area, however given the hydrogeologic setting it is possible that springs may be present.
Groundwater flow direction	Groundwater flow is interpreted to be in a southerly – southeasterly direction, approximately parallel to the Twizel River.
Depth to groundwater	Groundwater is expected to be shallow, ECan bore records indicate groundwater levels within 1-2 m of ground surface and may be shallower in places.
Existing bores	13 identified on ECan database within the area interest, 9 of which are classified as active for domestic and/or stockwater supply. Bore depths range from 3 m to 24 m below ground level.

The site intersects the community drinking water protection zone for the Twizel public water supply wells. The protection zone, as defined in Schedule 1 of the Land and Water Regional Plan[8] (LWRP), is larger than previously modelled in 2008[9] and the area shown on District Plan Maps.

[5] Cooksey, K. (2008) Hydrogeology of the Mackenzie Basin. MSc Thesis. Department of Geological Sciences. University of Canterbury.
[6] Cox, S.C.; Barrell, D.J.A. (compilers) (2007): Geology of the Aoraki area. Institute of Geological and Nuclear Sciences 1:250 000 geological map 15. 1 sheet + 71 p. Lower Hutt, New Zealand. GNS Science.
[7] Depression springs form where the groundwater table has intersected the ground surface due to a change in topography.
[8] Environment Canterbury https://www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-land-and-water-regional-plan/
[9] Greg Birdling, 2008 Opus Modelling of the Twizel Water Supply Protection Zone - Proposed Plan Change 13 Officer Report on Twizel Submissions, Patricia Harte, Davie Lovell-Smith, 15 October 2008, (p17)

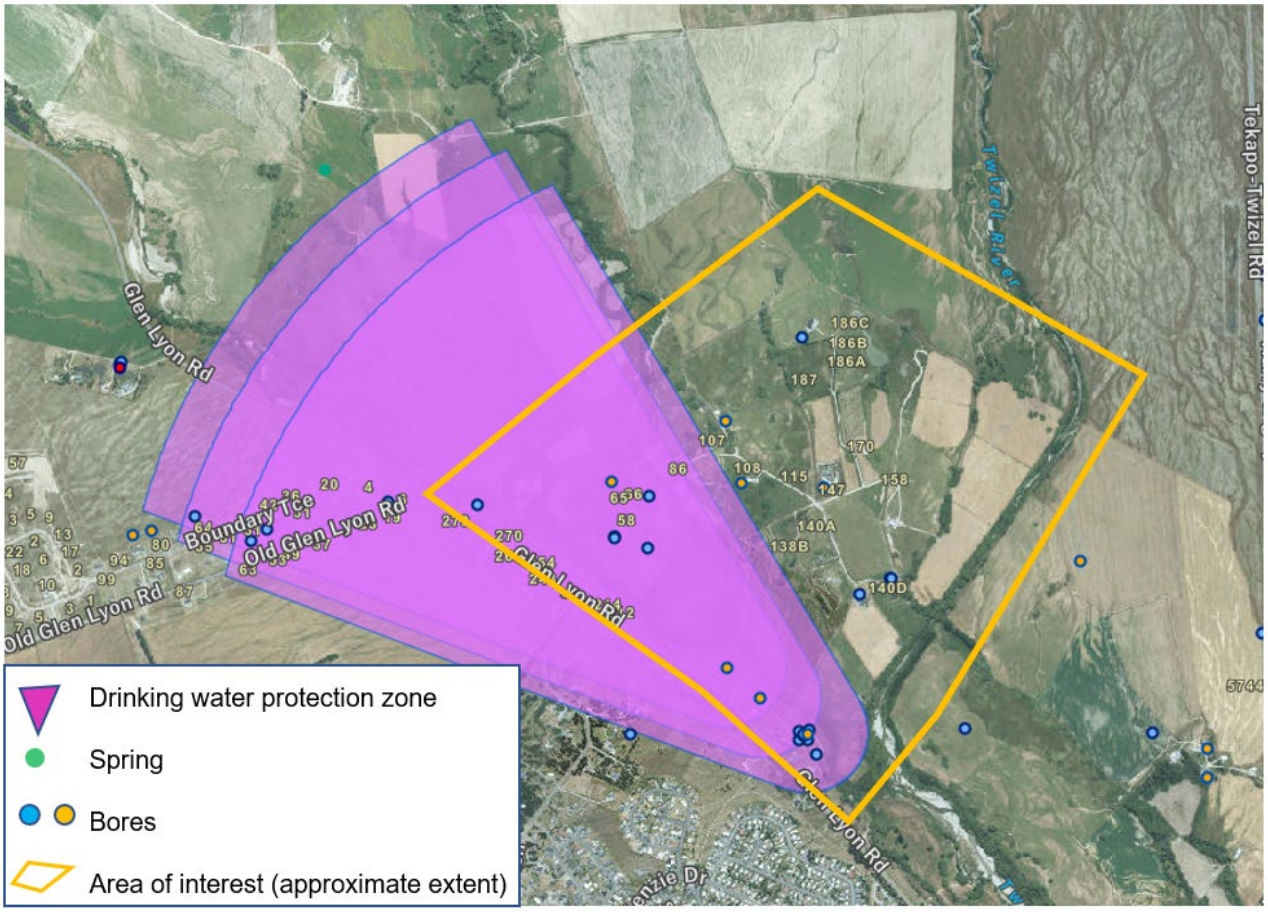


Figure 17 Drinking water protection zone and bores near Lyford Lane, Twizel

MDC has recently commissioned WSP to develop a Drinking Water Safety Plan (DWSP) for Twizel's drinking water supply[10]. The DWSP utilised Source Water Risk Management Areas (SWRMA) as detailed in the Ministry for the Environment's draft consultation document on updating the National Environmental Standards for Sources of Drinking Water (NES-DW). SWRMA's can be defined by three levels[11]:

- *"SWRMA 1 is the immediate area around the source water take where there is an immediate risk of contamination because there is very little time to respond to any contamination before it enters the water supply.*
- *SWRMA 2 is a larger area where activities need to be managed, to mitigate more medium-term risks of contamination, particularly microbiological risks. The size will vary because it is based on the time it takes for water to flow to the source.*
- *SWRMA 3 is the entire catchment area for the source water. Persistent contaminants and cumulative effects of all activities within the catchment are the management focus in this area, and they are considered to be appropriately managed under the RMA. The proposed amendments to the NES-DW aim to clarify that consenting decisions must address source water risks".*

An overview of the DWPZ in comparison to the SWRMA zones for Twizel's source water is shown in Figure 18.

[10] WSP. 2022. Twizel Drinking Water Safety Plan. Christchurch: WSP
[11] Ministry for the Environment. 2022. Kia kaha ake te tiakina o ngā puna wai-inu / Improving the protection of drinking-water sources: Proposed amendments to the Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007: Consultation document. Wellington: Ministry for the Environment.

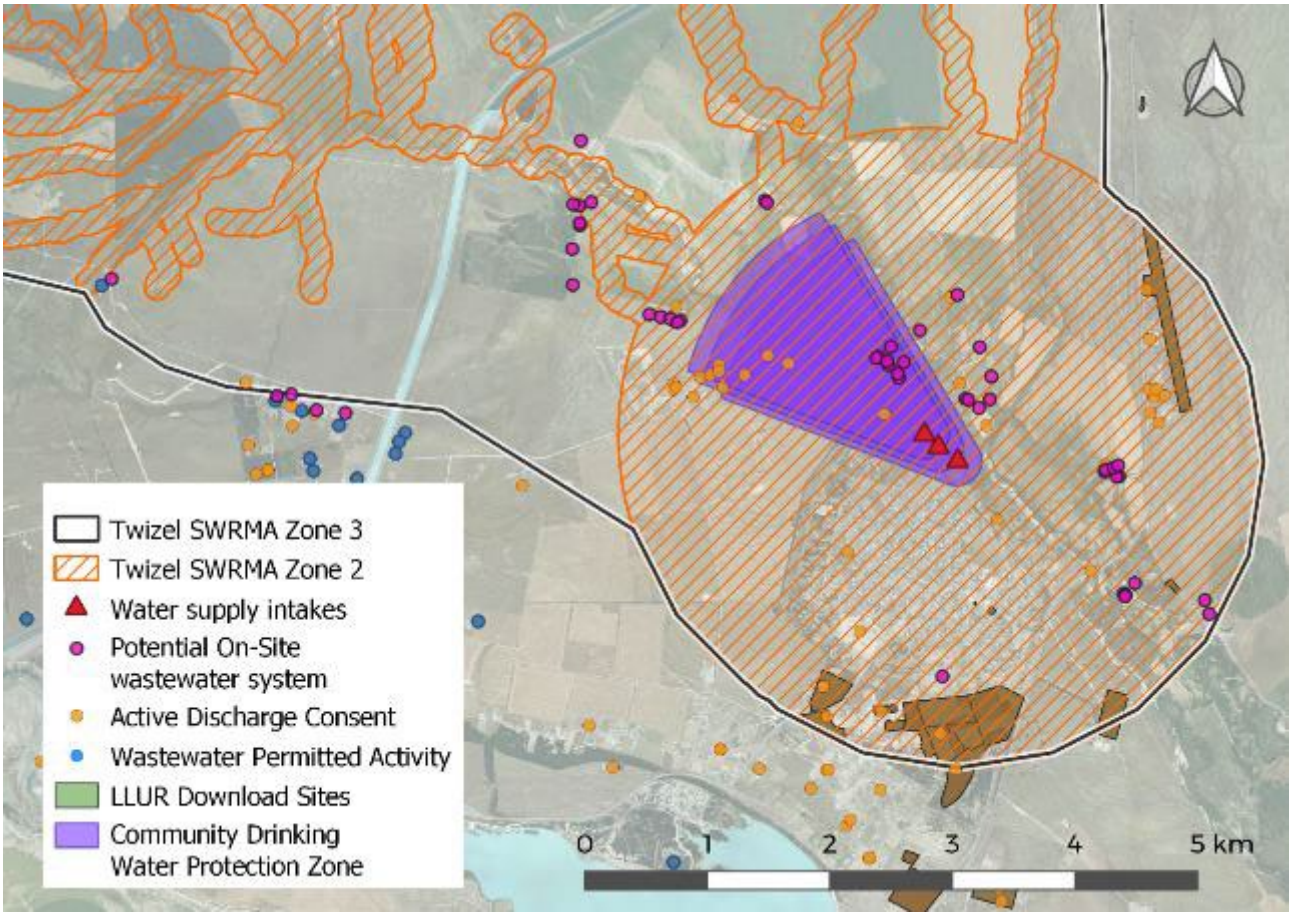


Figure 18 ***Discharge consents, wastewater permitted activity sites and potential on-site wastewater systems around the Twizel water supply bores (WSP, 2022).***

As shown, there are several potential on-site wastewater systems within SWRMA Zone 2, and this area is considerably larger than the DWPZ. By definition the SWRMA Zone 2 bares risk of contamination from above ground land use. Therefore, adoption of the existing DWPZ, in favour of SWRMA Zone 2, as an exclusion zone for disposal of domestic wastewater does not fully remove the risk of contamination to the aquifer and thus drinking water.

Summary

The desktop review has identified the following:

– Groundwater is likely to be shallow, within 1-2 m of ground surface and potentially shallower.
– Springs may be present in low lying areas
– The shallow aquifer is utilised for domestic and public water supply
– The site intersects the community drinking water protection zone for the Twizel supply wells. Some on-site septic systems dispose domestic waste to ground above this zone.
– The entirety of the site is within the SWRMA Zone 2, and by MfE's guidance all discharges introduce risk to the towns source water.

A-3 Flood risk review

This project involves the installation of a new wastewater pipe system in Lyford Lane with connectivity to the existing network in Glen Lyon Road.

There are several waterway crossings of Lyford Lane and Figure 19 shows their general location. Table 18 summarises the 1% AEP peak flows at each location extracted from the NIWA information. Note these peak flows do not take account of storm/rainfall events occurring as a result of future climate change.

Figure 19 Topographic Map showing main waterway locations

Table 18 Lyford Lane – Desktop Flow Review

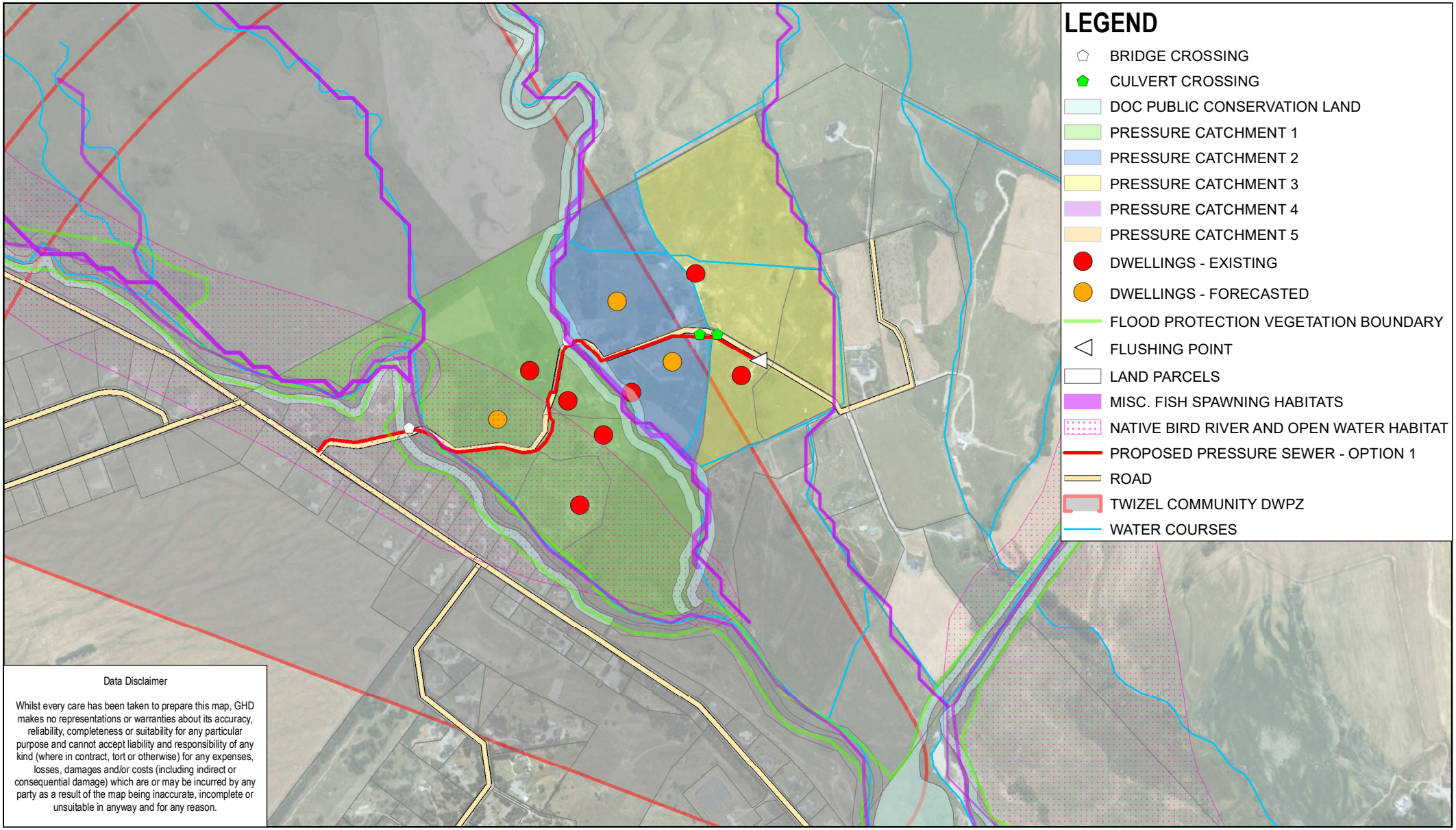
Location	1% AEP Peak Flow (m^3/s)
1 (Fraser Stream)	64
2 (Dry Stream)	6.0
3 (tributary)	2.2
4 (tributary)	2.0

Potential Flood Risk Summary

No detailed topographic information has been sighted to inform an understanding of peak waterway flood levels and velocities. However, the desktop review indicates that based on waterway flows, there is potentially a significant flood risk to proposed project infrastructure where this infrastructure crosses Fraser Stream. There is also potentially a flood risk in the vicinity of the Dry Stream crossing.

Appendix B

Overview drawings



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Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

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MACKENZIE DISTRICT COUNCIL
LYFORD LANE
WASTEWATER FEASIBILITY OPTION ASSESSMENT

Project No. **12589590**
Revision No. **A**
Date **18/01/2023**

OPTION 1 OVERVIEW

FIGURE 1

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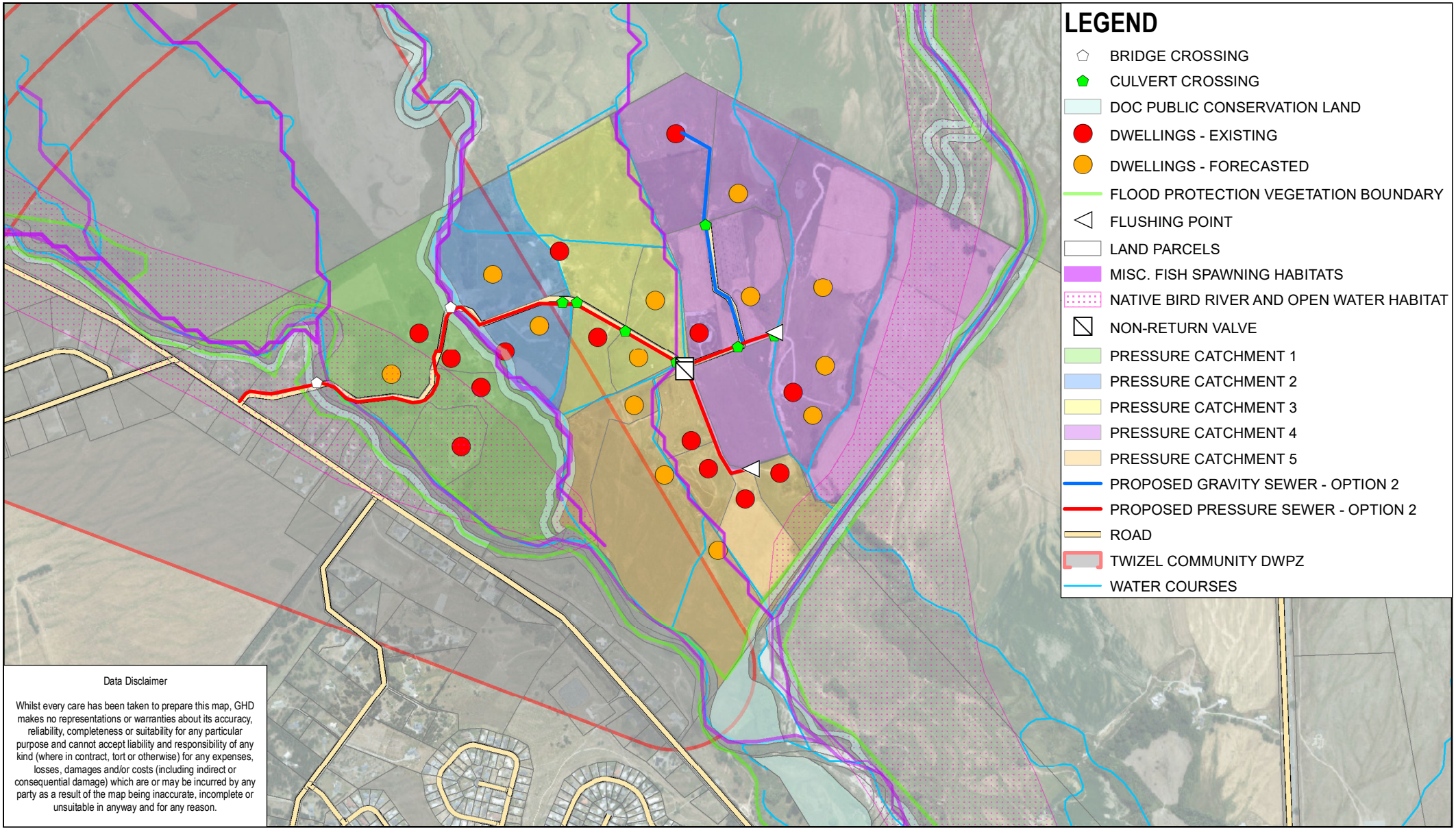

Data Disclaimer

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Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

GHD

MACKENZIE DISTRICT COUNCIL
LYFORD LANE
WASTEWATER FEASIBILITY OPTION ASSESSMENT

Project No. **12589590**
Revision No. **A**
Date **18/01/2023**

OPTION 2 OVERVIEW

FIGURE 1

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Appendix C

Hydraulic analysis summary

Table 19 Hydraulic Analysis for Option 1 (DWPZ Properties Only) – Existing Demand

Zone No.	Conn. To Zone	No. Pumps in Zone	Accumulated Pumps in Zone	Max Velocity (mps) Low	Length Of Main (m)	**Pipe Size (mm)**	Accum Friction Loss (m)	Static Head (m)	**TDH H**	**Accumulated Retention Time Downstream (Hr)**
1	1	4	7	**0.92**	752	**50**	28.18	4	**32.18**	**4.91**
2	1	1	3	**0.64**	334	**50**	32.70	5	**37.70**	**5.09**
3	2	2	2	**0.64**	110	**50**	34.19	6	**40.19**	**2.51**

Table 20 Hydraulic Analysis for Option 1 (DWPZ Properties Only) – Future Demand

Zone No.	Conn. To Zone	No. Pumps in Zone	Accumulated Pumps in Zone	**Max Velocity (mps) Low**	Length Of Main (m)	**Pipe Size (mm)**	Accum Friction Loss (m)	Static Head (m)	**TDH H**	**Accumulated Retention Time Downstream (Hr)**
1	1	5	10	**1.03**	752	**50**	20.31	4	**39.02**	**3.44**
2	1	3	5	**0.85**	334	**50**	45.65	5	**50.65**	**3.05**
3	1	2	2	**0.64**	110	**50**	47.14	6	**53.14**	**2.51**

Table 21 Hydraulic Analysis for Option 2 (All properties on Lyford Lane) – Existing Demand

Zone No.	Conn. To Zone	No. Pumps in Zone	Accumulated Pumps in Zone	**Max Velocity (mps) Low**	Length Of Main (m)	**Pipe Size (mm)**	Accum Friction Loss (m)	Static Head (m)	**TDH H**	**Accumulated Retention Time Downstream (Hr)**
1	1	4	13	**0.69**	752	**63**	12.99	4	**16.99**	**4.30**
2	1	1	9	**0.61**	334	**63**	17.44	5	**22.44**	**2.76**
3	2	2	8	**0.59**	320	**63**	21.41	6	**27.41**	**2.97**
4	3	2	2	**0.64**	268	**50**	25.04	7	**32.04**	**6.12**
5	3	4	4	**0.82**	349	**50**	31.58	10	**41.58**	**3.99**

Table 22 Hydraulic Analysis for Option 2 (All properties on Lyford Lane) – Future Demand

Zone No.	Conn. To Zone	No. Pumps in Zone	Accumulated Pumps in Zone	**Max Velocity (mps) Low**	Length Of Main (m)	Pipe Size (mm)	Accum Friction Loss (m)	Static Head (m)	**TDH H**	**Accumulated Retention Time Downstream (Hr)**
1	1	5	26	**0.93**	752	**63**	24.21	4	**28.21**	**2.15**
2	1	3	21	**0.84**	334	**63**	32.94	5	**37.94**	**1.18**
3	2	4	18	**0.79**	320	**63**	40.19	6	**46.19**	**1.32**
4	3	7	7	**0.92**	268	**50**	50.24	7	**57.24**	**1.75**
5	3	7	7	**0.92**	349	**50**	53.28	10	**63.28**	**2.28**

Appendix D

Cost estimate

Mackenzie DC Wastewater and Remote Water Supply Extensions
Budgetary Cost Estimate
Location: **Lyford Lane Option 1**

Prepared by: **S Moroney**
Checked by: **A Bresler**
Date: **18/01/2023**

		Description		Unit	Quantity	Unit cost	Total Cost	Comments
1		**PRELIMINARY AND GENERAL**						
	1	Documentation, bonds and insurances, Establishment, Distablishment, Traffic Control, As-Built		LS	1.00	$30,200.00	$30,200.00	20% of costs (less E/One Pump Systems)
			Subtotal				**$30,200.00**	
2		**GROUND INVESTIGATIONS**						
	1	Trial pits / potholes		LS	1.00	$1,400.00	$1,400.00	Previous tenders
			Subtotal				**$1,400.00**	
3		**CONSTRUCT MAIN**						
		Note: All pipe sizes are Nominal Internal Diameter unless stated otherwise.						
		Dia. (mm)	**Pipe laying**					
	1	**DN 50 HDPE**	Wastewater pressure main (supply and install)	m	1196.00	$40.00	$47,840.00	Previous tenders/QV cost buidler
		Dewatering		Day	10.00	$700.00	$7,000.00	Previous tenders
3a		**Over and extra items** - to be expended solely on the instruction of the Engineer (Provisional).						
		PVC pipe for bridge crossings	DN100 Galvanized Steel Pipe (supply and install)	m	40.00	$400.00	$16,000.00	Previous tenders/QV cost buidler
		PVC pipe for culvert crossings	DN100 Galvanized Steel Pipe (supply and install)	m	10.00	$400.00	$4,000.00	Previous tenders/QV cost buidler
		Flushing point		Ea.	1.00	$1,240.00	$1,240.00	Previous tenders/QV cost buidler
		Boundary kit		Ea.	10.00	$1,240.00	$12,400.00	Previous tenders/QV cost buidler
		E/One Pump System (supply and install)		Ea.	10.00	$23,000.00	$230,000.00	MDC
			Subtotal				**$318,480.00**	
4		**TESTING**						
	1	Pressure testing and commissioning		LS	1.00	$800.00	$800.00	Previous tenders
			Subtotal				**$800.00**	
5		**ODOUR TREATMENT**						
	1	Armatec GDOF-12 Odour Treatment Dome (supply and install)		LS	1.00	$6,250.00	$6,250.00	Supplier/previous tenders
	2	Concrete slab base (450 mm x 450 mm)		m^3	0.15	$1,000.00	$200.00	Supplier/previous tenders
			Subtotal				**$6,450.00**	
6		**CUT-IN DETAILS**						
	1	Connect pressure sewer to the manhole new Lyford Lane (Asset ID: GLLYSM135)		LS	1.00	$1,500.00	$1,500.00	Previous tenders/QV cost buidler
			Subtotal				**$1,500.00**	
7		**REINSTATEMENT**						
	1	GAP 20 drainage layer		m3	110.00	$90.00	$9,900.00	QV cost buidler
	2	Hard fill layer		m3	65.00	$100.00	$6,500.00	Assuming reinstatement as per MDC unsealed carriage way guidelines for 1m deep trench Assumed 30% of reinstatement is in the carriagway: import all layers
	3	Finished surface		m3	11.00	$110.00	$1,210.00	70% in berm: assumed the drainage layer (6.1) is imported. Other fill layers (6.2, 6.3) are excavated and backfilled from trench.
			Subtotal				**$17,610.00**	
8		**MISCELANEOUS**						
	1	Allowance for additional small works items not included in the preceding items				30%	$34,900.00	30% of costs (less E/One Pump Systems)
			Subtotal				**$34,900.00**	
BASE CONSTRUCTION COST ESTIMATE							**$411,340.00**	
PROFESSIONAL FEES							**$112,000.00**	Allowance for professional services
		Design Fee (excluding Construction Supervision)					$62,000.00	
		Consenting (excluding archeological and cultural engagement)					$50,000.00	
CONTINGENCY						20%	**$ 104,700.00**	20% of costs inclusive of professional fees and incl. E/One Pump Systems
BUDGET COST ESTIMATE							**$628,040.00**	**Excluding GST**

Mackenzie DC Wastewater and Remote Water Supply Extensions
Budgetary Cost Estimate
Location: **Lyford Lane Option 2**

Prepared by: **S Moroney**
Checked by: **A Bresler**
Date: **18/01/2023**

		Description	Unit	Quantity	Unit cost	Total Cost	Comments
1		**PRELIMINARY AND GENERAL**					
	1	Documentation, bonds and insurances, Establishment, Distablishment, Traffic Control, As-Built	LS	1.00	$53,400.00	$53,400.00	15% of costs (less E/One Pump Systems)
			Subtotal			**$53,400.00**	
2		**GROUND INVESTIGATIONS**					
	1	Trial pits / potholes	LS	1.00	$4,700.00	$4,700.00	Previous tenders/QV cost buidler
			Subtotal			**$4,700.00**	
3		**CONSTRUCT MAIN**					
		Note: All pipe sizes are Nominal Internal Diameter unless stated otherwise.					
		Dia. (mm) **Pipe laying**					
	1	**DN 50** Wastewater pressure main (supply and install)	m	617.00	$40.00	$24,680.00	Supplier information. QV Cost Builder
	2	**DN 63** Wastewater pressure main (supply and install)	m	1406.00	$40.00	$56,240.00	Supplier information. QV Cost Builder
	4	**DN 100** Wastewater gravity main (supply and install)	m	519.00	$120.00	$62,280.00	Previous tenders/QV cost buidler
		Dewatering	Day	20.00	$700.00	$14,000.00	Previous tenders
3a		**Over and extra items** - to be expended solely on the instruction of the Engineer (Provisional).					
		PVC pipe for bridge crossings DN100 Galvanized Steel Pipe (supply and install)	m	40.00	$400.00	$16,000.00	Previous tenders/QV cost buidler
		PVC pipe for culvert crossings DN100 Galvanized Steel Pipe (supply and install)	m	35.00	$400.00	$14,000.00	Previous tenders/QV cost buidler
		Flushing point	Ea.	2.00	$1,240.00	$2,480.00	Supplier information. QV Cost Builder
		Boundary kit	Ea.	26.00	$1,240.00	$32,240.00	Supplier information. QV Cost Builder
		E/One Pump System (supply and install)	Ea.	26.00	$23,000.00	$598,000.00	MDC
			Subtotal			**$819,920.00**	
4		**TESTING**					
	1	Pressure testing and commissioning	LS	1.00	$1,700.00	$1,700.00	Previous tenders
			Subtotal			**$1,700.00**	
5		**ODOUR TREATMENT**					
	1	Armatec GDOF-12 Odour Treatment Dome (supply and install)	LS	1.00	$6,250.00	$6,250.00	Supplier/previous tenders
	2	Concrete slab base (450 mm x 450 mm)	m^3	0.15	$1,000.00	$200.00	Supplier/previous tenders
			Subtotal			**$6,450.00**	
6		**CUT-IN DETAILS**					
	1	Connect pressure sewer to the manhole new Lyford Lane (Asset ID: GLLYSM135)	LS	1.00	$1,500.00	$1,500.00	Previous tenders/QV cost buidler
			Subtotal			**$1,500.00**	
7		**REINSTATEMENT**					
	1	GAP20 drainage layer	m3	230.00	$90.00	$20,700.00	QV cost buidler
	2	Hard fill layer	m3	140.00	$100.00	$14,000.00	Assuming reinstatement as per MDC unsealed carriage way guidelines for 1m deep trench Assumed 30% of reinstatement is in the carriagway: import all layers
	3	Finished surface	m3	25.00	$110.00	$2,750.00	70% in berm: assumed the drainage layer (6.1) is imported. Other fill layers (6.2, 6.3) are excavated and backfilled from trench.
			Subtotal			**$37,450.00**	
8		**MISCELANEOUS**					
	1	Allowance for additional small works items not included in the items above			30%	$82,200.00	30% of costs (less E/One Pump Systems)
			Subtotal			**$82,200.00**	
BASE CONSTRUCTION COST ESTIMATE						**$1,007,320.00**	
PROFESSIONAL FEES						**$173,000.00**	Allowance for professional services
		Design Fee (excluding Construction Supervision)				$123,000.00	
		Consenting (excluding archeological and cultural engagement)				$50,000.00	
CONTINGENCY					20%	**$ 236,100.00**	20% of costs inclusive of professional fees and incl. E/One Pump Systems
BUDGET COST ESTIMATE						**$1,416,420.00**	**Excluding GST**

Mackenzie DC Wastewater and Remote Water Supply Extensions
Budgetary Cost Estimate
Location: **Lyford Lane Option 2.1**

Prepared by: **S Moroney**
Checked by: **A Bresler**
Date: **18/01/2023**

		Description	Unit	Quantity	Unit cost	Total Cost	Comments
1		**PRELIMINARY AND GENERAL**					
	1	Documentation, bonds and insurances, Establishment, Distablishment, Traffic Control, As-Built	LS	1.00	$50,200.00	$50,200.00	15% of costs (less E/One Pump Systems)
			Subtotal			**$50,200.00**	
2		**GROUND INVESTIGATIONS**					
	1	Trial pits / potholes	LS	1.00	$4,400.00	$4,400.00	Previous tenders/QV cost buidler
			Subtotal			**$4,400.00**	
3		**CONSTRUCT MAIN**					
		Note: All pipe sizes are Nominal Internal Diameter unless stated otherwise.					
		Dia. (mm) **Pipe laying**					
	1	**DN 50** Wastewater pressure main (supply and install)	m	617.00	$40.00	$24,680.00	Supplier information. QV Cost Builder
	2	**DN 63** Wastewater pressure main (supply and install)	m	1406.00	$40.00	$56,240.00	Supplier information. QV Cost Builder
	4	**DN 100** Wastewater gravity main (supply and install)	m	519.00	$120.00	$62,280.00	Previous tenders/QV cost buidler
		Dewatering	Day	20.00	$700.00	$14,000.00	Previous tenders
3a		**Over and extra items** - to be expended solely on the instruction of the Engineer (Provisional).					
		PVC pipe for bridge crossings DN100 Galvanized Steel Pipe (supply and install)	m	40.00	$400.00	$16,000.00	Previous tenders/QV cost buidler
		PVC pipe for culvert crossings DN100 Galvanized Steel Pipe (supply and install)	m	35.00	$400.00	$14,000.00	Previous tenders/QV cost buidler
		Flushing point	Ea.	2.00	$1,240.00	$2,480.00	Supplier information. QV Cost Builder
		Boundary kit	Ea.	13.00	$1,240.00	$16,120.00	Supplier information. QV Cost Builder
		E/One Pump System (supply and install)	Ea.	13.00	$23,000.00	$299,000.00	MDC
			Subtotal			**$504,800.00**	
4		**TESTING**					
	1	Pressure testing and commissioning	LS	1.00	$1,700.00	$1,700.00	Previous tenders
			Subtotal			**$1,700.00**	
5		**ODOUR TREATMENT**					
	1	Armatec GDOF-12 Odour Treatment Dome (supply and install)	LS	1.00	$6,250.00	$6,250.00	Supplier/previous tenders
	2	Concrete slab base (450 mm x 450 mm)	m^3	0.15	$1,000.00	$200.00	Supplier/previous tenders
			Subtotal			**$6,450.00**	
6		**CUT-IN DETAILS**					
	1	Connect pressure sewer to the manhole new Lyford Lane (Asset ID: GLLYSM135)	LS	1.00	$1,500.00	$1,500.00	Previous tenders/QV cost buidler
			Subtotal			**$1,500.00**	
7		**REINSTATEMENT**					
	1	GAP20 drainage layer	m3	230.00	$90.00	$20,700.00	QV cost buidler
	2	Hard fill layer	m3	140.00	$100.00	$14,000.00	Assuming reinstatement as per MDC unsealed carriage way guidelines for 1m deep trench Assumed 30% of reinstatement is in the carriagway: import all layers
	3	Finished surface	m3	25.00	$110.00	$2,750.00	70% in berm: assumed the drainage layer (6.1) is imported. Other fill layers (6.2, 6.3) are excavated and backfilled from trench.
			Subtotal			**$37,450.00**	
8		**MISCELANEOUS**					
	1	Allowance for additional small works items not included in the items above			30%	$77,200.00	30% of costs (less E/One Pump Systems)
			Subtotal			**$77,200.00**	
BASE CONSTRUCTION COST ESTIMATE						**$683,700.00**	
PROFESSIONAL FEES						**$173,000.00**	Allowance for professional services
		Design Fee (excluding Construction Supervision)				$123,000.00	
		Consenting (excluding archeological and cultural engagement)				$50,000.00	
CONTINGENCY					20%	**$ 171,400.00**	20% of costs inclusive of professional fees and incl. E/One Pump Systems
BUDGET COST ESTIMATE						**$1,028,100.00**	**Excluding GST**

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