BEFORE THE COMMISSIONERS APPOINTED BY THE CENTRAL OTAGO DISTRICT COUNCIL

UNDER	the Resource Management Act 1991
IN THE MATTER	of RC230179 an application for a 33-lot subdivision at Rocky Point on Tarras-Cromwell Road (SH8)
BY	**TKO PROPERTIES LIMITED**
	Applicant

STATEMENT OF EVIDENCE OF JOHN STERNBERG

Dated: 25/10/2024

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Statement of evidence of John Sternberg

Introduction

[1] My name is John Derrick Sternberg. [water and wastewater engineering, BSc Civil, MSc Waters, CPEng, 40 years in the waters industry].

[2] I have been instructed by TKO Properties Limited to give expert water and wastewater evidence in respect of RC230179, an application for a 30-lot subdivision located at Rocky Point on Tarras-Cromwell Road (SH8).

Code of Conduct for Expert Witnesses

[3] While this is not an Environment Court hearing I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2023. This evidence is within my area of expertise, except where I state that I am relying on material produced by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of evidence

[4] My evidence will address:

(a) my original water and wastewater assessment, including any updates or changes to that assessment, as appended to this evidence;

(b) my response to the water and wastewater matters raised in submissions [to the extent these have not been addressed in (a)] and;

(c) my response to the water and wastewater matters raised in the Central Otago District Council planner's section 42A report.

Water and Wastewater Assessment – Executive Summary

[5] I have assessed various options for the provision of adequate water and wastewater services for this development, as discussed within CKL's "Water and Wastewater Assessment" (refer Appendix 1). The **executive summary** of this report is included below:

TKO Properties Ltd are proposing to subdivide Lot 1 Deposited Plan 561457, Lakefront Terrace, Bendigo. The proposed subdivision is colloquially known

as the Rocky Point Development. The development includes 30 lots, with a mix of residential, large residential and communal use. CKL has been commissioned to conduct a conceptual level assessment for the treatment and disposal of wastewater, as well as the provision of water supply options for the proposed development, to support a resource consent application.

The findings of the investigation are summarised below. The enclosed assessment considered factors such as site characteristics, site geology, cost, regulatory requirements, resilience, sustainability, and environmental effects. This revision is based on extensive discussions with the client and includes further considerations for water supply options, storage, wildfire, irrigation and wastewater flows.

A service agency agreement will be created to ensure the ongoing maintenance of all water supply and wastewater devices and infrastructure, in accordance with the operation and monitoring recommendations within Section 4.7 and 5.4.

Drawings depicting the scheme and discussed options can be found in Appendix 1.

Water Supply

Multiple options have been considered for the supply and treatment of water. Each option focused on providing a safe water supply and level of service to meet obligations as a water service provider, as per requirements of Taumata Arowai (water services regulator for Aotearoa). It is intended that water shall be supplied to the proposed development from the Chinamans Terrace water scheme (existing bore to the north of the subject lot, with a permit to extract 2,735 m^3/day from the aquifer). Water quality is generally good, with no pretreatment requirements envisaged at this stage. The Langelier saturation index was slightly high, but acceptable. This will be confirmed at detail design stage.

Wildfire Management NZ have been engaged to devise a strategy for combating wildfire. Two types of sprinklers have been recommended to mitigate this risk: vegetation sprinklers (to reduce and slow fire spread in key risk areas, particularly focussed on up-slopes and gullies) and ember sprinklers (to mitigate against the risk of ember attack (drifting embers)). The development infrastructure will provide for vegetation sprinkler supply 185,000 L. It will also provide for ember sprinkler water supply up to 150,000L (2 sprinklers per lot 1 – 26). Ember sprinklers can be pulsed on and off (1 min on, 1 min off) to reduce water storage requirements, and/or water storage volume can be increased over time if the need is increased.

Treatment will be required to provide safe, treated water in accordance with the NZ Drinking Water Standards requirements in light of responsibilities laid out in the Drinking Water Quality Assurance Rules. It is proposed to adopt Taumata Arowai's Acceptable Solution for Mixed-Use Rural Water Supplies

(Appendix 3). A similar, alternative option would be the Bore and Spring supply Acceptable Solution.

After a concept level assessment of various options, a preferred option (Option A) was chosen:

- Water supplied to all lots from the Chinamans Terrace Scheme to the southeast of the development.
- Expansion of the existing bank of raw water at Chinamans terrace, located at a suitable location to provide sufficient head for sprinklers, without the need for boosting. The proposed systems can be expanded to account for additional demands such as irrigation. It is recommended to split the storage, with two supplies:
    - Storage system 1: storing 48 hours of domestic use and 30 minutes of hydrant demand with appropriate pretreatment and protection from stagnation/ contamination (e.g. a steel tank with an effective capacity of 90,000L (Pioneer GT110, or similar) or 3 – 4 large plastic tanks). This can be increased to include buffer storage.
    - Storage system 2: storing vegetation sprinkler and ember suppression sprinkler demand. This equates to approximately 340,000L. This can be stored in tanks or in a lined pond (more economical). In the event of the latter being adopted, it is recommended to install a floating plastic cover if a pond is implemented and/or appropriate auto-flushing filtration units (e.g. Arkal, Amiad, Filtersafe) to prevent sprinklers from blocking during a fire.
- Trunk mains and reticulation networks from each storage system installed to reticulate water to the Rocky Point development via gravity.
    - Reticulation System 1: will convey domestic use and fire hydrant demand.
    - Reticulation System 2: will convey vegetation sprinkler and ember suppression sprinkler demand.
    - Pressure reducing valves installed at lot connections, as necessary to regulate the pressure and flow of water for domestic consumption and/or sprinkler water.
    - It is proposed that both mains be laid within common trench, where possible.
    - Large differential pressure between the top and bottom terrace requires a break-pressure tank to be situated at an appropriate location (access, aesthetics) and will serve to balance pressure and provide buffer storage for domestic and fire hydrants on the bottom terrace i.e. the bottom terrace will operate as a separate water supply and pressure zone.
- Installation (at time of building) and maintenance of independent treatment and disinfection units at each lot (30 of), sized accordingly (assumes that water quality will be of an acceptable standard to enable appropriate treatment at each lot (e.g. filtration and UV)).

- A bulk water meter at the outlet of domestic water storage system is proposed to measure water supplied. In addition, individual water meters at each lot are proposed to measure water consumed to allow for water consumption trends/monitoring as well as water loss management.
- Fire hydrants to be provided in accordance with SNZ PAS 4509:2008 and a FW-2 rating, to combat structure fires within the development.
- Wildfire sprinklers to be provided as outlined in Sections 4.2.4 and 4.3.

Other options which were considered included combining the domestic and wildfire storage and reticulation systems, installation of a new groundwater bore or a bifurcation of the existing bore's rising main to serve lots 27 – 30, bulk storage within development (same elevation) with booster pumps, or the installation of a centralised water treatment plant. Ultimately, these are all viable solutions for water supply. However, as discussed in the detailed option assessment in Section 4.5, Option A provided:

- The least risk of contamination using point of entry treatment systems. This is due to the potential for stagnation within the reticulation network when not fully utilised (occupancy/use dependant).
- The most economic option, due to the utilisation of gravity for reticulation.
- Smaller infrastructure footprint due to less pumps: reducing excavation area and reducing effect on ecology and high value landscape, reduced risk.
- Single point of supply for domestic use, simplifying water consumption monitoring and water loss management and enabling equitable payment for what is used, if required.
- Treatment at point of entry. The current water quality testing results show that minimal treatment will be required to get water to an acceptable solution, which suits point-of-entry treatment systems.

It is recommended to:

- Adopt Option A as the basis for detailed design and further community engagement, as per Section 4.4.1.
- Complete a definitive assessment of costs (Capex and Opex) and optimise storage size/location.
- Investigate the use of water conservation strategies by rainwater harvesting and storage for localised irrigation and emergency use (e.g. 2,000L 'slimline' tanks).
- A suitably qualified fire engineer should be engaged to confirm the firefighting strategy for the development as per Section 4.4. FENZ shall also be consulted for approval.
- Develop an operation and maintenance agreement as per Section 4.6.

Wastewater

In accordance with NZS4404:2010, the theoretical annual average dry weather flow for the development was estimated to be approximately 18,000 L/day (lots 1 – 30). The expected peak wet weather flow was estimated to be approximately 1.1 L/s.

Multiple options have been considered for the treatment and disposal of wastewater. The analysis focused on identifying cost-effective and sustainable solutions to ensure compliance with relevant standards and regulations whilst minimising detrimental environmental effects. The options assessment within this report identified that this can be achieved through the implementation of Option A:

- Lots 1 – 3 and 19 – 30 are recommended for implementation of on-site treatment and disposal. Secondary level treatment is highly recommended for these lots due to the high ecological value of the area. The onsite systems are expected to consist of an Aerated Wastewater Treatment System (AWTS) with bed disposal, however this shall be determined at building consent stage pending site-specific analysis on each lot.
- The remaining lots (4 – 18) are considered unsuitable for on-site treatment and disposal. It is recommended to install a low-pressure sewer reticulation system, with on-site grinder pumps (e.g. Aquatec Enduraplex or similar) and small bore (50mm) rising mains to convey effluent off-lot to the area west of lot 20 for treatment and disposal. Treatment can be achieved via a commercial (communal) WWTP and land disposal (e.g. Eloy Oxyfix, Innoflow or similar) or a large septic tank and aeration chamber, capable of treating approximately 11,000 L/day (average flow from lots 4 – 18). This equates to approximately 1,100m² primary disposal area + 550m² reserve area. It is recommended that the WWTP has flow and quality monitoring. The system must be capable of treating wastewater to an acceptable secondary level prior to land disposal, in accordance with ASNZ 1547:2012. A discharge (prior to land disposal) quality of 20mg/l (BOD5) and 30mg/l (SS) is expected – the processes can generally be refined to suit requirements.

Other options that were investigated included, using a communal pump station instead of a low-pressure grinder sewer system, splitting the communal treatment system into two to three treatment and disposal areas, reticulating all effluent from lots 1 – 30 to a centralised WWTP and polishing within a subsurface engineered wetland near lot 28 with a discharge to the Clutha River, or reticulating all effluent from lots 1 – 30 to a centralised WWTP and disposing to land. Ultimately, these are all viable solutions. However, as discussed in the detailed option assessment in Section 5.2, Option A provided:

- The most efficient laying of reticulation, as small-bore rising mains can be installed at approximately 600mm (cover) below ground and offers more flexibility to reticulation layout. The pipes are sealed and

hence minimise inflow and infiltration, reducing the volume to be treated and disposed.

- Reduced visual impact of treatment and disposal system by pumping all reticulated effluent to the area west of lot 20 for disposal.
- Least risk (not discharging to river)
- Where possible, disposal fields can be placed to avoid existing vegetation and habitat.
- Smallest possible area needed for centralised disposal (for lots that cannot be serviced on-lot), reducing effect on high value ecology.
- Most economical option due to limited reticulation and on-site treatment systems being installed at building consent stage.

It is recommended to:

- Use Option A as the basis for detailed design and further community engagement.
- Complete a definitive assessment of costs (Capex and Opex) at detail design stage to optimise conveyance, treatment and disposal.
- Develop an operation and maintenance agreement as per Section 4.6, clearly outlining monitoring, sampling and reporting obligations and requirements for the Rocky Point services company.

Responses to Submissions

[6] The relevant submissions relating to Water and Wastewater have been addressed as follows;

[7] Iwi Auhaka (Kāti Huirapa Rūnaka ki Puketeraki, Te Rūnanga o Ōtākou and Te Rūnanga o Moeraki (Kā Rūnaka)) oppose the application. Their concerns pertaining to water and wastewater are:

(a) ***The Wastewater Suitability Report by Mt Iron Geodrill only provides indicative concepts of what a wastewater disposal system could look like based on the soil conditions across the site. The report cautions at other factors that could affect these recommendations given that the exact locations for buildings and types of development are still unknown*****.**

The appended “Water and Wastewater Assessment” report provides a detailed analysis of concept system designs (Refer to Section 5.2 for more information). These concepts have been analysed based on the building locations and development land use given within the original Resource Consent Application.

(b) ***The preference of Kā Rūnaka is for a fully reticulated wastewater treatment system rather than individual wastewater disposal systems.***

This option has been assessed together with alternative options. Refer to Option D or E within CKLs "Water and Wastewater Assessment".

The space required to implement this option is significant and a potential disposal field was not identified within the bounds of the proposed development. Various alternatives were assessed, including pumping to the Clutha River but this comes with high environmental risk. An alternative, hybrid comprising of on-site treatment and communal treatment and disposal is recommended and offers environmental, cultural and economic benefits.

(c) ***The source of the water supply is not clear in the application. Mismanagement and appropriation of water sources in Otago has resulted in most catchments being over-allocated, a situation which is deeply concerning for Kā Rūnaka. Further information is required on the adequacy of the water supply to cater for the scale of the development and the certainty that it will continue to be available in future, given the new limits on water takes currently being developed under a new Land and Water Regional Plan for Otago.***

Refer to Section 4.1 of CKL's "Water and Wastewater Assessment":

A water supply bore has been drilled approximately 370 metres northeast of the intersection of Loop Road and State Highway 8, Tarras. The bore takes water from an unconfined aquifer adjacent to the Clutha River to serve Rocky Point, Chinamans Terrace and future development in the Bendigo Hills. Recharge is primarily from Lake Dunstan.

A permit has been given to extract 2,735 m^3/day from the aquifer at a maximum rate of 32 L/s. This extraction is referred to as the Chinamans Terrace water scheme. It is intended that water shall be supplied to the proposed development from the Chinamans Terrace water scheme.

The proposed development will draw from that scheme and necessary treatment, storage and boosting will be required to satisfy water quality, potable and fire demand requirements. Options for supply using new groundwater bores have also been explored. 500,000 L/day of the bore water supply has been allocated to Chinamans Terrace, the proposed Rocky Point development, and future developments in the Bendigo Hills.

It is assumed that sufficient supply can be drawn from the 500,000 L/day allowance to meet the demands of the Rocky Point development. As per Section 4.4.1 of the "Water and Wastewater Assessment" the average daily potable water demand is estimated to be 22,500 L/day (aside from once off filling of the wildfire storage tank/pond). This leaves approximately 477,500 L/day to serve Chinamans Terrace, and future development in the Bendigo Hills area.

Furthermore, a bulk water meter at the outlet of domestic water storage system is proposed to measure water supplied. In addition, individual water meters at each lot are proposed to measure water consumed to allow for water consumption trends and monitoring as well as water loss management.

Therefore, estimated water demand is as follows:

- Average daily demand per lot = 3 p * 250 L/day/p = 750 L/day
- Average daily demand = 30 lots * 750 L/day ≈ 22,500 L/day
- Peak demand = 22,500 L/day * 5 ≈ 1.3 L/s

[8] Central Otago Environmental Society (COES) oppose the application. Their concerns pertaining to water and wastewater are:

(a) ***COES opposes the application due to the adverse effects of buildings, curtilage, roading (water tabling) power supply, water supply, storm water and waste water tanks and disposal fields and recreational tracking on the Outstanding Natural Landscape (ONL) values identified by the district plan.***

COES go on to explain that the landscape within the proposed development has important biodiversity, natural, physical, cultural and recreational values. The landscape also has rare and endangered species of flora and fauna.

The ecological effect of the options presented within CKL's "Water and Wastewater Assessment" report have been considered at a high level. This is particularly true for the concept design of the wastewater system.

CKL have not been engaged to assess the ecological effects of the entire development. However, factors that can limit the effect of the wastewater and water infrastructure include, for example:

- Limiting excavation areas by minimising flow contributions, reducing the size of effluent disposal fields as much as possible (if applicable) and minimising environmental effects. Methods to do this could include:
    - Installing water reduction fixtures in households to reduce wastewater production.
    - Grey water harvesting to reduce wastewater loads.
    - Installing sand filter beds which require a smaller disposal footprint than conventional trench disposal.
    - Treat effluent to a high standard (secondary level as per ASNZ1547:2012), which would increase the allowable application rate of ground disposal fields, thereby reducing the disposal footprint.

- Limiting excavation areas by reducing the size of reticulation systems as much as possible. This could include:
    - Implementing on-site treatment and disposal where possible.
    - Implementing small-bore, low-pressure reticulation (reducing depth of excavation).
    - Potentially laying pipes in common trenches, where feasible

- Preventing the discharge of untreated wastewater.
    - This includes installing a well-constructed, well-maintained system that treats wastewater to a high level.
    - Ensuring the treatment plant has adequate capacity (modular so can be increased easily to suit if required)
    - All considered options presented provide this.

- Minimising water storage footprints by reticulating fire water for hydrants utilising available water pressure.

(b) ***This proposal is insensitive to the highly significant ecological values and outstanding landscape with high potential for unintended consequences like fire (noting Mt Iron, there is increasing pressure from landowners and FENZ for kanuka to be removed from around houses to reduce fire risk. Should more subdivisions be allowed in areas of known high fire risk associated with high biodiversity values?)***

Section 4.3 of the CKL "Water and Wastewater Assessment" report addresses the provision of fire-fighting water supply. This includes a recommendation for a qualified fire engineer to quantify the risk of wildfire and provide mitigation techniques. FENZ should also be engaged to review any proposed mitigation measures. Over and above allowance for structure fire-fighting from fire hydrants (in line with PAS4509 FW-2), further allowances have been made for fighting wildfire. Provision has been made for storage, reticulation, sprinklers (ember suppression and vegetation sprinklers with an automatic flame recognition sensor and control valves), as outlined in CKL Water and Wastewater Assessment report.

[9] The Department of Conservation (DOC) oppose the application:

(a) ***The proposed activity would have adverse effects and potentially significant adverse effects on the environment with the proposed clearance of four hectares of indigenous vegetation in an***

ecosystem dominated by at-risk plant species, and with the presence of at least two threatened plant species.

The application has not made mention of the conservation covenant.

The site contains significant indigenous biodiversity values and is a significant natural area using the assessment criteria in Appendix 1 of the National Policy Statement for Indigenous Biodiversity 2023 (NPSIB).

The application and assessment of effects has not fully identified the Threatened or At-Risk species present and affected by the proposed activity. Therefore, the assessment of effects in inadequate.

Please refer to Section [8](a) above.

[10] Fire and Emergency New Zealand (FENZ) are neutral to the application. The concerns pertaining to water and wastewater are:

(a) ***Fire and Emergency request that with respect to firefighting water supply, the consent notice condition should reference the firefighting water supply Code of Practice – SNZ 4509:2008.***

CKL's "Water and Wastewater Assessment" report references SNZ 4509:2008.

(b) ***Fire and Emergency request that the gradient of the Bendigo Road Loop and the rights of ways is not steeper than 1:5 (20%).***

The current roading design has a maximum slope angle of 15%. The slope of the right of ways will be determined at detailed design.

(c) ***Fire and Emergency request that where buildings are to be located greater than 70m from the road or right of way, the private driveways have a minimum carriageway width of 4m with a width of 3.5m at the entrances.***

This is acknowledged and can be confirmed at detailed design stage.

[11] Central Otago-Lakes Branch Forest and Bird oppose the application. Their concerns pertaining to water and wastewater are:

(a) ***Considers that there will be more than minor effects on rural landscape character and on the values of the ONL. Development into the Landscape Protection Area is considered to undermine the purpose of that area and undermines the purpose of the conservation covenant.***

The effects on the landscape can be reduced using the strategies discussed in Section [8](a) above. The effect of the proposed water and wastewater infrastructure must be considered in a detailed ecological assessment.

(b) ***Notes the potential for increased fire risk from the development.***

Refer to Section [8](b) above.

[12] Land Information New Zealand are neutral to the application, citing that the effect on the lakebed will be less than minor.

[13] Waka Kotahi oppose the application. Their concerns pertaining to water and wastewater are:

(a) ***Requests a full integrated transport assessment if Council is to consider granting consent. Submitter indicates that an upgrade of the SH8/Bendigo Loop Road intersection would be required, along with a separate right hand turn bay***. ***It is also noted that stormwater and wastewater must be managed entirely on site so that there is no runoff onto the state highway or into the state highway stormwater network.***

The detailed design of the intersection upgrade must include devices to manage and treat stormwater runoff from the increased pervious area due to the upgrade (covered in separate evidence/reporting by CKL). Wastewater treatment and disposal for bottom lots will be contained on the lots and no overflow is expected to the state highway.

[14] There were 6 other submissions which opposed the application due to adverse effects on the outstanding natural landscape, ecology and natural character: H. Pledger, K. Wardle, L. Lucas, P. Blakely, R. Moorehouse, and S. Kenderdine.

Please refer to Section [8](a) above. The effect of the proposed water and wastewater infrastructure must be considered in a detailed ecological assessment.

Section 42 Responses – 28 March 2024

[15] In response to relevant sections of the S-42A report, we comment as follows;

[16] S-42A report, Section 6.51:

(a) ***It is not clear how the supply is intended to be apportioned between the lots. However, I consider that 500,000 litres would be more than enough to provide a domestic supply to the proposed subdivision, on the basis of each lot requiring 1,000 to 1,500 litres per day.***

Refer to Section [7](c) above. The average daily demand has been calculated as follows:

- Average daily demand per lot = 3 p * 250 L/day/p = 750 L/day
- Average daily demand = 30 lots * 750 L/day ≈ 22,500 L/day
- Peak demand = 22,500 L/day * 5 = 112,500 L/day
- Peak demand ≈ 1.3 L/s

The bulk storage system recommended within the CKL report provides for 48 hours based on this average daily demand as well as 45m³ reserve for firefighting. This storage is also dynamic due to the bore supply from Chinamans Terrace. The break-pressure tank between the top and bottom terrace will also provide some buffer capacity for the bottom terrace.

I consider this to be an adequate capacity for potable supply. However, the bulk storage system can be increased following discussions with

council's development engineers. Further allowance can also be provided to allow for irrigation or other activities.

(b) ***The Chinamans Terrace Water Supply Scheme does not guarantee the quality of the water supply. The water would require treatment, either at point of use on each lot, or at point of supply by the entity set up to manage the water.***

Options for the treatment and supply of water to the development is discussed in Section 4.5 of CKL's "Water and Wastewater Assessment" report. It was recommended that water quality testing of all potential water supplies is carried out to determine the required treatment processes. Results have since become available and are appended to the CKL report entitled "Water and Wastewater Assessment" report (Appendix 2). In summary, results indicate that water quality is good with acceptable and adequate contaminant levels for point of entry treatment (UV, filter). The water has a slightly elevated Langelier Index i.e. is slightly aggressive to metals and may require pretreatment at the proposed bulk storage facility. This will be confirmed at detail design.

[17] S-42A report, Section 6.52:

(a) ***Aukaha's submission indicates that the initial source of the water (Where Chinamans Terrace source the water for the scheme) is not clear in the application and raises concerns about the potential for overallocation of the catchment and ongoing certainty of the supply in the context of potential new limits on water takes as part of the development of the Otago Regional Council's proposed Land and Water Regional Plan***.

Refer to Section [7](c) above.

[18] S-42A report, Section 6.53:

(a) ***I note that the entity set up to supply water would be considered a drinking water supplier under the Water Services Act 2021. Sections 21 and 22 of that Act requires drinking water suppliers provide a safe supply of drinking water and ensure that the water supplied complies with drinking water standards. Given the***

supply cannot be guaranteed by Chinamans Terrace to be of a certain quality, this would require treatment of the water at the point of supply. I consider the volume of supply the applicant is currently entitled to is sufficient to provide domestic water to the proposed new lots. I consider it appropriate that, if consent is granted, that conditions be imposed requiring the water supply entity be required to treat the water to a standard compliant with the Water Services (Drinking Water Standards for New Zealand) Regulations 2022, instead of requiring point of use treatment, in order to maintain consistency with the obligations of a water supplier under the Water Services Act.

The development lends well to compliance with Drinking Water Acceptable Solution for Taumata Arowai Mixed-use Rural Water Supplies. In terms of this requirement, end point or point of entry (POE) treatment is acceptable provided the raw water quality allows (e.g. Si content). Following water (from Chinaman's Terrace Scheme) quality tests, the water quality lends well to this application and POE has been adopted (this provides other benefits as well, also covered in the CKL report).

(b) ***I also recommend that conditions be imposed requiring copies of the ownership, management and operational documentation of the new water supply entity be provided to Council, along with as-built plans of the network and evidence of a legal entitlement of at least 1,000 litres of water is available to each lot per day, per the recommendations of Council's land development engineers.***

These are acceptable and reasonable conditions. Regarding the 1,000L/lot allowance, please refer to Section [16](a).

[19] S-42A report, Section 6.56:

(a) ***Council's land development engineers recommend on-site storage. However, assuming firefighting water supply can be achieved through hydrants in the water reticulation consistent with SNZ PAS 4509:2008, on-site storage would not be required. In order to comply with SNZ PAS 4509:2008, the system would***

need to provide sufficient water storage and flows to provide an effective firefighting supply. Details on exact levels of storage proposed is missing from the application.

Details of fire-fighting storage is provided within the "Water and Wastewater Assessment" report (refer to Section 4.3 – 4.5). The general philosophy for firefighting is as follows:

- Adequate bulk storage for FW2 classification (45m³), in accordance with SNZ PAS 4509 will be reserved in bulk storage tanks for hydrant fire-fighting purposes.

- Fire hydrants will be located where acceptable access for a fire truck can be provided. Spacing of hydrants will be in accordance with NZS 4404 and SNZ PAS 4509 to provide FW-2 coverage. This rating requires an available water supply of 25 L/s from 2 hydrants, within 135 and 270 m distance respectively, with sufficient volume for 30 minutes of firefighting (45m³). This water will be stored in a bulk storage system, as per Section 4.5.

- Due to elevation difference between the top and bottom terrace, a break pressure tank will be required to reduce pressure at the bottom terrace. This tank will also be utilised for buffer storage for both domestic and fire water. This will be assessed at detailed design stage but may comprise a separate storage bank (e.g. 3 x 30,000L tanks) automatically topped up from the top terrace water main.

Further details about the provision of water for wildfire protection can be found in Section 4.3.2.

[20] S-42A report, Section 6.57:

(a) ***FENZ's submission assumes that all lots would have on-site storage and seeks to clarify that this storage needs to comply with SNZ PAS 4509:2008. FENZ's interests are predominantly ensuring access to a sufficient volume and rate of water for controlling and extinguishing fires. Given this, I see no reason why a reticulated system that also complied with the relevant parts of 4509 should***

not also be acceptable to FENZ. I invite them to clarify their position if this is not the case.

I agree that a reticulated system with hydrants can successfully satisfy required water volumes and flow rates as per SNZ PAS 4509:2008. However, I also invite FENZ to provide comment on this matter, after reviewing the contents within CKL's "Water and Wastewater Assessment" report.

[21] S-42A report, Section 6.58:

(a) ***I note that a large volume of water would need to be stored to provide sufficient storage volume to comply with SNZ-PAS 4509:2008. Water for the development is proposed to be stored on Lot 2 DP 561457, but storage volumes are not specified in the application. The required volume should be determined by the applicant, in consultation with FENZ, prior to the hearing. However, I consider that, in principle, the proposed Lots 1-13 and 15-29 can have adequate provision for firefighting water through the reticulated water network***.

I agree that adequate fire-fighting volumes can be provided for the proposed development, in accordance with SNZ PAS 4509:2008, as outlined in CKL's "Water and Wastewater Assessment" report (refer to Section 4.5). Bulk storage will allow for a minimum of 45m³ firewater volume at the top terrace as well as a further 45m³ at the break-pressure tank between the top and bottom terrace – the former will provide fire-hydrant supply to the top terrace and the latter to the bottom terrace hydrants in the event of a fire. Both storage facilities will also include 48 hours of domestic water supply respectively. To provide further security of supply, a low water level alarm can be set above the 45m³ threshold to notify management if the firewater reserve/storage level is in danger of being encroached. This will ensure that a minimum of 45m³ in each storage facility is reserved for fire at all times.

[22] S-42A report, Section 6.59:

(a) ***I note that on-site water storage will be required for each lot to provide a water reserve in the event of a supply disruption and to smooth out fluctuations in water usage. The exact size would depend on the requirements of the scheme operator. Council requires at least 20,000L of static water storage in a 30,000L tank where firefighting is required. This leaves 10,000L of storage for day-to-day use. I consider this to be a useful benchmark for what level of water storage would be required on each lot and, unless the applicant provides confirmation from Chinamans Terrace of what is an acceptable level of on-site storage for users of their scheme. Required on-site water storage volumes should be imposed as a consent notice on the proposed residential lots if consent is granted***.

As noted above, provision will be made for bulk storage to provide domestic and fire-hydrant water supply to the top and bottom terrace dwellings. This negates the need for provision of separate on- site storage at each dwelling.

[23] S-42A report, Section 6.60:

(a) ***The applicant advises that Lots 14 and 30-33 would not be covered by the proposed hydrants. These lots would require on-site water storage. The exact volume of water would vary depending on the use of the lots. If Council grants consent, this should be registered as a consent notice on the new titles. Lots 14 and 30 (And any other lots found to not be covered during detailed design works of the water network) would require at least a 30,000 litre storage tank. Lots 31-33 would need to have sufficient volume to comply with SNZ PAS 4509-2008 depending on the final use of the lots. This could be determined as part of any future resource consent for the use of these lots, with the consent notice reinforcing the need to demonstrate compliance with the standard O&M manual be lodged with Council.***

The lots have been reviewed since as per the updated scheme plan. All lots can now be catered for from the proposed bulk storage fire hydrant/domestic water tanks.

[24] S-42A report, Section 6.62:

(a) ***I have assessed the application on the assumption that the treatment plant*** [wastewater] ***will remain in the same location as this is what is currently proposed*** [to the south-west of current Lot 20]***. Council's land development engineers consider that a privately owned, communal reticulated wastewater system is undesirable due to potential issues with the management of the system and recommends against Lots 8-20*** [refers to outdated scheme plan from June 2023] ***being serviced for wastewater in this fashion. However, they concur with Mt Iron Geodrill that the other lots could manage their wastewater on-site in accordance with AS/NZS 1547:2012. Aukaha's submission states a preference for a fully reticulated wastewater system, rather than individual wastewater systems on each site, given the potential risks to ground and surface water bodies from individualised systems and the uncertainty inherent in the application with how wastewater will be managed.***

Options for treatment and disposal locations are detailed in CKL's "Water and Wastewater Assessment".

The scheme plan has since been revised. Lots 8 – 20 are now in the position of Lots 4 – 19 as per Coterra Overall Layout Plan, dated June 2024.

I agree that wastewater from Lots 4 – 18 are unsuitable for on-site treatment and disposal due to space constraints and shallow rock within the soil profile. Therefore, a reticulated system is required to safely treat and dispose of wastewater from these lots. Lot 19 (previously Lot 20) has also been designated as suitable for on-site disposal (pending site-specific investigation) due to the extension of its boundaries.

I disagree that a fully reticulated solution has less inherent uncertainty than on-site systems, as indicated by the submission by Aukaha. Most uncertainty associated with wastewater systems is a result of poor maintenance and operating procedures. As described by the applicant,

consent conditions will require the formation of an entity ('Rocky Point Services Association') that will manage the maintenance of all infrastructure within the subdivision. Therefore, maintenance of the communal treatment plant will be managed by the new entity who will also be responsible for ensuring treatment facilities on individual lots are adequately maintained by the lot owners. i.e. the proposed management entity will ensure adequate maintenance is undertaken and hence risk mitigated.

It is recommended that detailed design of onsite wastewater systems is carried out at building consent stage by a suitably qualified engineer. As described in CKL's "Water and Wastewater Assessment" (section 5.2), on-site treatment and disposal systems are expected to consist of an Aerated Wastewater Treatment System (AWTS) with bed disposal, treating effluent to secondary levels as per ASNZ1547:2012.

(b) ***I note that compliance with AS/NZS 1547:2012 intended to result in systems that adequately protect public health and the environment for systems with design flows up to 14,000 litres per week, or 10 persons. The standard notes that any system managing more wastewater, such as the proposed reticulated system, would need to be designed by a suitably qualified person. Design of the treatment and discharge system would need to be site specific, but the design of laterals and mains would need to be based on NZS 4404:2004 and Council's 2008 addendum to that standard. I also note that the Regional Plan: Water for Otago manages the effects of wastewater discharges on surface and ground water quality. In particular, the proposed shared system would also require consent to breach Rule 12.A.1.4 of that plan as the discharge would exceed 2,000 litres per day.***

Detailed design of all reticulated systems will be required at detailed design stage by a suitably qualified engineer. As described in CKL's "Water and Wastewater Assessment" report (section 5.2), the treatment system is expected to consist of a commercial WWTP (Eloy Oxyfix C-90, Innoflow or similar). Notes about reticulation are also provided above and in Section 5.2 and 5.3 of CKL's report.

[25] S-42A report, Section 6.63:

(a) ***I note that the wastewater concept put forward by Mt Iron Geodrill assumes the system would be used by 13 lots, with 5 persons per lot, and a daily flow allowance of 165 litres per person, per day, with buildings on each lot incorporating water reduction fixtures. This equates to 10,275 litres of wastewater to be treated per day. Mt Iron Geodrill's calculation in Section 6.1.1 of their report assumes 9,900 litres per day. This carries over into their indicative design calculations for the discharge fields. While not a large discrepancy, this may have implications for the design of the system. No ground investigations (Boreholes or test pits) have been provided in the proposed new dispersal field location. Therefore, the recommendations from Mt Iron Geodrill regarding the proposed drainage field are now largely irrelevant to the application*** .

Please see updated calculations and proposed disposal areas in CKL's "Water and Wastewater Assessment" (section 5.2) report.

For the case of Option A which is equivalent to the assessment by Mt Iron Geodrill, the primary disposal area has been calculated to be approximately 1,100m².

Please also refer to Appendix 4 of CKL's report for soil testing carried out within the proposed communal disposal area. Whilst additional ground investigations have been undertaken, I agree that further ground investigations within the proposed disposal field may be required at detailed design.

[26] S-42A report, Section 6.64:

(a) ***Where a management structure is provided in support of a proposal including a reticulated wastewater system that clearly outlines the entities responsible for the system and their obligations, I do not consider the private ownership and management of a reticulated wastewater network should automatically be considered unacceptable management of***

wastewater. I do not consider there to be reasons why such a system could never work, in principle, although I do also accept the concerns of Council's engineers that a communal system can be poorly managed, particularly where ongoing responsibilities are not clear and there are no or limited formal procedures in place to manage the system. Poorly managed systems can have adverse effects for both the parties connected to the system and the receiving environment. The effect of a failure is also potentially much greater than if an individual allotment's system fails. Currently, there is no information about the intended operation or management of the shared system.

(b) As noted in CKL's "Water and Wastewater Assessment" report, a hybrid system is proposed and deemed most appropriate for this development, given a number of factors, also outlined in CKL's report. However, I acknowledge the importance of adequate operation and maintenance of individual as well as communal treatment and disposal systems. To address the latter, it is proposed that adequate maintenance is ensured through an entity ('Rocky Point Services Association') which will be equipped with operating and maintenance instructions and have access to specialist maintenance company's for assistance as/if required.

[27] S-42A report, Section 6.65:

(a) ***I note that the proposed dispersal area is at a higher elevation than the lots it would service and the proposed treatment plant. Assuming the treatment plant remains in the same place, gravity connections could be made to the plant, with treated wastewater then needing to be pumped up to the dispersal field. I consider this to be largely an engineering matter, with the only risks to the environment being the added complexity of the system creating a higher risk of the system failing in the event that it is not constructed, operated or maintained adequately.***

As outlined above, the 'Rocky Point Services Association' will be responsible for ensuring adequate operation and maintenance of all infrastructure is planned and implemented to sustain a safe and healthy

environment. Further, the proposed reticulation comprises a mix of gravity and small-bore pressure sewers. In the event of failure, the latter have the ability to store approximately 1 day's effluent on site in cases of emergency and an alarm will notify the resident as well as the service entity ('Rocky Point Services Association') of the issue – to enable timeous attention.

[28] S-42A report, Section 6.66:

(a) ***I note that the proposed wastewater reticulation is indicative only and crosses steep terrain in some parts, for example between Lots 11 and 12. While the system generally flows downhill towards the treatment plant, it is not immediately clear from the site investigation plan showing the proposed system that the gradients of its pipe network will keep wastewater flows below the 3m/s upper limit specified in Clause 5.3.5.6*** [of NZS 4404:2004]. ***Wastewater flowing too fast can impact on the operation of the system through leaving solid material behind in the pipe or cause hydraulic jumping at gradient changes, potentially damaging the pipe. I consider that, in principle, the network could be designed to avoid this. However, if consent were to be granted, the consent holder would need to be able to demonstrate Clause 5.3.5.6 was complied with, or precautions taken in accordance with the clause prior to Council giving engineering acceptance for the works prior to them commencing.***

The communal treatment facility has been relocated. All wastewater will be pumped via low-pressure sewer systems to the treatment plant.

[29] S-42A report, Section 6.67:

(a) ***Reticulated wastewater for all the proposed lots, as requested by Aukaha, would serve to concentrate wastewater discharge to one location. This would avoid localised effects on groundwater quality and vegetation growth associated with individualised treatment and disposal systems, but would likely result in a greater overall effect around the discharge point of the network. No information is available about the design of the treatment and***

discharge system proposed by the applicant, and the applicant has confirmed that they do not propose to adopt Aukaha's requested changes. As identified previously, several aspects of the Mt Iron Geodrill assessment have been superseded without replacement information being provided. Limited detail is available to Council regarding any follow-up investigations undertaken by CKL at the time of writing. Given this, I cannot be satisfied that either the system proposed by the applicant, or that proposed by Aukaha will be adequate to manage wastewater from the subdivision.

CKL's report addresses the current proposal for a hybrid wastewater treatment and disposal system. Coupled with the developer's proposal to establish the 'Rocky Point Services Association', this will provide an adequate operations and maintenance regime to ensure a sustainable wastewater treatment and disposal solution.

[30] S-42A report, Section 6.68:

(a) ***Lots 1-11, 15 and 16 are all located within 150m of the proposed shared wastewater treatment plant and dispersal field. Locating residential activities close to larger scale wastewater treatment plants can have effects on the amenity of the occupants of the residential activity and have potential reverse sensitivity effects. These effects have not been considered by the applicant. In the event that Council accepts the proposal by considers the proposal as a breach of Rule 4.7.6A.k, there is insufficient information for me to conclude that effects on their amenity, or on their health, will be adequately managed by the proposal. I would require details about the design and intended operation of the treatment plant, in particular. In the event that Council accepts the partially reticulated, partially on-site reticulated wastewater disposal proposed by the applicant, I consider that these effects would be acceptable in the context of the District Plan framework.***

The communal facility will treat sewage from less than 100 people, therefore is not in breach of Rule 4.7.6A.k. However, to mitigate any adverse amenity effects on Lots, no oxidation ponds will be used, a package

plant (Eloy Oxyfix, Innoflow or similar) will be used to reduce odour production, the plant will be mostly buried, and the disposal field is proposed to be approximately 40m (worst case) from the nearest dwelling. The location of the treatment plant and disposal field can also be refined at detailed design stage to maximise the separation from Lots. For example, with reference to CKL drawing 5001 R6, the treatment plant could be placed further west, in the middle of the disposal field, with the disposal beds placed appropriately to either side.

[31] S-42A report, Section 6.69:

(a) ***Overall, I consider it likely that the proposal will be able to be adequately serviced for wastewater. However, I consider that there is currently insufficient information to make a definitive conclusion. Nor do I consider there to be sufficient information to make a recommendation between the systems proposed by the applicant and Aukaha. However, with the information available to me, I consider it is likely that wastewater management proposed by the applicant can be achieved without significant adverse effects on the environment.***

CKL's updated report entitled "Water and Wastewater Assessment" provides full detail of the proposed water and wastewater systems for the development. I agree that the proposed solutions can achieve effective wastewater management without significant adverse effects to the environment.

Section 42A responses – Supplementary Report – 27th September 2024

[32] Provision of Three Waters, Electricity and Telecommunications Services

(a) **Page 12, 1st Paragraph: any lots that are not close enough to be covered by hydrants, or where the flow rates specified in Table 2 of SNZ PAS 4509:2008 are not able to be met, a minimum 30,000 litre water storage tank with 20,000 litres retained for firefighting purposes would be required at the time and dwelling was constructed. If consent is granted, any lots that do not have hydrant coverage should be identified prior to the issue of Section**

224(c) certification, and a consent notice condition registered against any new title(s) requiring a storage tank.

The lots have been reviewed since as per the updated scheme plan. All lots can now be catered for from the proposed bulk storage fire hydrant/domestic water tanks. However, this consent condition could still apply.

(b) **Page 12, 2nd Paragraph: With 15 lots proposed to be reliant on the reticulated wastewater system, I do not consider that the required wastewater plant would service more than 100 people (An average of 6.6 persons per lot) and, so, the system would not trigger Rule 4.7.6A.k of the Plan.**

Refer to Section [30](a) above as well as [32](c) below for updated wastewater demand calculations.

(c) **Page 12, 3rd paragraph: CKL indicates that the 2.7 persons per lot estimate was based on NZS 4404:2010. On review of Section 5 of NZS 4404:2010 (Wastewater), I could not find reference to 2.7 persons per lot being the assumed occupancy rate.**

The figure of 2.7 people/house was based on the national norm as per Stats NZ results. However, this has been reviewed in accordance with NZS4404 and a figure of 3 persons per lot has been adopted. In line with this, the water demand and wastewater flow estimates have been adjusted, in line with NZS4404 recommendations, as follows;

Estimated water demand:

- Average 3 occupants per lot (based on NZS4404).
- Each occupant uses 250 L/day (NZS 4404 recommendation)
- Peak factor = 5 (NZS 4404 recommendation)
- Average daily demand per lot = 3 p * 250 L/day/p = 750 L/day
- Average daily demand = 30 lots * 750 L/day ≈ 22,500 L/day
- Peak demand = 22,500 L/day * 5 ≈ 1.3 L/s

Theoretical total wastewater flows (lots 1 – 30):

- Average 3.0 occupants per lot
- Each occupant produces 200 L/day
- Dry weather diurnal peak factor = 2.5
- Peak factor for wet weather = 2 (note this will reduce significantly if/where low pressure pumping/small bore systems are used)
- Annual average dry weather flow (AADW) = 30 lots x 3 p x 200 L/p ≈ 18,000 L/day
- Expected peak wet weather flow (PWWF) = 18,000 L/day x 2.5 x 2/(3600x24) ≈ 1.1 L/s

Daily wastewater flows to treatment plant (lots 4 – 18):

- Average Daily Flow (lots 4 – 18) = 15 lots * 3 p/lot * 200 L/p + 20% contingency ≈ 11,000 L/day.
- Primary disposal Area = 11,000 L/day / 10 L/m²/day = 1,100m²
- Reserve area = 50% * 1,100 m² = 550 m²

A 20% contingency allowance has been provided for to allow for the potential connection of additional lots, should this become necessary. Typically, ASNZ1547 requires a reserve area of 100% (of the primary disposal area) for large disposal systems. However, due to the extensive monitoring and maintenance regime that is required for this system, a 50% reserve area is considered appropriate.

Further, it should be noted that the wastewater treatment system proposed is of a modular nature and can be adjusted/expanded, if necessary.

(d) **Page 12, Paragraph 4: I cannot currently be certain that the system would be adequately designed based on the assumptions used by CKL.**

Please refer to updated/increased wastewater allowance calculations in [32](c) above with discussion on contingency, reserve areas and

modularity. I consider the proposed system can be adequately designed to serve the proposed lots.

Closure

In closure I believe that the provisions made for water supply for domestic consumption, structure firefighting, wildfire fighting as well as the reticulation, treatment and disposal of wastewater are fit for purpose. They are in accordance with the Central Otago code of practice, SNZ PAS 4509:2008, good engineering practice and are appropriate for the proposed development.

I acknowledge that some refinements will be required at detailed design stage but none that would significantly change the proposed solution.

APPENDIX 1 – “Water and Wastewater Assessment”

CKL

Planning | Surveying | Engineering | Environmental

Water and Wastewater Assessment

Rocky Point - Bendigo Loop Road

TKO Properties Ltd

Document Information

Client	**Infracon Limited for TKO Properties Ltd**
Site Location	Bendigo Loop Road, Central Otago
Legal Description	Lot 1 DP 561457
CKL Reference	A23205
Office of Origin	Auckland

Author	Joe Allely		
Signed		**Date**	22/07/2024

Reviewed By	John Sternberg		
Signed		**Date**	22/07/2024

Authorised By	John Sternberg		
Signed		**Date**	22/07/2024

Revision	Status	Date	Author	Reviewed By	Authorised By
0	Issued	7/03/2024	JA	KG, JS	JS
1	Issued	8/03/2024	JA	KG, JS	JS
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3	Issued	9/07/2024	JA	JS	JS
4	Issued	12/07/2024	JA	JS	JS
5	Issued	22/07/2024	JA	JS	JS
6	Issued	25/10/2024	JA	JS	JS

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Appendices

1 Executive Summary

TKO Properties Ltd are proposing to subdivide Lot 1 Deposited Plan 561457, Lakefront Terrace, Bendigo. The proposed subdivision is colloquially known as the Rocky Point Development. The development includes 30 lots, with a mix of residential, large residential and communal use. CKL has been commissioned to conduct a conceptual level assessment for the treatment and disposal of wastewater, as well as the provision of water supply options for the proposed development, to support a resource consent application.

The findings of the investigation are summarised below. The enclosed assessment considered factors such as site characteristics, site geology, cost, regulatory requirements, resilience, sustainability, and environmental effects. This revision is based on extensive discussions with the client and includes further considerations for water supply options, storage, wildfire, irrigation and wastewater flows.

A service agency agreement will be created to ensure the ongoing maintenance of all water supply and wastewater devices and infrastructure, in accordance with the operation and monitoring recommendations within Section 4.7 and 5.4.

Drawings depicting the scheme and discussed options can be found in Appendix 1.

Water Supply

Multiple options have been considered for the supply and treatment of water. Each option focused on providing a safe water supply and level of service to meet obligations as a water service provider, as per requirements of Taumata Arowai (water services regulator for Aotearoa). It is intended that water shall be supplied to the proposed development from the Chinamans Terrace water scheme (existing bore to the north of the subject lot, with a permit to extract 2,735 m^3/day from the aquifer). Water quality is generally good, with no pretreatment requirements envisaged at this stage. The Langelier saturation index was slightly high, but acceptable. This will be confirmed at detail design stage.

Wildfire Management NZ have been engaged to devise a strategy for combating wildfire. Two types of sprinklers have been recommended to mitigate this risk: vegetation sprinklers (to reduce and slow fire spread in key risk areas, particularly focussed on up-slopes and gullies) and ember sprinklers (to mitigate against the risk of ember attack (drifting embers)). The development infrastructure will provide for vegetation sprinkler supply 185,000 L. It will also provide for ember sprinkler water supply up to 150,000L (2 sprinklers per lot 1 – 26). Ember sprinklers can be pulsed on and off (1 min on, 1 min off) to reduce water storage requirements, and/or water storage volume can be increased over time if the need is increased.

Treatment will be required to provide safe, treated water in accordance with the NZ Drinking Water Standards requirements in light of responsibilities laid out in the Drinking Water Quality Assurance Rules. It is proposed to adopt Taumata Arowai's Acceptable Solution for Mixed-Use Rural Water Supplies (Appendix 3). A similar, alternative option would be the Bore and Spring supply Acceptable Solution.

After a concept level assessment of various options, a preferred option (Option A) was chosen:

- Water supplied to all lots from the Chinamans Terrace Scheme to the southeast of the development.
- Expansion of the existing bank of raw water at Chinamans terrace, located at a suitable location to provide sufficient head for sprinklers, without the need for boosting. The proposed systems can be expanded to account for additional demands such as irrigation. It is recommended to split the storage, with two supplies:
    - Storage system 1: storing 48 hours of domestic use and 30 minutes of hydrant demand with appropriate pretreatment and protection from stagnation/ contamination (e.g. a steel tank with an effective capacity of 90,000L (Pioneer GT110, or similar) or 3 – 4 large plastic tanks). This can be increased to include buffer storage.

    - Storage system 2: storing vegetation sprinkler and ember suppression sprinkler demand. This equates to approximately 340,000L. This can be stored in tanks or in a lined pond (more economical). In the event of the latter being adopted, it is recommended to install a floating plastic cover if a pond is implemented and/or appropriate auto-flushing filtration units (e.g. Arkal, Amiad, Filtersafe) to prevent sprinklers from blocking during a fire.
- Trunk mains and reticulation networks from each storage system installed to reticulate water to the Rocky Point development via gravity.
    - Reticulation System 1: will convey domestic use and fire hydrant demand.
    - Reticulation System 2: will convey vegetation sprinkler and ember suppression sprinkler demand.
    - Pressure reducing valves installed at lot connections, as necessary to regulate the pressure and flow of water for domestic consumption and/or sprinkler water.
    - It is proposed that both mains be laid within common trench, where possible.
    - Large differential pressure between the top and bottom terrace requires a break-pressure tank to be situated at an appropriate location (access, aesthetics) and will serve to balance pressure and provide buffer storage for domestic and fire hydrants on the bottom terrace i.e. the bottom terrace will operate as a separate water supply and pressure zone.
- Installation (at time of building) and maintenance of independent treatment and disinfection units at each lot (30 of), sized accordingly (assumes that water quality will be of an acceptable standard to enable appropriate treatment at each lot (e.g. filtration and UV)).
- A bulk water meter at the outlet of domestic water storage system is proposed to measure water supplied. In addition, individual water meters at each lot are proposed to measure water consumed to allow for water consumption trends/monitoring as well as water loss management.
- Fire hydrants to be provided in accordance with SNZ PAS 4509:2008 and a FW-2 rating, to combat structure fires within the development.
- Wildfire sprinklers to be provided as outlined in Sections 4.2.4 and 4.3.

Other options which were considered included combining the domestic and wildfire storage and reticulation systems, installation of a new groundwater bore or a bifurcation of the existing bore's rising main to serve lots 27 – 30, bulk storage within development (same elevation) with booster pumps, or the installation of a centralised water treatment plant. Ultimately, these are all viable solutions for water supply. However, as discussed in the detailed option assessment in Section 4.5, Option A provided:

- The least risk of contamination using point of entry treatment systems. This is due to the potential for stagnation within the reticulation network when not fully utilised (occupancy/use dependant).
- The most economic option, due to the utilisation of gravity for reticulation.
- Smaller infrastructure footprint due to less pumps: reducing excavation area and reducing effect on ecology and high value landscape, reduced risk.
- Single point of supply for domestic use, simplifying water consumption monitoring and water loss management and enabling equitable payment for what is used, if required.
- Treatment at point of entry. The current water quality testing results show that minimal treatment will be required to get water to an acceptable solution, which suits point-of-entry treatment systems.

It is recommended to:

- Adopt Option A as the basis for detailed design and further community engagement, as per Section 4.4.1.
- Complete a definitive assessment of costs (Capex and Opex) and optimise storage size/location.
- Investigate the use of water conservation strategies by rainwater harvesting and storage for localised irrigation and emergency use (e.g. 2,000L 'slimline' tanks).
- A suitably qualified fire engineer should be engaged to confirm the firefighting strategy for the development as per Section 4.4. FENZ shall also be consulted for approval.
- Develop an operation and maintenance agreement as per Section 4.6.

Wastewater

In accordance with NZS4404:2010, the theoretical annual average dry weather flow for the development was estimated to be approximately 18,000 L/day (lots 1 – 30). The expected peak wet weather flow was estimated to be approximately 1.1 L/s.

Multiple options have been considered for the treatment and disposal of wastewater. The analysis focused on identifying cost-effective and sustainable solutions to ensure compliance with relevant standards and regulations whilst minimising detrimental environmental effects. The options assessment within this report identified that this can be achieved through the implementation of Option A:

- Lots 1 – 3 and 19 – 30 are recommended for implementation of on-site treatment and disposal. Secondary level treatment is highly recommended for these lots due to the high ecological value of the area. The onsite systems are expected to consist of an Aerated Wastewater Treatment System (AWTS) with bed disposal, however this shall be determined at building consent stage pending site-specific analysis on each lot.
- The remaining lots (4 – 18) are considered unsuitable for on-site treatment and disposal. It is recommended to install a low-pressure sewer reticulation system, with on-site grinder pumps (e.g. Aquatec Enduraplex or similar) and small bore (50mm) rising mains to convey effluent off-lot to the area west of lot 20 for treatment and disposal. Treatment can be achieved via a commercial (communal) WWTP and land disposal (e.g. Eloy Oxyfix, Innoflow or similar) or a large septic tank and aeration chamber, capable of treating approximately 11,000 L/day (average flow from lots 4 – 18). This equates to approximately 1,100m² primary disposal area + 550m² reserve area. It is recommended that the WWTP has flow and quality monitoring. The system must be capable of treating wastewater to an acceptable secondary level prior to land disposal, in accordance with ASNZ 1547:2012. A discharge (prior to land disposal) quality of 20mg/l (BOD5) and 30mg/l (SS) is expected – the processes can generally be refined to suit requirements.

Other options that were investigated included, using a communal pump station instead of a low-pressure grinder sewer system, splitting the communal treatment system into two to three treatment and disposal areas, reticulating all effluent from lots 1 – 30 to a centralised WWTP and polishing within a subsurface engineered wetland near lot 28 with a discharge to the Clutha River, or reticulating all effluent from lots 1 – 30 to a centralised WWTP and disposing to land. Ultimately, these are all viable solutions. However, as discussed in the detailed option assessment in Section 5.2, Option A provided:

- The most efficient laying of reticulation, as small-bore rising mains can be installed at approximately 600mm (cover) below ground and offers more flexibility to reticulation layout. The pipes are sealed and hence minimise inflow and infiltration, reducing the volume to be treated and disposed.
- Reduced visual impact of treatment and disposal system by pumping all reticulated effluent to the area west of lot 20 for disposal.
- Least risk (not discharging to river)
- Where possible, disposal fields can be placed to avoid existing vegetation and habitat.
- Smallest possible area needed for centralised disposal (for lots that cannot be serviced on-lot), reducing effect on high value ecology.
- Most economical option due to limited reticulation and on-site treatment systems being installed at building consent stage.

It is recommended to:

- Use Option A as the basis for detailed design and further community engagement.
- Complete a definitive assessment of costs (Capex and Opex) at detail design stage to optimise conveyance, treatment and disposal.
- Develop an operation and maintenance agreement as per Section 4.6, clearly outlining monitoring, sampling and reporting obligations and requirements for the Rocky Point services company.

2 Introduction

CKL have been engaged to provide an assessment of options of three waters infrastructure for a multi-lot subdivision in the Bendigo Hills, Central Otago area. This report has been prepared in support of future resource consent applications to Council and for the benefit of interested parties.

The scope of this report includes a concept-level assessment of:

- Water supply, storage, treatment, and reticulation for potable and firefighting purposes
- Wastewater management, primary and secondary treatment, and disposal

Stormwater management recommendations are provided in a separate CKL report titled "Stormwater Management Plan and Flood Risk Assessment".

2.1 Related documents

Reference has been made to the following site-specific documents:

- "Application for Resource Consent for a Comprehensive Residential Development at Rocky Point" prepared by Brown & Company Planning Group, dated the 15th of June 2023. A revision of this document is currently being prepared.
- "Suitability for Onsite Domestic Wastewater Disposal Report" prepared by Mt Iron Geodrill on the 6th of June 2023, reference G23068.
- "Professional Opinion for Possible On-site Wastewater Disposal" prepared by Mt Iron Geodrill on the 5th of March 2024.
- "Terrestrial Ecology Impact Assessment" prepared by Beale Consultants in June 2023, reference INN01.
- "Archaeological Assessment of Proposed Rocky Point Subdivision, Central Otago" prepared by University of Otago, Southern Pacific Archaeological Research, dated January 2023.
- A "Water Permit to take Groundwater" has been granted for a water supply bore in the 'Chinamans Terrace' area, reference 2001.928. This supply bore is discussed further in Section 2.3.
- An initial assessment for the supply of water to the development has been carried out by Irritech Otago LTD, dated the 15th of March 2023.
- "Stormwater Management Plan" by CKL, prepared concurrently with this report.

The assessments within this report are also in accordance with the following standards and guidelines:

- "Waterways, Wetlands and Drainage Guide" by Christchurch City Council, dated February 2003.
- AS/NZS 1547:2012: Onsite Domestic-Wastewater Management
- "On-site Wastewater Management in the Auckland Region", by Auckland Council, referred to as GD06/2021
- Central Otago District Council – Addendum to NZS 4404:2004 – July 2008
- NZS 4404:2010 Land Development and Subdivision Infrastructure
- SNZ PAS 4509:2008 New Zealand Fire Service Firefighting Water Supplies Code of Practice
- Water Services Act 2021
- Water Services (Drinking Water Standards for New Zealand) Regulations 2022
- Taumata Arowai - Water Supply Provider Quality Assurance Rules 2022
- Taumata Arowai – Drinking Water Acceptable Solutions 2022

2.2 Site Location

The project area is situated in the lower reaches of the Dunstan Ranges and is colloquially known as Rocky Point. The proposed development is located at Lakefront Terrace, Bendigo, Lot 1 DP 561457. To the east of

the development is 'Chinamans Terrace', which consists of approximately 65Ha of viticulture area. The site is bordered to the northwest by State Highway 8/Tarras-Cromwell Road and is accessed from the north on Bendigo Loop Road. The project location and extent of the development is shown in Figure 1.

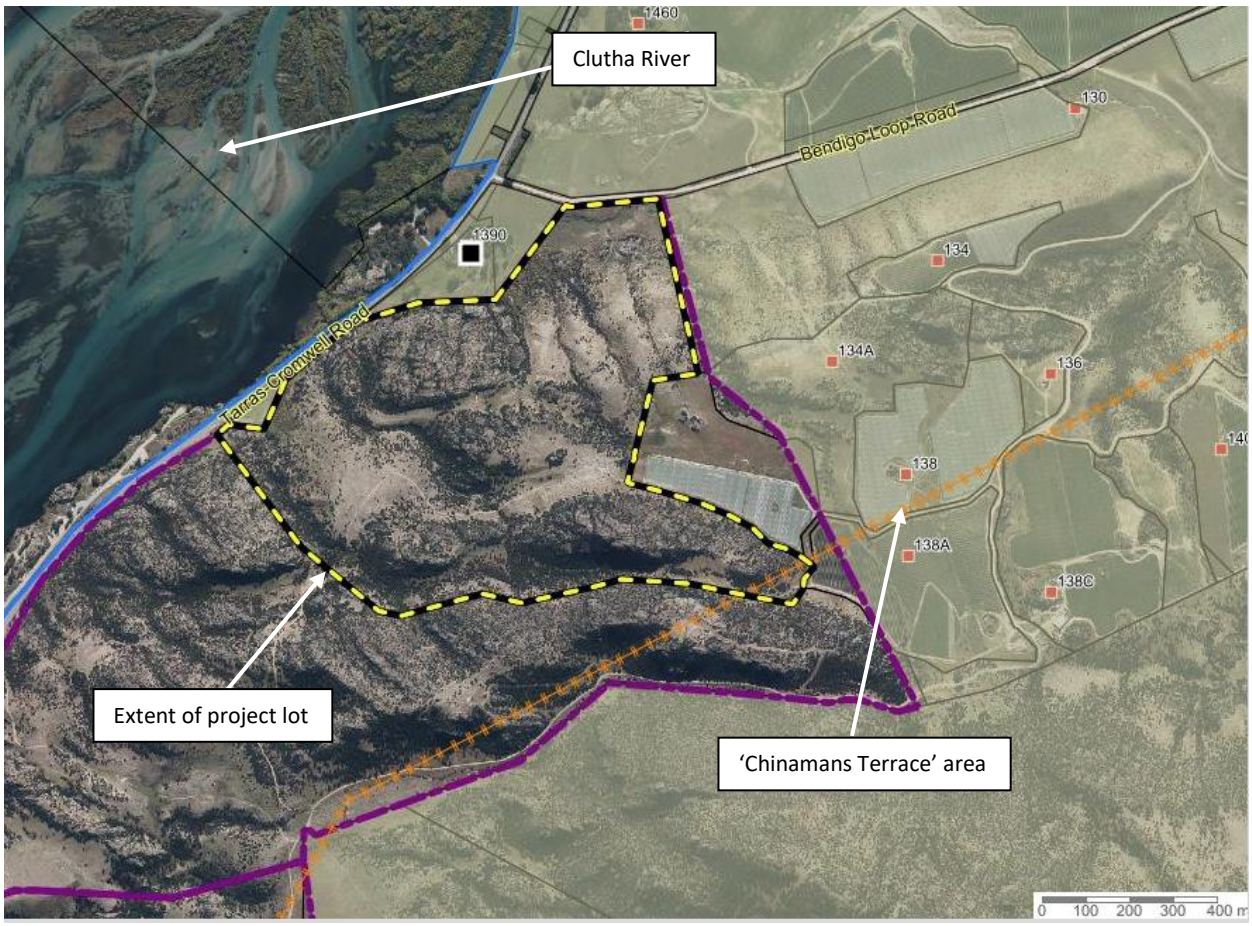


Figure 1: Site Location and project extent

2.3 Existing Site Conditions

Terrain grades across the site vary between gently sloping to very steep, and generally slope towards the northwest/west. The hills are incised by minor ridgelines, gullies and ephemeral overland flow paths that largely direct surface water to the northwest and towards two culverts installed beneath State Highway 8. From here, water is conveyed towards the Clutha River and Lake Dunstan. The site and surrounding area are populated by kanuka scrub and shrubland (shown in Figure 2), cushion field and exotic grassland with very high ecological value (Beale Consultants, reference INN01). Refer to Appendix 5 for photos of the site. A landscape assessment has been carried out for the site by Baxter Design. The assessment is summarised in the resource consent application by Brown & Company.

As per the soil evaluation by Mt Iron Geodrill (reference G23068), the soil profile across much of the site consists of schist rock with variable cover of alluvial material. Shallow rock and rocky outcrops were observed in multiple locations. The alluvial material is described as glacier deposits consisting of moderately weathered, poorly sorted, sandy gravel with silt lenses. Permeability testing within the project area confirmed the soils as category 4 (in accordance with AS/NZS1547:2012) with permeabilities of 0.11 m/d – 0.62 m/d observed.

Figure 2: Typical landscape throughout development.

3 Proposed Development

The proposed development comprises 30 lots with a mix of residential, large residential and communal uses as shown in Figure 3.

The proposal includes the construction of a new accessway, beginning at Bendigo Loop Road and ending near the top of the development at a cul-de-sac. The proposed accessway will have grades ranging from 8% - 15%, a carriageway width of 5.5m, and a total length of approximately 1.5 km.

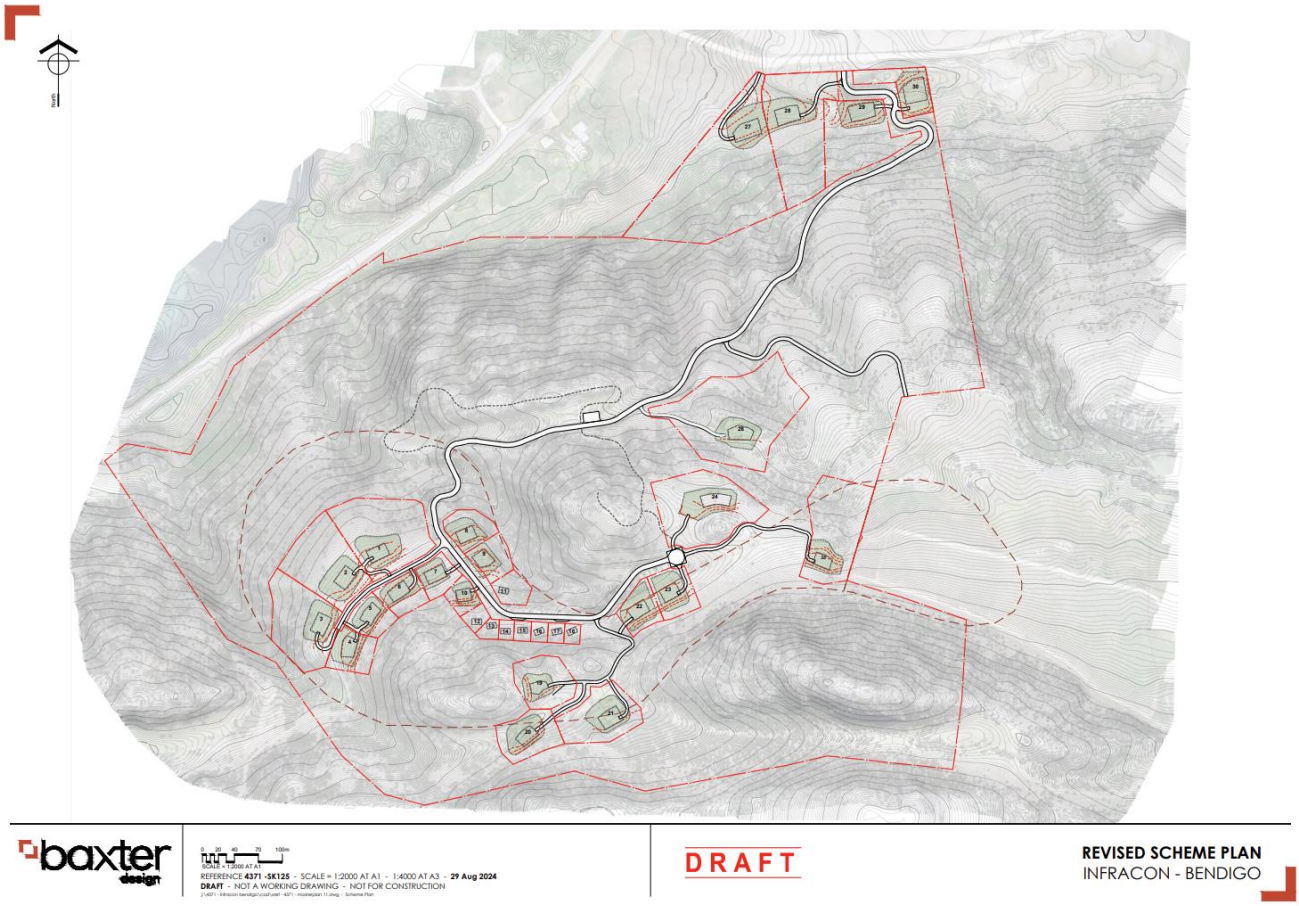


Figure 3: Proposed development scheme plan[1]

4 Water Supply

4.1 Background

A water supply bore has been drilled approximately 370 metres northeast from the intersection of Loop Road and State Highway 8, Tarras. The bore takes water from an unconfined aquifer adjacent to the Clutha River to serve Rocky Point, Chinamans Terrace and future development in the Bendigo Hills. Soil profiles within the aquifer consists of unconsolidated Clutha Outwash gravels. Recharge is primarily from Lake Dunstan. A permit has been given to extract 2,735 m^3/day from the aquifer at a maximum rate of 32 L/s. This extraction is referred to as the Chinamans Terrace water scheme.

It is intended that water shall be supplied to the proposed development from the Chinamans Terrace water scheme. The proposed development will draw water from that scheme and necessary treatment, storage and boosting will be provided to satisfy water quality, domestic and fire demand requirements. Options for supply using new groundwater bores have also been explored.

As per the resource consent application (Brown & Company, 2023), 500,000 L/day of the bore water supply has been allocated to Chinamans Terrace, the proposed Rocky Point development, and future developments in the Bendigo Hills. It is assumed that sufficient supply can be drawn from the 500,000 L/day allowance to meet the demands of the Rocky Point development.

[1] Sourced from Baxter: Revised Scheme Plan, dated the 29th August 2024.

Water from the bore is currently reticulated to and stored in four 25,000L plastic header tanks approximately 800m southeast of the proposed development. The ground level at the four existing water tanks is estimated to be approximately RL 410m. The ground level at the highest point of the subdivision (to the east of Lot 25) is estimated to have a level of approximately 340m.

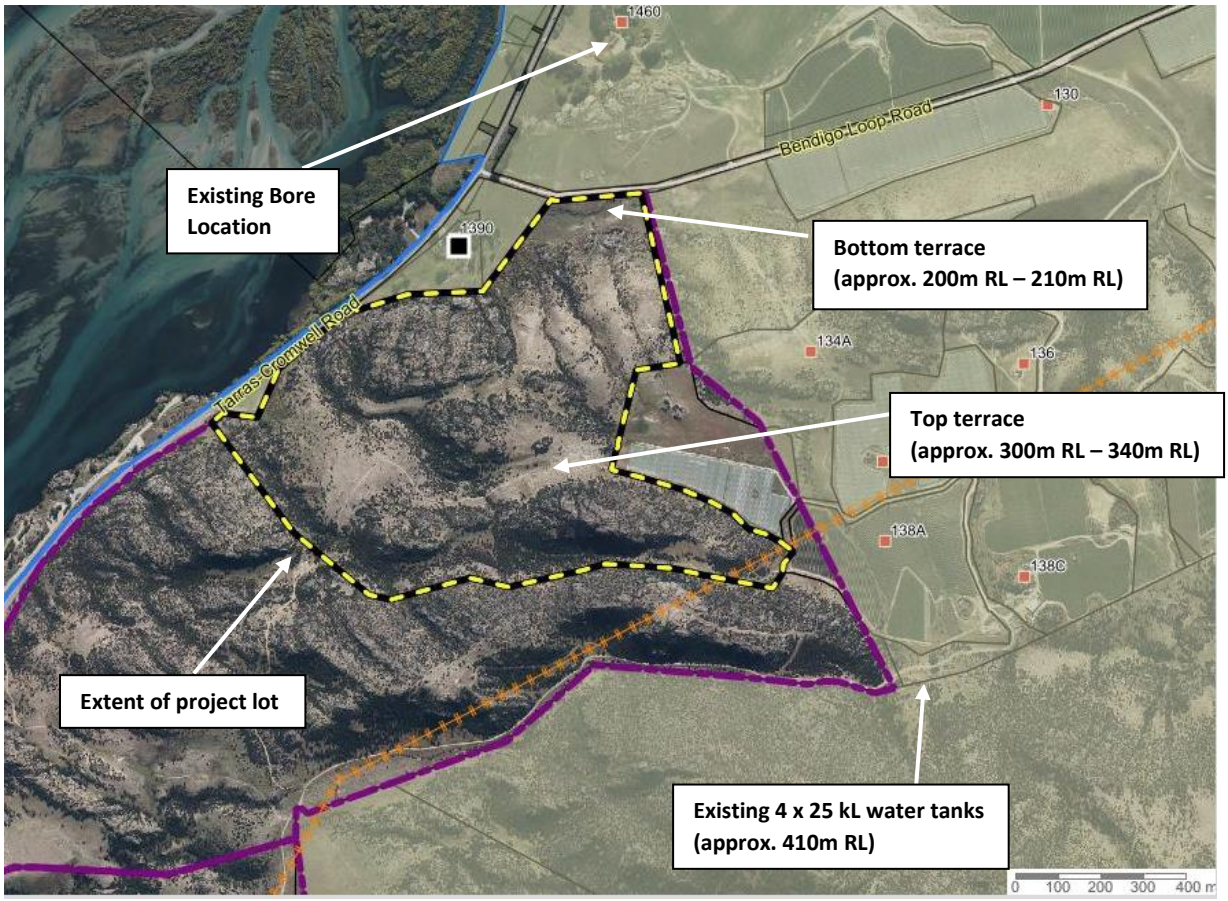


Figure 4: Chinamans water scheme[2]. Levels estimated from GIS, TBC by survey.

Water quality testing has been carried out to understand the required treatment process required to meet Drinking Water Standards. Water quality is generally good, with no staining or pretreatment requirements envisaged at this stage. The Langelier saturation index was slightly high, but acceptable. The results of the testing are attached in Appendix 2. Additional testing will be required at detailed design stage as per Taumata Arowai requirements.

The area has been identified to have a risk of wildfire. Storage of water must include provision for wildfire fighting.

4.2 Regulatory Obligations and Compliance Considerations

Taumata Arowai have the responsibility as a national water supply regulator to ensure that safe drinking water is provided as per the Water Services Act 2021 and NZS 4404:2010. Water supply to the development will require various considerations as per requirements by Taumata Arowai. Broadly, this includes the following:

- Water quality – safe drinking water, meeting maximum acceptable values as per Drinking Water Standards 2022, Drinking Water Quality Assurance Rules 2022, and Drinking Water Acceptable Solution. Regarding the latter, it is considered that either of the acceptable solutions below apply;

[2] Reference: Annotated snip from GIS maps.

- Acceptable solution for mixed use and rural water supplies – as the Chinamans scheme supplies predominantly rural irrigation water.
- Acceptable solution for Spring and Bore Water Supplies – as water is supplied from the Chinamans Terrace scheme which has bore water as its source.

- Both have very similar implications in terms of responsibilities for provision of safe water supply for this development. For ease of reference, the former has been adopted.
  - This development is classified as a Small (26 – 100 people) network supply. This classification has been made based on the limited average size of the designated building platforms and an assumed occupancy rate of approximately 3 p/dwelling.
  - It is intended that the supply of water will come from the existing Chinamans Terrace bore supply, operated by others, and stored and treated and supplied to the development in accordance with Taumata Arowai's Drinking Water Acceptable Solution (noted above). This document outlines the requirements for the water supply, including initial source quality testing, treatment, operation, maintenance, monitoring, incident and emergency management, training, and auditing. Refer Appendix 3.
- Water pressure – to be adequate for domestic use and to satisfy firefighting requirements (wildfire requirements and SNZ PAS 4509:2008).
- Storage – appropriately situated, accessible and sufficient capacity and resilience to cater for emergencies (fire).
- Fire protection – in accordance with SNZ PAS 4509:2008 as well as FENZ requirements for wildfire in this vicinity (refer Wildfire NZ recommendations).
- Adequate treatment and disinfection for potable use.
- Operation and maintenance arrangements for the water scheme as well as the water treatment and storage facilities.

4.3 Firewater

The provision for firefighting supply is detailed below, in accordance with SNZ PAS 4509 and recommendations by Wildfire Management NZ.

4.3.1 Structure fires

The recommended general philosophy for structure fires within the development is that they are contained using fire hydrants.

- Adequate bulk storage for FW-2 rating will be reserved for fighting structure fires, in accordance with SNZ PAS 4509. Bulk storage shall be dedicated, or level controlled (reserved).

- Fire hydrants will be installed to serve all lots with acceptable access for a fire truck. Spacing of hydrants will be in accordance with NZS 4404 and SNZ PAS 4509 to provide FW-2 coverage.
  - Fire hydrants must be capable of providing FW-2 required flow rate as per Section 4.4.2.
  - Fire truck access to the hydrants will be provided via the access road for the development. The proposed grade (8-15%) is within the allowable maximum (1V:5H as per SNZ PAS 4509:2008).
  - Where access to hydrants is not practical, independent storage (min. 45m^3) will be provided at those specific dwellings (e.g. 2 x 25,000L tanks with a firehose coupling).
  - If these are connected to treated potable water line backflow devices will be fitted to prevent contamination of potable water by raw water.

- Firewater to the top terrace will be provided as described above, via the combined domestic/fire storage and water main.

- Supply of FW-2 firefighting to the bottom terrace (lots 27 – 30):
    - Due to elevation difference between the top and bottom terrace, a break pressure tank (and/or pressure reducing valves) will be required to reduce pressure. This tank will also be utilised for further buffer storage for both domestic and fire water. This may comprise a separate storage bank (e.g. 3 x 30,000L tanks) automatically topped up from the top terrace water main. This will be finalised at detail design stage.

4.3.2 Wildfire provision

Wildfire Management NZ have been engaged to devise a strategy for combating wildfire. Two types of sprinklers have been recommended with demands and required pressures as per Section 4.4.3.

Vegetation sprinklers are recommended to reduce and slow fire spread in key risk areas, particularly focussed on up-slopes and gullies. The effect of this overhead water onto vegetation will be to reduce radiant heat, slow fire spread, and provide a buffer between fire and buildings. A secondary benefit of this sprinkler is that it can in the future assist in the greening of this vegetation buffer via irrigation, reducing fire risk.

Private ember suppression sprinklers are proposed (pending site-specific assessments of residual fire risk at design and consenting stage of each dwelling on Lots 1-26) to mitigate against the risk of ember attack from wildfire. It will be the responsibility of the lot owner to ensure adequate water supply to meet ember suppression needs. The development infrastructure will provision for this water supply up to 150,000L (2 sprinklers per lot 1 – 26). Should this not be adequate, lot owners will need to supplement this supply with their own domestic supply and/or private storage.

The operating and control system for these sprinklers will be investigated at detailed design stage. However, generally it is expected that a fire detection system (e.g. Attentis flame recognition sensor) will be installed, which will trigger control valves strategically placed around the development. Consideration will be given to ensure that the number of control valves is optimised in relation to sprinkler response time.

Refer to assessment by Wildfire Management NZ for more details.

4.4 Estimated Water Demand

The total water requirement for the development has been calculated using three different demands as discussed below: domestic water, structure firefighting and wildfire fighting.

4.4.1 Domestic water demand

The following assumptions have been made to calculate the domestic water supply demand, in accordance with NZS 4404:2010:

- Average 3 occupants per lot (based on NZS4404).
- Each occupant uses 250 L/day (NZS 4404 recommendation)
- Peak factor = 5 (NZS 4404 recommendation)

Therefore, estimated water demand is as follows:

- Average daily demand per lot = 3 p * 250 L/day/p = 750 L/day
- Average daily demand = 30 lots * 750 L/day ≈ 22,500 L/day
- Peak demand = 22,500 L/day * 5 ≈ 1.3 L/s

The above is a reasonable assumption, based on the expected demographic and usage. It should be noted however that storage can easily be upgraded if required and reticulation will be sized to suit fire demand so there is adequate capacity to accommodate changes.

4.4.2 Structure-fire water demand

Fire hydrants are recommended to combat structure fires within the development (refer to Section 4.3.1 for more details). With reference to SNZ PAS 4509:2008, we have assumed that a FW-2 rating would apply to the development. This rating requires an available water supply of 25 L/s from 2 hydrants, within 135 and 270 m distance respectively, with sufficient volume for 30 minutes of firefighting. This yields an additional volume requirement for fire hydrants of approximately 45,000 L.

Some of the larger lots may be designated for use as communal residential activity, leisure activities, or accommodation facilities. It is expected that such facilities may require sprinkler protection, but these lots have also been assumed to have an FW-2 rating for the purpose of this high-level assessment. Internal sprinkler systems could also be implemented for single dwellings to reduce the firefighting water classification and associated water volume required.

It is recommended that a suitably qualified fire engineer is consulted during detailed design to confirm fire ratings and, if/where required, design sprinkler protection for buildings, also considering Fire and Emergency New Zealand (FENZ) requirements.

4.4.3 Wildfire sprinkler water demand

Wildfire Management NZ have been engaged to devise a strategy for combating wildfire. Two types of sprinklers have been recommended.

- Ember suppression sprinklers: sprinklers installed strategically on the corner of roofs. The following assumptions have been made:
    - The sprinklers have an allowable pressure range of 3.0 bar to 4.0 bar and a discharge rate of approximately 25 L/min. This is based on a Rolland 22 sprinkler with a 4.5mm nozzle (to be confirmed at detailed design stage.
    - The smaller lots (e.g. lots 11 – 18) will be able to share coverage.
    - Lots have been assumed to have two ember sprinklers each. Recommendation from Wildfire Management NZ is to have four per Lot. This shall be confirmed at detailed design stage
    - Number of lots requiring sprinklers = 25 (confined to higher risk, top lots only)
    - Total number of sprinklers = 50 (considering coverage of sprinklers and proposed house sizes)
    - Demand = 1250 L/min = 20.8 L/s
    - Required firefighting time = 120 minutes
    - Storage volume required ≈ 150,000 L.
    - Wildfire Management NZ recommended 300,000L however will accept 150,000L if ember sprinklers can be pulsed on and off (1 min on, 1 min off) to reduce water storage requirements, and/or water storage volume can be increased over time if the need is increased.
    - Detailed assessment shall be carried out at building consent stage to determine how many sprinklers are required per lot (based on structure size, material used and location). If more than 150,000L is required, storage can be increased to accommodate the additional requirements. It can be noted that the 150,000 l is conservative as the replenishment rate (dynamic) of the tanks (from Chinamans) has been ignored – this will be reviewed at detail design.

- Vegetation sprinklers (external sprinkler system): sprinklers installed strategically based on vegetation within predicted wildfire spread zones. The following assumptions have been made:
    - The sprinklers have an allowable pressure range of 4.0 bar to 6.5 bar and a discharge rate of approximately 79 L/min. This is based on a Hunter I-40 sprinkler with a #44 nozzle (to be confirmed at detailed design stage.
    - It is estimated that there shall be approximately 26 sprinklers.
    - Demand = 2054 L/min = 34.2 L/s
    - Required firefighting time = 90 minutes
    - Storage volume required ≈ 185,000 L
    - These sprinklers could be pulsed after an initial 20 minute wet down phase to increase run time.

Refer to Section 4.3.2 for more details.

4.4.4 Total water demand during wildfire

The total water demand has been calculated for the following assumed **wildfire situation**, deemed to be the worst-case scenario:

- It is assumed that domestic consumption will cease, and minimal domestic demand required in the event of a wild fire– it would be marginal anyway in context of overall demand in this scenario even if local hoses were used to suppress localised fire.
- As discussed in Section 4.3, the preferred firefighting supply option for the bottom terrace (lots 27 – 30) is **fire hydrants**. For the worst-case scenario, we have assumed that two hydrants are operating at 12.5 L/s (each) for 30 minutes (45,000 L). These can be supplied from separate storage (break-pressure) tanks.
- All **ember sprinklers** are operating at full capacity with pulsing: 20.8 L/s for 120 minutes (150,000 L).
- All **vegetation sprinklers** are operating at full capacity: 34.2 L/s for 90 minutes (185,000 L)

Therefore, the total water demand is 80.1 L/s, and the total required storage is approximately 390,000 L. These assumptions shall be confirmed by a fire engineer before detailed design stage. Refer to Section 4.5 for details of how this water will be stored and reticulated.

4.4.5 Irrigation Water

If irrigation is required to support vegetation growth the storage system described in Section 4.5.1 can be expanded to cater for this demand. For example:

- 6,000 plants proposed at 1m spacings
- Each plant would require approximately 5 L/day.
- Total daily demand of 30,000 L.

This could be accommodated by expanding the proposed storage system with an additional 30,000L above ground tank. It is recommended to consult with an irrigation specialist to determine the method of application. However, dripper lines are recommended (due to water use efficiency, simple control methods, and small diameter reticulation pipes) – water feed will be controlled using pressure regulation and timers set to irrigate at night, off-peak.

4.5 Options for Bulk Water Supply and Reticulation

A concept-level options assessment has been carried out, identifying a preferred option (Option A) for bulk water treatment and supply for the proposed development. Indicative plans are shown in Appendix 1, and

Figure 5 below. An assessment of the chosen option is shown in Table 1. High level modelling has been carried out to determine the indicative pipe sizes given on the attached indicative plan.

Other potential options have been identified and are discussed in Section 4.5.2. All options have been assessed in accordance with Central Otago District Council and NZS 4404:2010 requirements.

4.5.1 Water supply and storage – Option A

This option would comprise;

- **Water supplied to all lots from the Chinaman's Terrace Scheme** to the southeast of the development (top of the development).

- **Expansion of the existing bank** of 4 x 25,000 L raw water storage tanks at Chinaman's terrace, or at an intermediate location. Approval will be required from the neighbours for the placement of tanks at this location. It is recommended to split storage into **two supplies:**
    - **Storage system 1: storing 48 hours of domestic use and 30 minutes of hydrant demand** as per Section 4.4. This equates to approximately 90,000 L.
        - As part of this water will be used for domestic supply, the storage vessel(s) must be contained, without the potential for stagnation or contamination from waterfowl.
        - E.g. steel tank with an effective capacity of 90,000L (Pioneer GT110, or similar). Alternatively, 3 – 4 large plastic tanks could be installed, as indicated on drawing 6002.
        - If pretreatment is necessary (pending further water quality testing at design stage), this can be installed in the same location.
        - The tank(s) could be located at a suitable location to provide sufficient pressure head for domestic use and hydrants, without the need for boosting.
        - This storage volume is based on the minimum requirements for the development, but this can easily be increased to include buffer storage (to cater for intensification or irrigation).
    - **Storage system 2: storing vegetation sprinkler and ember suppression sprinkler demand as per 4.3.2.** This equates to approximately 340,000L.
        - This can be stored in tanks or in a lined pond (proposed).
        - It is recommended to install a floating plastic cover if a pond is implemented and/or appropriate auto-flushing filtration units (e.g. Arkal, Amiad, Filtersafe Trident etc.) to prevent sprinklers from blocking during a fire.
        - The pond/tanks could be located at a suitable location to provide sufficient head for sprinklers, without the need for boosting.
        - Similarly to storage system 1: the required volume can be increased to include buffer storage (to cater for intensification or irrigation).
    - It can be noted that storage is dynamic i.e. storage will be replenished during use providing additional supply, over and above the static volume provided.

- **Trunk mains and reticulation networks from each storage system** are recommended to reticulate water to the Rocky Point development **via gravity**. Indicative pipe sizes are shown on drawing 6002
    - **Reticulation System 1: will convey domestic use and hydrant demand** as per Section 4.4.
    - **Reticulation System 2: will convey vegetation sprinkler and ember suppression sprinkler demand** as per Section 4.4.

- Pressure reducing valves installed at lot connections, as necessary to regulate the pressure and flow of water for domestic consumption.
- It is proposed that both mains be laid within common trench, where possible.
- Large differential pressure between the top and bottom terrace requires a break-pressure tank (and/or pressure reducing valves) to be situated at an appropriate location (access, aesthetics) and will serve to balance pressure and provide buffer storage for domestic and fire hydrants on the bottom terrace i.e. the bottom terrace will operate as a separate water supply and pressure zone.

- Installation (at time of building) and maintenance of **independent treatment and disinfection units at each lot (30)**, sized accordingly. This assumes that water quality will be of an acceptable standard to enable appropriate treatment at each lot (e.g. filtration and ultra violet (UV)). It is recommended that a condition of consent be that a treatment device be installed at building consent stage and that an appropriate maintenance agreement be set in place for sustained operation (further discussed in Section 4.7).

- A bulk water meter at the outlet of domestic water storage system is proposed to measure water supplied. In addition, individual water meters at each lot are recommended to measure water consumed. This will allow for water consumption trends/monitoring as well as water balancing and **water loss management** measures to be implemented.

- **Fire hydrants** to be provided in accordance with SNZ PAS 4509:2008, as outlined below in Section 4.3.1.

- **Wildfire sprinklers** with an appropriate automatic operating system to be provided as outlined in Sections 4.3.2 and 4.4.3.

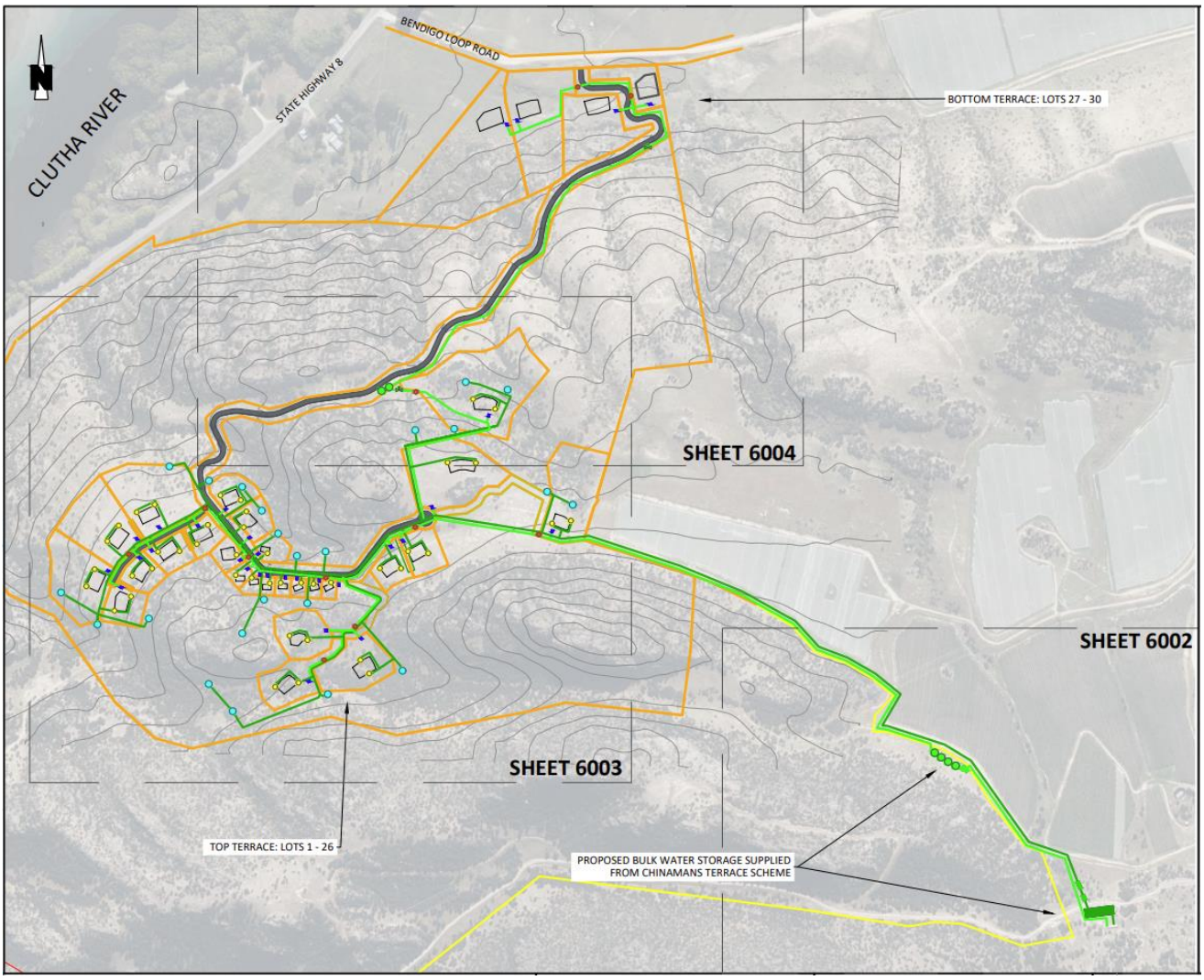


Figure 5: Water supply, option A (refer Appendix 1, drawings 6001 - 6004).

The benefits and challenges associated with Option A are described in Table 1 below.

Table 1: Concept level assessment of Option A for water supply and storage

Benefits/Pros	Challenges/Cons
Option A	
- The large flow rates required for wildfire fighting mean that high pressure is required. By utilising the steep terrain to produce adequate pressure head, the need for large, expensive booster pumps is negated: economical, no pumping costs, lower carbon footprint, no need for backup generators, reduced risk. - Aesthetics: no pump station within development. - This storage bank could also be expanded further in the future to serve further development in the area. For example, the proposed house site on lot 10 within the Bendigo Hills development. Water main pipe	- Regulation of high pressures. This can be mitigated by installing break pressure tanks and pressure reducing valves where necessary. - Risk of point-of-entry treatment systems being disabled in power outage, posing risk to customers. However, water quality is generally good and water quality monitoring and reporting will highlight any risks (E.coli) from the supply source and temporary boil notices would be imposed. - Many point of entry treatment systems to maintain. This will be mitigated by creating Rocky Point Services LTD to manage all maintenance agreements with owners. This is discussed further in Section 4.7.

Benefits/Pros	Challenges/Cons
sizing could include some contingency for situations such as this. - Smaller infrastructure footprint due to less pumps: reducing excavation area and reducing effect on ecology and high value landscape. - Single point of supply for domestic use, simplifying water consumption monitoring and loss management and enabling equitable payment for what is used, if required. - Treatment at point of entry - treatment and reducing risk of contaminated water i.e. treat when used. The current water quality testing results show that minimal treatment will be required to get water to an acceptable solution, which suits point-of-entry treatment systems.	

4.5.2 Water supply – other options considered

Several other options have been considered during this assessment. Notable options comprise of:

- **Option B:** Equivalent to Option A, except all water is stored within a combined storage system.
    - Benefits: less complicated reticulation installation, and single trunk main supplying whole development.
    - Challenges: More complex pressure management, large volume of water requiring high quality storage vessel (e.g. steel tanks as opposed to a pond system). This cost is considerable.
    - Conclusion: Less economical than Option A due to cost of a combined storage system.

- **Option C:** Equivalent to Option A, except water supply for top terrace provided by existing header tanks in Chinaman's Terrace Scheme as per Option A, and water supply for bottom terrace provided by **EITHER** a bifurcation of the Chinaman's Terrace Scheme near lot 30 **OR** a new groundwater bore in the bottom terrace.
    - Benefits: less complicated pressure regulation required and reticulation installation, as no water main is required between lot 26 and the bottom terrace.
    - Challenges: installation of bifurcation or groundwater bore, independent storage facility, booster pumps required if using a bore, separate reticulation systems, separate metering systems, separate water quality monitoring, backup diesel generator required.
    - Conclusion: challenges outweigh benefits, in comparison to Option A.

- **Option D:** Equivalent to Option A, except bulk storage is placed near lot 25, and booster pumps are installed to provide adequate pressure.
    - Benefits: smaller trunk main between and existing header tanks and development than Option A, bulk storage would be located within the development lot.
    - Challenges: very large pumps required for boosting, ongoing pump energy costs, backup diesel generator required, pressure reduction requirements but would still be required to regulate pressure between the top and bottom terrace.
    - Conclusion: this cost of the booster pumps makes this option uneconomical in comparison to Option A.

- **Option E:** Equivalent to Option A, except bulk storage is placed near lot 25, a centralised water treatment plant is installed near lot 25, and booster pumps are installed to provide adequate pressure.
    - Benefits: smaller trunk main between existing header tanks and development than Option A, bulk storage would be located within the development lot, one treatment system with single maintenance agreement for treatment.
    - Challenges: very large pumps required for boosting, ongoing pump energy costs, backup diesel generator required, pressure reduction requirements would still be required to regulate pressure between the top and bottom terrace, raw water would be split from potable water after treatment so the reticulation system would be larger with more excavation and vegetation damage, and risk of stagnation and potential re-contamination in reticulation in times of low use.
    - Conclusion: this cost of the booster pumps makes this option uneconomical in comparison to Option A.

4.5.3 Summary – water supply options

Option A is recommended. This option provides a robust solution for the provision of domestic water, firewater and wildfire management (and irrigation if required). In line with the proposed scheme, Rocky Point Services LTD and operating and maintenance guidelines will provide a sustainable source of water for the development whilst accounting for the management of wildfire potential in this area (discussed in Section 4.7).

4.6 Water Sensitive Design

Water conservation techniques can be investigated further at design stage. Such techniques could include rainwater harvesting (for irrigation or emergency storage), grey-water recycling (flushing toilets, irrigation) and water-reduction fixtures. Installation of individual water meters as well as a bulk water meter will enable water consumption monitoring, water balancing and a water loss management protocol to be established.

4.7 Operating and Maintenance and Reporting

A Service Agency (Rocky Point Services LTD) will be established to ensure appropriate level of service is maintained through regular maintenance of infrastructure and required level of sampling, testing, and reporting sustained – in line with Taumata Arowai requirements for Acceptable Solutions.

A water management plan will be prepared for the agency incorporating for example;

- An operations and maintenance (O&M) guideline for the pretreatment systems (if required), water storage, reticulation, pumps (if required), individual filtration and UV systems, hydrants, sprinklers, pressure reduction valves, and control valves. Appropriate servicing/replacement protocols will be stablished to ensure safe and sustainable water treatment and supply.
- A consent condition will be required for each property to install an appropriate treatment facility and engage a maintenance contractor approved by the service agency, to ensure sustained acceptable and safe water quality.
- Monitoring of water supplied and consumed and water demand/loss management.
- Reporting on water quality with an appropriate water quality sampling and testing regime in accordance with the Drinking Water Quality Assurance Rules 2022 and Acceptable Solutions requirements (refer Appendix 3).

- A regular fire hydrant inspection and testing regime, in terms of SNZ PAS 4509, Appendix G. Similarly, wildfire protection sprinklers and any control valves will need regular inspections and testing. Emergency/contingency plan to address quality/security of supply issues.
- Easy access to key infrastructure for O&M (considering the site location and terrain).

5 Wastewater Management and Disposal

The treatment and disposal of wastewater has been assessed in accordance with AS/NZS 1547:2012 and NZS4404:2010 in compliance with Central Otago District Council requirements.

5.1 Total Wastewater Flow Estimate

The following assumptions have been made in order to estimate the theoretical total peak wastewater flows from the development (Lots 1- 30), in accordance with NZS 4404:2010 and ASNZ1547:2012:

- Average 3.0 occupants per lot
- Each occupant produces 200 L/day
- Dry weather diurnal peak factor = 2.5
- Peak factor for wet weather = 2 (note this will reduce significantly if/where low pressure pumping/small bore systems are used)

Estimated theoretical total wastewater water production is as follows.

- Annual average dry weather flow (AADW) = 30 lots x 3 p x 200 L/p ≈ 18,000 L/day
- Expected peak wet weather flow (PWWF) = 18,000 L/day x 2.5 x 2/(3600x24) ≈ 1.1 L/s

This calculation applies a peak factor to model the effect of infiltration of groundwater and inflow of stormwater into the wastewater network. With modern construction techniques and materials such polyethylene piping, the amount of infiltration and inflow is likely to be reduced. In addition, should any of the development utilise low pressure grinder pumps and small-bore sewers, these systems experience less infiltration. As such, the above peak wastewater flow is considered to be conservative.

5.2 Options for Wastewater Treatment and Disposal

A concept-level options assessment has been carried out, identifying a preferred option (Option A) for the reticulation, treatment and disposal of wastewater from the proposed development. An indicative wastewater plan for the chosen option is shown in Appendix 1.

The design loading rate for on-site disposal to ground has been assumed to be 10 mm/day, as per AS/NZS 1547:2012. Potential areas for land disposal are limited due to shallow/exposed rock and steep topography across much of the site (refer Mt Iron Geodrill (reference G23068)).

5.2.1 Wastewater treatment and disposal – Option A

This option proposes a combination of on-site treatment and reticulation, as per the recommendations from Mt Iron Geodrill (reference G23068). An indicative site plan is shown in Figure 6.

The soil evaluation by Mt Iron Geodrill (reference G23068) identified that some lots are suitable for onsite treatment and disposal. Secondary level treatment is highly recommended for these lots due to the high ecological value of the area. The onsite systems are expected to consist of an Aerated Wastewater Treatment System (AWTS) with bed disposal, however this shall be determined at building consent stage pending site-

specific analysis by a suitably qualified engineer. Due to lot size, ecological effect, soil type and topographical location, lots 1 – 3 and 19 – 30 are recommended for implementation of on-site treatment and disposal.

The remaining lots (4 – 18) are considered unsuitable for on-site treatment and disposal due to shallow depth to rock or limited lot sizes. A reticulation system is required to convey effluent off-lot to the area west of lot 20 for treatment and disposal. Pumping is required. Option A consists of using a low-pressure sewer reticulation system, with on-site grinder pumps (e.g. Aquatec Enduraplex, E-One or similar) and small bore (50mm) rising mains. Treatment can be achieved via a commercial (communal) WWTP and land disposal.

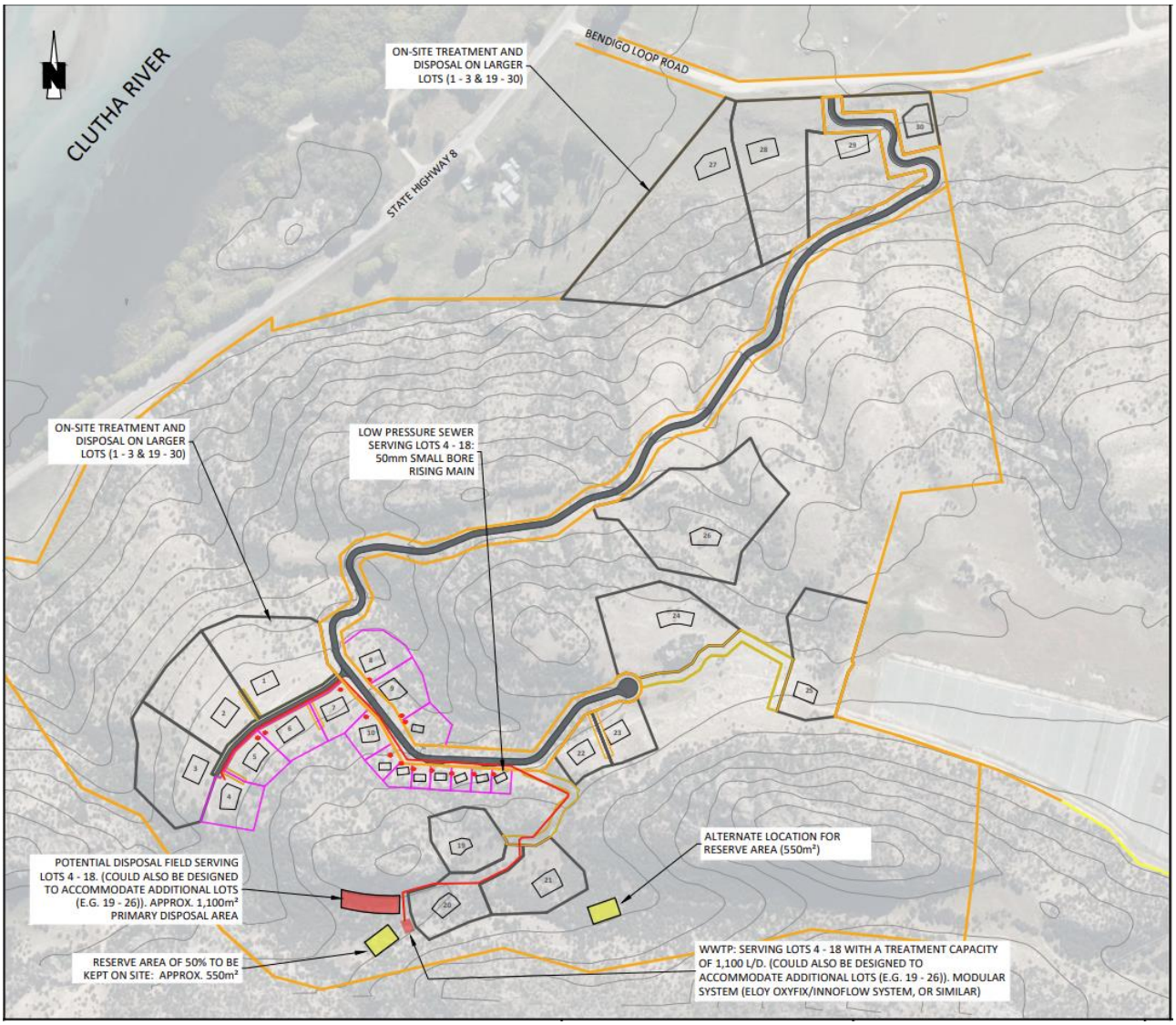


Figure 6: Wastewater management Option A. [3]

The chosen communal wastewater treatment plant (WWTP) will comprise of a commercial WWTP (e.g. Eloy Oxyfix, Innoflow or similar) or a large septic tank and aeration chamber, capable of treating approximately 11,000 L/day, equating to approximately 1,100m² primary disposal area[4] and a 550m² reserve area (refer discussion below). A 20% contingency has been added to allow for the potential connection of additional lots, should this become necessary.

- Average Daily Flow (lots 4 – 18) = 15 lots * 3 p/lot * 200 L/p + 20% contingency ≈ 11,000 L/day.

[3] Ref: Appendix A, drawing 5001.
[4] Based on NZS4404 and a soil permeability of 10 mm/day.

- Primary disposal Area = 11,000 L/day / 10 L/m²/day = 1,100 m²
- Reserve area = 50% * 1,100 m² = 550 m²

It is recommended that the WWTP has flow and quality monitoring. The system must be capable of treating wastewater to secondary level prior to land disposal, in accordance with ASNZ 1547:2012:

- BOD_5 less than or equal to 20 g/m³ with no sample greater than 30 g/m³
- TSS less than or equal to 30 g/m³ with no sample greater than 45 g/m³

Typically, ASNZ1547 requires a reserve area of 100% (of the primary disposal area) for large disposal systems. This reserve area is to be kept on site to replace or extend the disposal field if required. However, due to the extensive monitoring and maintenance regime that is required for this system, a 50% reserve area is considered appropriate. The proposed low pressure sewer systems can also be temporarily programmed to limit flows to the WWTP if the disposal field requires repair or extension.

The WWTP can be configured to provide a higher quality of effluent if required, by including additional, tertiary treatment modules. The exact layout of the reticulated system shall be determined at detailed design stage. The disposal method and size of the disposal areas is also subject to detailed design.

Geotechnical investigations of the proposed communal disposal area have been carried out, confirming that this area is suitable for treated wastewater disposal (refer Appendix 4).

Flood modelling, for large rainfall events (100yr ARI), has been carried out by CKL (refer separate CKL stormwater management report). The results show that the majority of stormwater flows from the adjacent gully are directed north, travelling in between lot 18 and 22, away from the proposed disposal field. The maximum depth of water directly to the south of the proposed disposal field during a 100-year return interval storm event has been modelled as 0.03m (30mm). Although this depth is minimal, to prevent any chance of flooding the effluent disposal area it is recommended to install a swale to direct surface flows away from the disposal field.

The benefits and challenges associated with Option A are described in Table 2 below.

Table 2: Concept level assessment of Option A for wastewater management

Benefits/Pros	Challenges/Cons
Option A	
- Utilises space on larger lots. - More economical for developer (pushes cost of on-site systems onto owners). - Increases resilience by separating systems. - Simple reticulation system. - Where possible, disposal fields can be placed to avoid existing vegetation and habitat. - Service agency can be setup to maintain system. Use of grinder pumps and low-pressure distribution system reduces infiltration and inflow and hence flows/disposal area, also provides versatility in timing and situation of grinder pumps and reticulation to suit staging of the development.	- Large disposal area: high ecological impact, large excavation - Need to engage consultants to carry out site-specific disposal assessments for each Lot using on-site disposal. - Pumping required - however, low pressure grinders and small-bore system will minimise ground water infiltration.

5.2.2 Wastewater – other options considered

Several other options have been considered during this assessment. Notable options comprise of:

- **Option B:** Equivalent to Option A, except the reticulation system serving lots 4 – 18 gravitates towards a communal pump station instead of individual grinder pumps on each lot.
    - Benefits: fewer pumps required, single pump station for maintenance, increased resilience by splitting systems
    - Challenges: deep excavation into rocky subsoil for gravity main and pump station wetwell, relatively large pump station and emergency storage, space/location.
    - Conclusion: a low-pressure sewer system reduces the excavation required, as a small bore rising main can be installed at approximately 600mm below ground.

- **Option C:** Equivalent to Option A, except the reticulation system serving lots 4 – 18 is split into two (or three) separate reticulation, treatment and disposal systems.
    - Benefits: smaller communal disposal fields, potentially fewer pumps required (due to some lots gravitating towards smaller centralised disposal fields.
    - Challenges: multiple communal treatment plants and disposal fields that are visible to public.
    - Conclusion: Pumping all reticulated effluent to the area west of lot 20 reduces the visual impact of the treatment and disposal system.

- **Option D:** reticulating all effluent from lots 1 – 30 to a centralised WWTP, polishing within a subsurface engineered wetland near lot 28, discharge to Clutha River.
    - Benefits: highest level of treatment, additional ecology amenity due to biodiversity within wetland, and less excavation (due to no on-site disposal fields).
    - Challenges: very long reticulation system (requiring pumping in some areas) with steep grades and rocky subsoil, high risk due to single treatment and disposal method, large WWTP (high cost), space requirement in bottom terrace for wetland, potential cultural concerns.
    - Conclusion: laying a single reticulation system from the top terrace down to the Clutha River makes this option less economical and impractical. High risk due to discharge to Clutha River.

- **Option E:** reticulating all effluent from lots 1 – 30 to a centralised WWTP, treating and disposing to land.
    - Benefits: high level of treatment, centralised treatment plant and one facility to operate and maintain.
    - Challenges: very long reticulation system (requiring pumping in some areas) with steep grades and rocky subsoil, higher risk of potential breakout in disposal bed (pending location), large WWTP capital cost, space requirement for disposal.
    - Conclusion: Not a practical or cost-effective option considering logistics and environmental (large land disposal area) considerations.

5.2.3 Summary – wastewater management options

In conclusion, Option A was selected as the most versatile and practical solution, considering environmental and cost impacts.

5.3 Staging the Development

The proposed development may be delivered in stages, which brings design considerations into the delivery of the wastewater services. These considerations are presented in the following sections.

5.3.1 Reticulation

A combination of gravity sewerage and low-pressure grinder pump and rising main installations is proposed. This provides flexibility to lots that can't be gravitated to the proposed WWTP and/or where house situation (on lot) may change significantly. Grinder pumps and small-bore reticulation also minimise the possibility of rainwater (or groundwater) infiltration and inflow, thus protecting the design capacity of the WWTP and disposal fields. Rising main pipe sizing should include some contingency to allow for intensification or for some lots previously designated for on-site treatment joining the reticulation system.

5.3.2 Treatment and disposal

It should be noted that the proposed WWTP and disposal fields are modular by nature of design and can be adapted to suit flows and requirements, assuming space (footprint) requirements are provided for. This is beneficial in terms on adapting to any uncertainties in development as well as staged growth/development.

The lots that have been marked for communal use (e.g. lot 28) may experience larger peak wastewater flows. It is recommended that the need for buffer storage is investigated/allowed for these lots at design stage.

5.4 Operating and Maintenance

As outlined in section 4.7, a Service Agency (Rocky Point Services LTD) will be established to ensure appropriate level of service is maintained through regular maintenance of infrastructure and required level of sampling, testing, and reporting sustained.

A wastewater management plan is to be developed for Rocky Point Services LTD to ensure that;

- An operations and maintenance (O&M) guideline for the wastewater scheme, treatment plant(s) and pumps (if required) are established.
- An O&M agreement with a party (generally vendor driven) qualified to provide this service is established. Where individual WWTP's are installed on-lot, property owners will be required to install the systems at time of build and to have a maintenance agreement with the supplier to ensure proper operation is sustained. This should be facilitated and monitored by Rocky Point Services LTD.
- An appropriate treated wastewater quality monitoring regime is established.
- Emergency/contingency plans should be established to address quality issues.
- Easy access to key infrastructure for O&M (considering the site location and terrain) is provided.

6 Conclusions and Recommendations

6.1 Water Supply

The developer has a responsibility to provide an adequate supply of safe drinking water and firefighting water, as discussed in Section 4.2. The main objective of the water supply system should be to achieve these obligations, whilst minimising environmental effects and increasing sustainability. The options assessment within this report identified that this can be achieved through the implementation of the preferred Option A (Section 4.5.1).

The establishment of a service agency (Rocky Point Services LTD) will be key to ensuring an adequate maintenance regime is established to sustain safe drinking water and an acceptable level of service for domestic water consumption and firefighting (including the provision and maintenance of wildfire sprinklers).

A centralised water treatment plant offers versatility of treatment to cope with any raw water quality. However, in the event that reticulated treated water is not turned over readily (initial stages of development, holiday homes etc.) there is a risk of water stagnation and re-contamination of the reticulation.

Conversely, point of entry (POE) units offer a number of benefits, financially and in terms of reducing risk of recontamination (other than power failure). This is the preferred option over a centralised treatment system. Should further water quality testing indicate any contaminants which are unable to be removed by point of entry units, then a pre-treatment system may be required in conjunction with individual POE units.

A conceptual storage and reticulation design for domestic and firewater has been provided. The location of the storage devices can be strategically located to provide adequate pressure via gravity. This is more economical, ecologically friendly, and resilient than providing a boosted system.

It is recommended to:

- Use Option A as the basis for detailed design and further community engagement, as per Section 4.5.1.
- Complete a definitive assessment requirements and locations, based on topography, geotechnical input and costs (Capex and Opex) to optimise storage size/location.
- Investigate the use of water conservation strategies by rainwater harvesting and storage for localised irrigation and emergency use (e.g. 2,000L 'slimline' tanks).
- A suitably qualified fire engineer should be engaged to confirm the firefighting strategy for the development as per Section 4.3. FENZ shall also be consulted for approval.
- Develop an operation and maintenance agreement as per Section 4.7.

6.2 Wastewater

The chosen wastewater treatment and disposal system must safely treat and dispose of effluent whilst minimising detrimental environmental effects. The options assessment within this report identified that this can be achieved through the implementation of Option A (Section 5.2.1).

The site presents difficult terrain for effluent disposal and reticulation, with steep grades, high ecological value and shallow rock. The implementation of on-site treatment and disposal (where possible) utilises space on larger lots and decreases the size of the required reticulation system (maximising the protection of high ecological areas). The use of secondary treatment systems reduces the risk of groundwater or surface water contamination.

Where pumped reticulation if required, it is recommended that this is achieved through a low-pressure sewer system. These systems utilise shallow, small bore rising mains which reduce the width/depth of required excavation and allow effluent to be conveyed over the difficult topography, whilst minimising inflow and infiltration and hence effluent flows.

The establishment of a service agency (Rocky Point Services LTD) will be key to ensuring an adequate maintenance and monitoring regime is established for sustaining good performance of the treatment and reticulation systems with high quality effluent being discharged from all treatment systems for ground disposal.

It is recommended to:

- Use Option A as the basis for detailed design and further community engagement, as per Section 5.2.1.
    - Lots 1 – 3 and 19 – 30 utilising individual on-site treatment and disposal systems.
    - Lots 4 – 18 reticulated to communal treatment plant using low-pressure grinder pumps and small bore rising mains.

- Communal treatment plant (with flow and quality monitoring) designed to accommodate an average daily flow of approximately 11,000 L/day, with a primary disposal area of approximately 1100m² and additional reserve area of 550m².

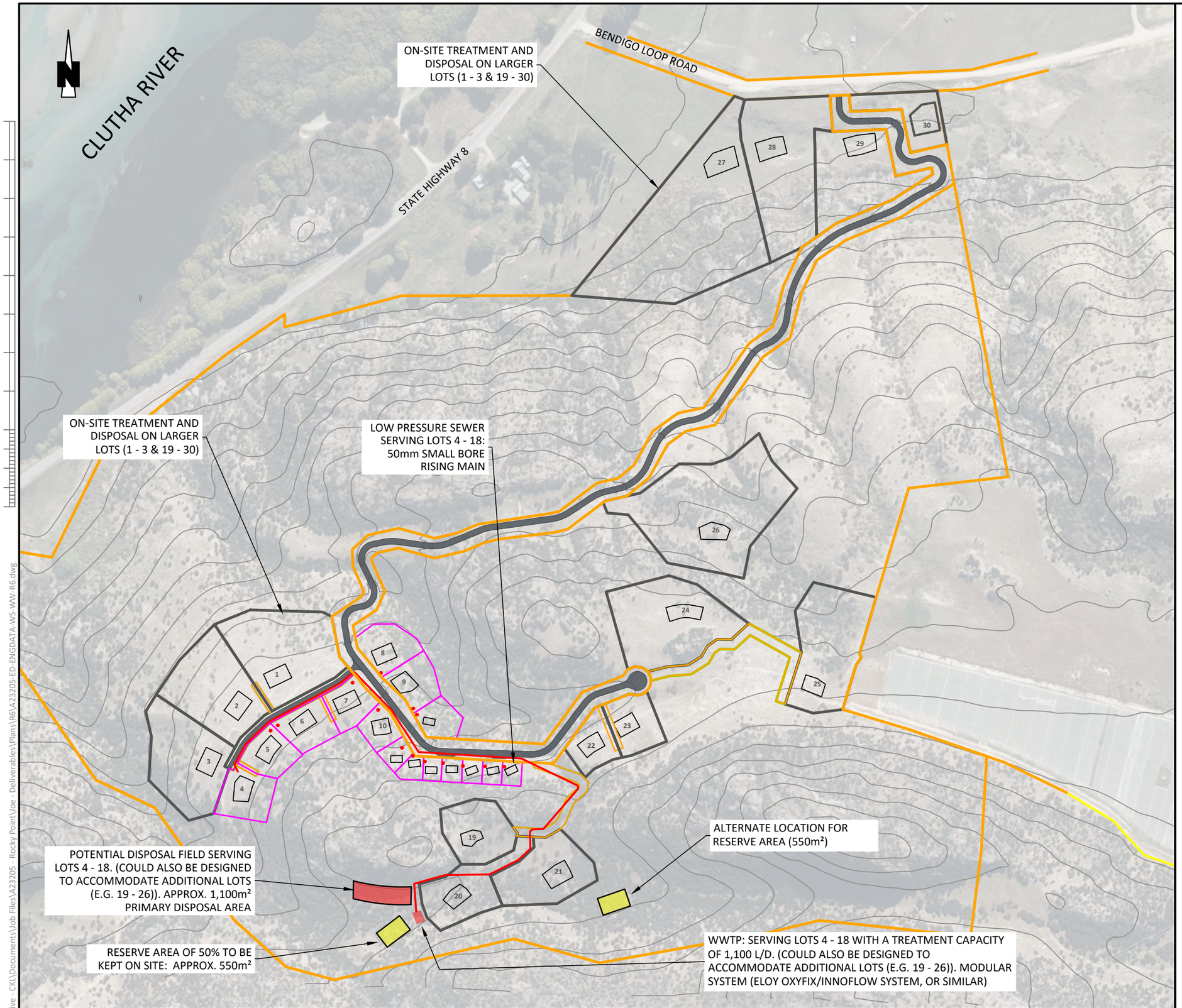
- Complete a definitive assessment of costs (Capex and Opex) at detail design stage to optimise conveyance, treatment and disposal.
- Develop an operation and maintenance agreement as per Section 5.4, clearly outlining monitoring, sampling and reporting obligations and requirements for the Rocky Point Services LTD.

7 Limitations

This report has been prepared solely for the benefit of our client with respect to the particular brief and it may not be relied upon in other contexts for any other purpose without the express approval by CKL. Neither CKL nor any employee or sub-consultant accepts any responsibility with respect to its use, either in full or in part, by any other person or entity. This disclaimer shall apply notwithstanding that the memo/report may be made available to other persons including Council for an application for consent, approval or to fulfil a legal requirement.

Appendix 1 Drawings

- Sheet 5001: Indicative Wastewater Plan (Option A)
- Sheet 6001: Indicative Water Supply Plan (Option A)
- Sheet 6002: Indicative Water Supply Plan (Option A)
- Sheet 6003: Indicative Water Supply Plan (Option A)
- Sheet 6004: Indicative Water Supply Plan (Option A)



LEGEND

- LOW PRESSURE GRINDER PUMP STATION
- LOTS SUITABLE FOR ON-SITE TREATMENT AND DISPOSAL
- LOTS DEEMED UNSUITABLE FOR ON-SITE TREATMENT AND DISPOSAL

NOTES

1) RETICULATION INSTALLATION METHOD SHALL BE DETERMINED BY LOCATION SPECIFIC GEOLOGICAL CONDITIONS. THE NEXT DESIGN STAGE WILL PROVIDE MORE CLARITY ON INFRASTRUCTURE DESIGN, CONSTRUCTION METHODOLOGY AND MATERIAL USE.
2) PUMPING IS REQUIRED TO REACH THE DISPOSAL AREA TO THE WEST OF LOT 20. THIS CAN BE ACHIEVED BY A SINGLE CENTRALIZED GRINDER PUMP STATION OR INDIVIDUAL GRINDER PUMPS ON EACH LOT. TBC AT DETAILED DESIGN.
3) REFER TO WS/WW REPORT FOR MORE DETAILS.
4) LOCATION AND SCALE OF DEVICES INDICATIVE ONLY (SUBJECT TO DETAILED DESIGN)
5) SITE SPECIFIC INVESTIGATION WILL BE CARRIED OUT TO DETERMINE ON-SITE TREATMENT AND DISPOSAL METHODS
6) INDICATIVE STRUCTURES SHOWN WITHIN LOTS. TBC AT DETAILED DESIGN STAGE

FOR RESOURCE CONSENT

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ROCKY POINT
TKO Properties LTD
Lakefront Terrace, Bendigo

INDICATIVE WASTEWATER PLAN
1 OF 5
OPTION A

Issue	Description	Checked	Date
01	INDICATIVE WW PLAN	JS	8/3/2024
03	INDICATIVE WW PLAN (OPTION 2)	JS	21/03/24
03	INDICATIVE WW PLAN (OPTION A)	JS	9/7/2024
04	UPDATED SCHEME PLAN	JS	12/07/24
05	UPDATED REV NUMBER	JS	22/07/24
06	UPDATED BDYS, WWTP AND EDF	JS	25/10/24

		Date
Designed:	JA	5/07/24
Drawn:	JA	5/07/24
Checked:	JS	6/07/24

Scale: 1:4000 (A3 Original)

Job No: A23205 | Dwg No: 5001 | Rev: 06

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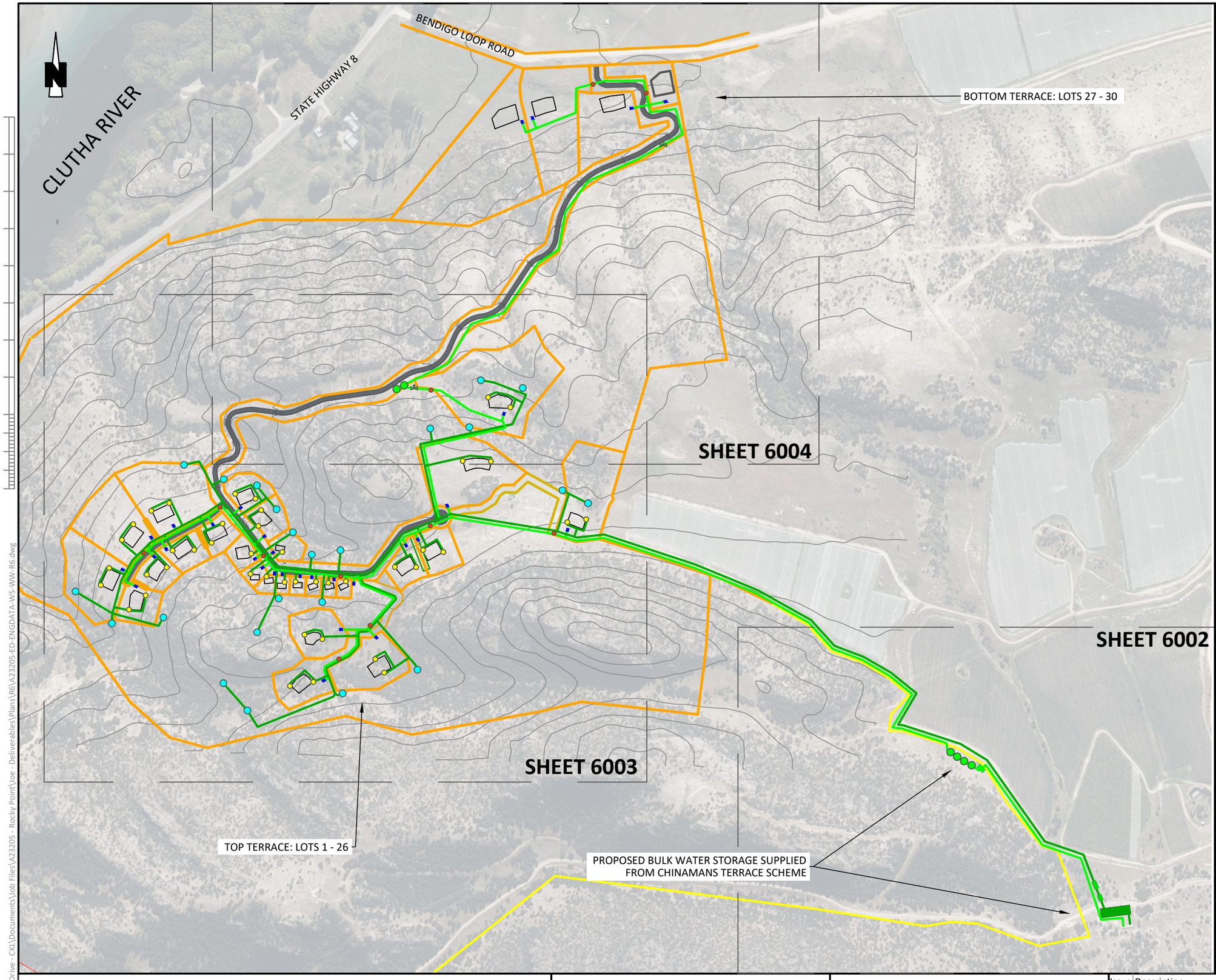

LEGEND

- RETICULATION SYSTEM 1 (DOMESTIC + HYDRANTS)
- RETICULATION SYSTEM 2 (WILDFIRE SPRINKLERS)
- FIRE HYDRANT
- ON-SITE TREATMENT (FILTER/UV, METERING OPTIONAL)
- WATER TANKS
- VEGETATION SPRINKLER
- EMBER SUPPRESSION SPRINKLER
- CONTROL VALVES (PRV = PRESSURE RELIEF, CV = CONTROL)
- PF PARTICULATE FILTER
- WM BULK WATER METER

NOTES

1) RETICULATION INSTALLATION METHOD SHALL BE DETERMINED BY LOCATION SPECIFIC GEOLOGICAL CONDITIONS.
2) REFER TO WS/WW REPORT FOR MORE DETAILS.
3) LOCATION OF DEVICES INDICATIVE ONLY (SUBJECT TO DETAILED DESIGN AND REVIEW FROM FENZ/WILDFIRE ENGINEER)
4) HYDRANTS TO BE INSTALLED AS PER SNZ PAS 4509:2008
5) PRESSURE REDUCTION SHALL BE INSTALLED WHERE NECESSARY, TBC AT DETAILED DESIGN STAGE.
6) INDICATIVE STRUCTURES SHOWN WITHIN LOTS. TBC AT DETAILED DESIGN STAGE
7) IF IRRIGATION IS REQUIRED TO SUPPORT VEGETATION GROWTH THE STORAGE SYSTEM CAN BE EXPANDED TO CATER FOR THIS DEMAND. IF REQUIRED: DRIPPER LINES ARE RECOMMENDED. WATER FEED WILL BE CONTROLLED USING PRESSURE REGULATION AND TIMERS SET TO IRRIGATE AT NIGHT, OFF-PEAK.
8) OPERATING AND CONTROL SYSTEM FOR WILDFIRE SPRINKLERS TBC AT DETAILED DESIGN STAGE. (E.G. FLAME RECOGNITION SENSOR WITH CONTROL VALVES FOR SPRINKLERS).

FOR RESOURCE CONSENT

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INDICATIVE WATER SUPPLY
2 OF 5
(OPTION A: WHOLE SITE)

Issue	Description	Checked	Date
01	INDICATIVE WS PLAN (OPTION A)	JS	8/03/24
02	INDICATIVE WS PLAN (OPTION A)	JS	21/03/24
03	INDICATIVE WS PLAN (WHOLE SITE)	JS	9/07/2024
04	UPDATED SCHEME PLAN	JS	12/07/2024
05	UPDATED REV NUMBER	JS	22/07/24
06	UPDATED BDYS, NOTES	JS	25/10/24

		Date
Designed:	JA	22/2/24
Drawn:	JA	28/2/24
Checked:	KG	29/02/24

Scale: 1:5000 (A3 Original)

Job No: A23205 | Dwg No: 6001 | Rev: 06

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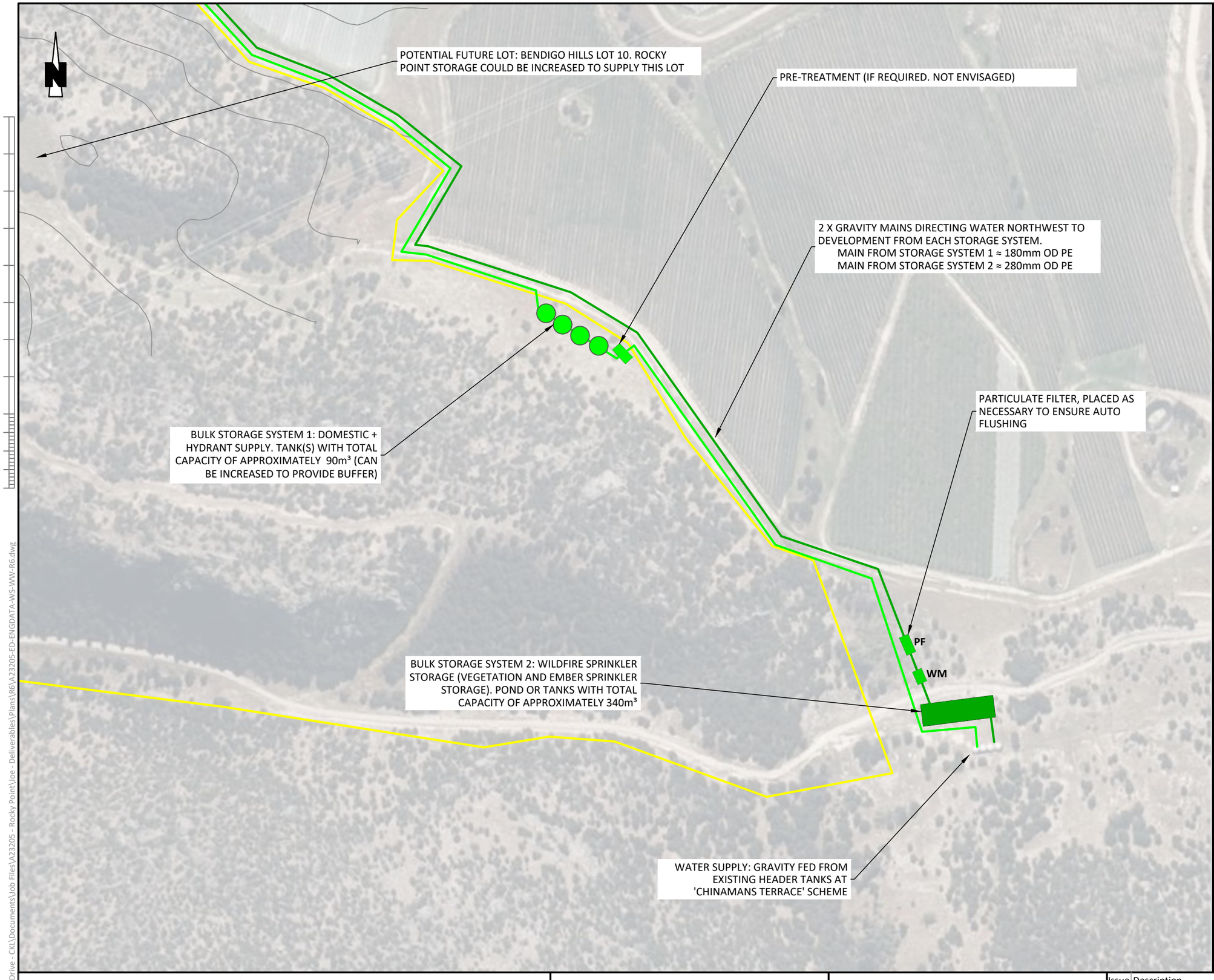

LEGEND

- RETICULATION SYSTEM 1 (DOMESTIC + HYDRANTS)
- RETICULATION SYSTEM 2 (WILDFIRE SPRINKLERS)
- FIRE HYDRANT
- ON-SITE TREATMENT (FILTER/UV, METERING OPTIONAL)
- WATER TANKS
- VEGETATION SPRINKLER
- EMBER SUPPRESSION SPRINKLER
- CONTROL VALVES (PRV = PRESSURE RELIEF, CV = CONTROL)
- PF PARTICULATE FILTER
- WM BULK WATER METER

NOTES

1) RETICULATION INSTALLATION METHOD SHALL BE DETERMINED BY LOCATION SPECIFIC GEOLOGICAL CONDITIONS.
2) REFER TO WS/WW REPORT FOR MORE DETAILS.
3) LOCATION OF DEVICES INDICATIVE ONLY (SUBJECT TO DETAILED DESIGN AND REVIEW FROM FENZ/WILDFIRE ENGINEER)
4) HYDRANTS TO BE INSTALLED AS PER SNZ PAS 4509:2008
5) PRESSURE REDUCTION SHALL BE INSTALLED WHERE NECESSARY, TBC AT DETAILED DESIGN STAGE.
6) INDICATIVE STRUCTURES SHOWN WITHIN LOTS. TBC AT DETAILED DESIGN STAGE
7) IF IRRIGATION IS REQUIRED TO SUPPORT VEGETATION GROWTH THE STORAGE SYSTEM CAN BE EXPANDED TO CATER FOR THIS DEMAND. IF REQUIRED: DRIPPER LINES ARE RECOMMENDED. WATER FEED WILL BE CONTROLLED USING PRESSURE REGULATION AND TIMERS SET TO IRRIGATE AT NIGHT, OFF-PEAK.
8) OPERATING AND CONTROL SYSTEM FOR WILDFIRE SPRINKLERS TBC AT DETAILED DESIGN STAGE. (E.G. FLAME RECOGNITION SENSOR WITH CONTROL VALVES FOR SPRINKLERS).

FOR RESOURCE CONSENT

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INDICATIVE WATER SUPPLY
3 OF 5
(OPTION A: STORAGE)

Issue	Description	Checked	Date
01	INDICATIVE WS PLAN (OPTION A)	JS	8/03/24
02	INDICATIVE WS PLAN (OPTION A)	JS	21/03/24
03	INDICATIVE WS PLAN (STORAGE)	JS	9/07/2024
04	UPDATED SCHEME PLAN	JS	12/07/2024
05	UPDATED REV NUMBER	JS	22/07/24
06	UPDATED BDYS, NOTES	JS	25/10/24

		Date
Designed:	JA	22/2/24
Drawn:	JA	28/2/24
Checked:	KG	29/02/24

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Job No: A23205 | Dwg No: 6002 | Rev: 06

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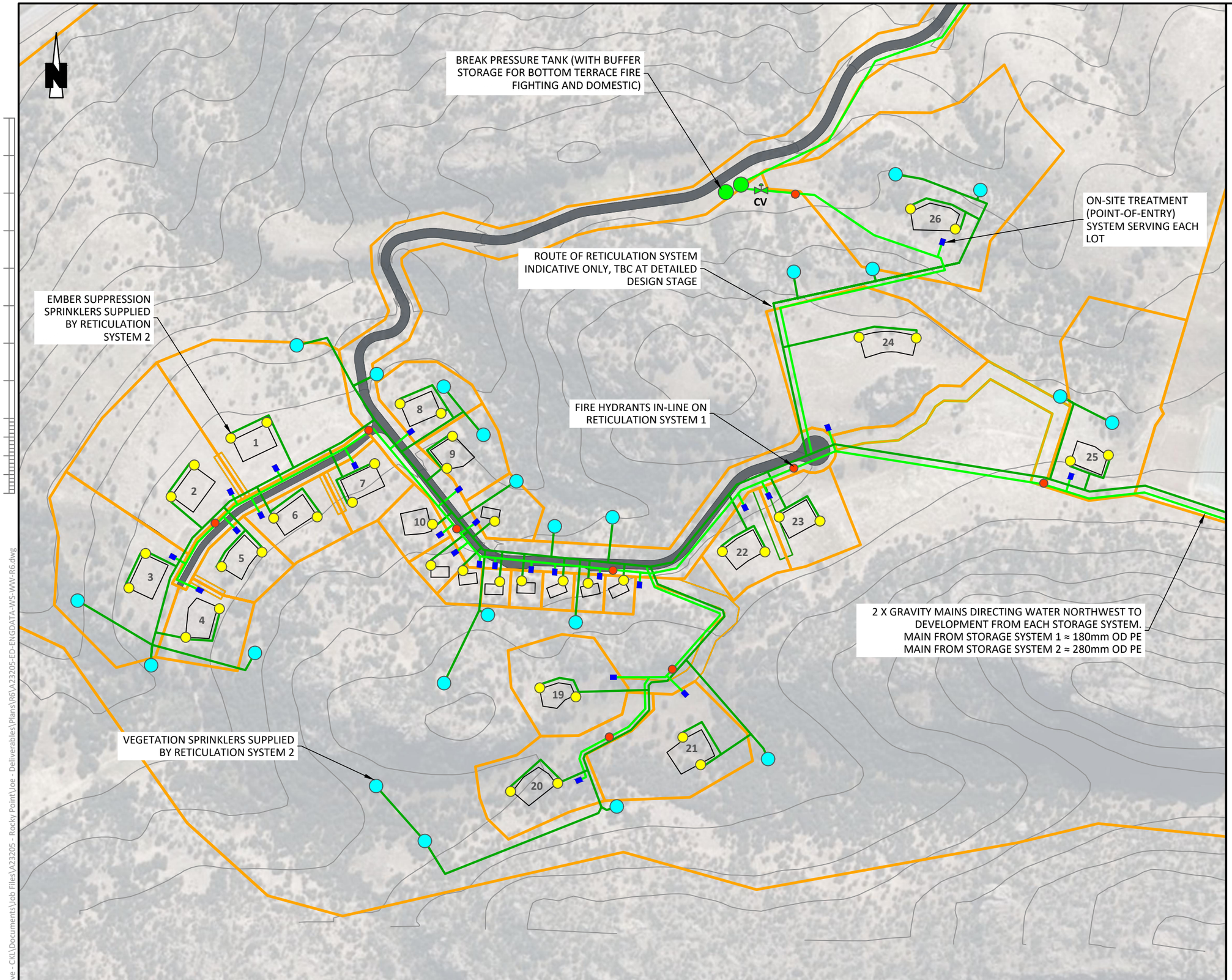

LEGEND

- RETICULATION SYSTEM 1 (DOMESTIC + HYDRANTS)
- RETICULATION SYSTEM 2 (WILDFIRE SPRINKLERS)
- FIRE HYDRANT
- ON-SITE TREATMENT (FILTER/UV, METERING OPTIONAL)
- WATER TANKS
- VEGETATION SPRINKLER
- EMBER SUPPRESSION SPRINKLER
- CONTROL VALVES (PRV = PRESSURE RELIEF, CV = CONTROL)
- PF — PARTICULATE FILTER
- WM — BULK WATER METER

NOTES

1) RETICULATION INSTALLATION METHOD SHALL BE DETERMINED BY LOCATION SPECIFIC GEOLOGICAL CONDITIONS.
2) REFER TO WS/WW REPORT FOR MORE DETAILS.
3) LOCATION OF DEVICES INDICATIVE ONLY (SUBJECT TO DETAILED DESIGN AND REVIEW FROM FENZ/WILDFIRE ENGINEER)
4) HYDRANTS TO BE INSTALLED AS PER SNZ PAS 4509:2008
5) PRESSURE REDUCTION SHALL BE INSTALLED WHERE NECESSARY, TBC AT DETAILED DESIGN STAGE.
6) INDICATIVE STRUCTURES SHOWN WITHIN LOTS. TBC AT DETAILED DESIGN STAGE
7) IF IRRIGATION IS REQUIRED TO SUPPORT VEGETATION GROWTH THE STORAGE SYSTEM CAN BE EXPANDED TO CATER FOR THIS DEMAND. IF REQUIRED: DRIPPER LINES ARE RECOMMENDED. WATER FEED WILL BE CONTROLLED USING PRESSURE REGULATION AND TIMERS SET TO IRRIGATE AT NIGHT, OFF-PEAK.
8) OPERATING AND CONTROL SYSTEM FOR WILDFIRE SPRINKLERS TBC AT DETAILED DESIGN STAGE. (E.G. FLAME RECOGNITION SENSOR WITH CONTROL VALVES FOR SPRINKLERS).

FOR RESOURCE CONSENT

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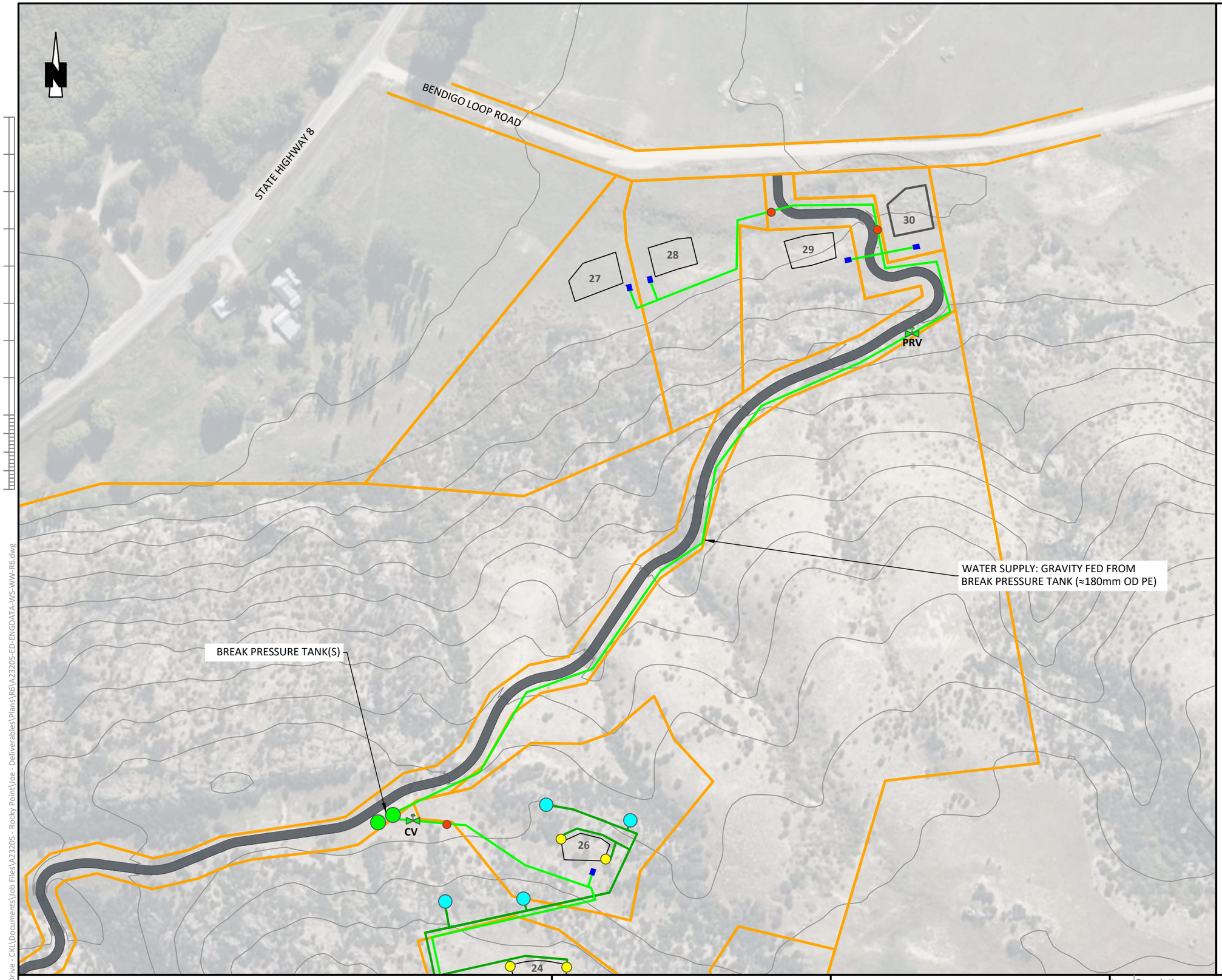
INDICATIVE WATER SUPPLY
4 OF 5
(OPTION A: TOP TERRACE)

Issue	Description	Checked	Date
01	INDICATIVE WS PLAN (OPTION A)	JS	8/03/24
02	INDICATIVE WS PLAN (OPTION A)	JS	21/03/24
03	INDICATIVE WS PLAN (TQP)	JS	8/07/2024
04	UPDATED SCHEME PLAN	JS	12/07/24
05	UPDATED REV NUMBER	JS	22/07/24
06	UPDATED BDYS, NOTES	JS	25/10/24

		Date
Designed:	JA	22/2/24
Drawn:	JA	28/2/24
Checked:	KG	29/02/24

Scale: 1:2500 (A3 Original)

Job No: A23205 | Dwg No: 6003 | Rev: 06



LEGEND

- RETICULATION SYSTEM 1 (DOMESTIC + HYDRANTS)
- RETICULATION SYSTEM 2 (WILDFIRE SPRINKLERS)
- FIRE HYDRANT
- ON-SITE TREATMENT (FILTER/UV, METERING OPTIONAL)
- WATER TANKS
- VEGETATION SPRINKLER
- EMBER SUPPRESSION SPRINKLER
- CONTROL VALVES (PRV = PRESSURE RELIEF, CV = CONTROL)
- PF — PARTICULATE FILTER
- WM — BULK WATER METER

NOTES

1) RETICULATION INSTALLATION METHOD SHALL BE DETERMINED BY LOCATION SPECIFIC GEOLOGICAL CONDITIONS.
2) REFER TO WS/WW REPORT FOR MORE DETAILS.
3) LOCATION OF DEVICES INDICATIVE ONLY (SUBJECT TO DETAILED DESIGN AND REVIEW FROM FENZ/WILDFIRE ENGINEER)
4) HYDRANTS TO BE INSTALLED AS PER SNZ PAS 4509:2008
5) PRESSURE REDUCTION SHALL BE INSTALLED WHERE NECESSARY, TBC AT DETAILED DESIGN STAGE.
6) INDICATIVE STRUCTURES SHOWN WITHIN LOTS. TBC AT DETAILED DESIGN STAGE
7) IF IRRIGATION IS REQUIRED TO SUPPORT VEGETATION GROWTH THE STORAGE SYSTEM CAN BE EXPANDED TO CATER FOR THIS DEMAND. IF REQUIRED: DRIPPER LINES ARE RECOMMENDED. WATER FEED WILL BE CONTROLLED USING PRESSURE REGULATION AND TIMERS SET TO IRRIGATE AT NIGHT, OFF-PEAK.
8) OPERATING AND CONTROL SYSTEM FOR WILDFIRE SPRINKLERS TBC AT DETAILED DESIGN STAGE. (E.G. FLAME RECOGNITION SENSOR WITH CONTROL VALVES FOR SPRINKLERS).

FOR RESOURCE CONSENT

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INDICATIVE WATER SUPPLY
5 OF 5
(OPTION A: BOTTOM TERRACE)

Issue	Description	Checked	Date
01	INDICATIVE WS PLAN (OPTION A)	JS	8/03/24
02	INDICATIVE WS PLAN (OPTION A)	JS	21/03/24
03	INDICATIVE WS PLAN (BOTTOM)	JS	8/07/2024
04	UPDATED SCHEME PLAN	JS	12/07/24
05	UPDATED REV NUMBER	JS	22/07/24
06	UPDATED BDYS, NOTES	JS	25/10/24

		Date
Designed:	JA	22/2/24
Drawn:	JA	28/2/24
Checked:	KG	29/02/24

Scale: 1:4000 (A3 Original)

Job No: A23205 | Dwg No: 6004 | Rev: 06

Appendix 2 Water Quality Testing Results

Analytica Laboratories Limited
Ruakura Research Centre
10 Bisley Road
Hamilton
sales@analytica.co.nz
www.analytica.co.nz

Certificate of Analysis

Courtney Browne
17 Kinross Street
Christchurch
Attention: C Hughes, Wanaka
Phone: 027 2220252
Email: okb4u8@gmail.com

Lab Reference: 24-16748
Submitted by: Matt Suddaby
Date Received: 24/05/2024
Testing Initiated: 24/05/2024
Date Completed: 31/05/2024
Order Number: 6347
Reference:

Sampling Site: Rocky Point, Bendigo (AKA Chinamas Tce)

Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories (or at the subcontracted laboratories, when applicable). Samples were in acceptable condition unless otherwise noted on this report.

LOR = Limit of Reporting.

MAV = Maximum acceptable value for compliance per *Water Services (Drinking Water Standards for New Zealand) Regulations 2022*.
Where N/A, a MAV is not outlined in the Drinking Water Standards for New Zealand document.

Please note: temperature on arrival of samples exceeded the recommended 10°C holding temperature.

Domestic Drinking Water Profile (Aggregates/Nutrients)

			Client Sample ID	Rocky Point, Bendigo
			Date Sampled	23/05/2024
Analyte	Unit	LOR	MAV	24-16748-1
Total Dissolved Solids	g/m^3	3	N/A	100
Total Dissolved Salts*	g/m^3	2	N/A	109
pH	pH	1	N/A	7.5
Turbidity	NTU	0.05	N/A	0.7
Electrical Conductivity	µS/cm	0.2	N/A	163
Total Alkalinity (CaCO3)	g $CaCO_3/m^3$	1	N/A	60.8
Total Hardness	g eqv. $CaCO_3/m^3$	0.05	N/A	63
Nitrate-N	g/m^3	0.002	11.3	0.830
Chloride	g/m^3	0.5	N/A	3.87
Sulfate	g/m^3	0.15	N/A	5.84

Domestic Drinking Water Profile (Elemental Analysis)

			Client Sample ID	Rocky Point, Bendigo
			Date Sampled	23/05/2024
Analyte	Unit	LOR	MAV	24-16748-1
Calcium	g/m^3	0.05	N/A	18.1
Magnesium	g/m^3	0.01	N/A	4.34
Potassium	g/m^3	0.05	N/A	1.2

Domestic Drinking Water Profile (Elemental Analysis)

			Client Sample ID	Rocky Point, Bendigo
			Date Sampled	23/05/2024
Sodium	g/m³	0.01	N/A	9.10
Arsenic	g/m³	0.0005	0.01	<0.00050
Lead	g/m³	0.00005	0.01	0.00045
Boron	g/m³	0.005	2.4	0.021
Iron	g/m³	0.005	N/A	0.072
Manganese	g/m³	0.0005	0.4	0.0023
Copper	g/m³	0.0002	2	0.0089
Zinc	g/m³	0.003	N/A	0.046

Domestic Drinking Water Profile (Microbiology)

			Client Sample ID	Rocky Point, Bendigo
			Date Sampled	23/05/2024
Analyte	Unit	LOR	MAV	24-16748-1
Enumerated E.coli	MPN/100mL	1	1	<1
Total Coliforms Enumerated	MPN/100mL	1	N/A	<1

Temperature on Arrival

			Client Sample ID	Rocky Point, Bendigo
			Date Sampled	23/05/2024
Analyte	Unit	LOR	MAV	24-16748-1
Temp on Arrival*	°C	0	N/A	15.9

Method Summary

Total Dissolved Solids	Filtration folllowed by complete drying at 180°C. (APHA 2540 C - Online edition).
Calculated TDS	Samples analysed as received using a conventional conductivity electrode. (APHA 2510 B - Modified - Auto-titrator - Online edition).EC value multiplied by constant of 0.67 to determine TDS (g/m^3).
pH	Samples measured as received using a conventional pH electrode. (APHA 4500 H^+ B. Online edition).
Turbidity	Samples analysed as received using a conventional turbidimeter. (APHA 2130 B Online edition - Modified).
Electrical Conductivity	Samples analysed as received using a conventional conductivity electrode. (APHA 2510 B - Modified - Auto-titrator - Online edition).
Total Alkalinity ($CaCO_3$)	Samples analysed as received by potentiometric titration. (APHA 2320 B Online edition).
Total Hardness	Result calculated from Total Magnesium and Calcium. (APHA 2340B - Online edition)
NO3-N	Calculated from oxidised nitrogen and Nitrite-N, measured colourimetrically by flow injection analysis. (APHA NO_3- I. Online edition)
Chloride	Analysis by Ion exchange chromatography following sample filtration. (APHA 4110 B - Online edition).
Sulfate	Analysis by Ion exchange chromatography following sample filtration. (APHA 4110B - Online edition).
Recoverable Trace Elements	Samples were analysed as received by the laboratory using ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8.
Enumerated E.coli	Samples analysed by Enzyme substrate E. coli test using Colilert-18 in 51 wells. Incubated at 35°C for 18 hours. APHA 9223 B Online Edition.

Method Summary

Total Coliform Enumerated	Samples analysed by Enzyme substrate coliform test using Colilert 18 in 97 wells. Incubated at 35°C for 18 hours. APHA 9223 B Online Edition.
Temp on Arrival	Measured on arrival by a digital infra-red laser thermometer.

Sandra Mathews, B.Eng.
Technologist

Alesha Avery, BSc(Tech),
Laboratory Technician

Bhumika Patel
Sample Reception Technician

Aesthetic Values for Drinking Water Notice 2022

Analyte	MAV	Guideline Value	Unit	Comment
Aluminium	1	< 0.1	mg/L	Above this value, complaints of depositions or discoloration may arise
Ammonia	N/A	< 1.5	mg/L	Odour threshold (alkaline conditions)
Calcium	N/A	N/A	N/A	See 'Hardness'
Chlorine (contingent on the supply being chlorinated)	5	0.3 - 1.0	mg/L as Cl_2	Free available chlorine Taste and odour threshold (pH dependant) Disinfection must not be compromised in trying to avoid taste and odour complaints
2-Chlorophenol	N/A	< 0.0001	mg/L	Taste threshold
		< 0.01		Odour threshold
Colour	N/A	< 15	TCU	Appearance
Copper	2	< 1	mg/L	Staining of laundry and sanitary ware
1,2-Dichlorobenzene	1.5	< 0.0003	mg/L	Odour threshold
		< 0.006		Taste threshold
2,4-Dichlorophenol	N/A	< 0.0003	mg/L	Taste threshold
		< 0.04		Odour threshold
Ethylbenzene	0.3	< 0.002	mg/L	Odour threshold
		< 0.08		Taste threshold
Hardness (total) (Ca + Mg) as CaCO3	N/A	< 200	mg/L	Scale deposition, scum formation (pH and alkalinity dependent) Low hardness (<100) may be more corrosive
		100–300		Taste threshold (Ca; counter ion dependent)
Hydrogen sulphide	N/A	< 0.05	mg/L	Taste and odour threshold
Iron	N/A	< 0.3	mg/L	Staining of laundry and sanitary ware
Magnesium	N/A	N/A	N/A	See 'Hardness'
Manganese	0.4	< 0.04	mg/L	Staining of laundry
		< 0.10		Taste threshold
Monochlorobenzene	N/A	< 0.01	mg/L	Taste and odour threshold
pH	N/A	7.0–8.5		Ideally 7.4 – 8.0. Most water with a low pH has a high plumbosolvency. Water with a high pH has a soapy taste and feel. A pH less than 8 is preferable for effective disinfection with chlorine
Sodium	N/A	< 200	mg/L	Taste threshold (counter ion dependent)
Styrene	0.03	< 0.004	mg/L	Odour threshold
Sulphate	N/A	< 250	mg/L	Taste threshold
Taste and odour	Acceptable to most consumers	Acceptable to most consumers		
Temperature	< 15°C	< 15°C		
Toluene	0.8	< 0.03	mg/L	Odour threshold
		< 0.04		Taste threshold
Total dissolved solids	N/A	< 1000	mg/L	Taste may become unacceptable from 600–1200 mg/L
Trichlorobenzenes (total)	See below	See below		
1,2,3-Trichlorobenzene	N/A	< 0.01	mg/L	Odour threshold
1,2,4-Trichlorobenzene	N/A	< 0.005	mg/L	Odour threshold
1,3,5-Trichlorobenzene	N/A	< 0.05	mg/L	Odour threshold
2,4,6-Trichlorophenol	0.2	< 0.002	mg/L	Taste threshold
		< 0.3	mg/L	Odour threshold
Turbidity	N/A	< 5	NTU	Appearance
Xylene	0.6	< 0.02	mg/L	Odour threshold
Zinc	N/A	< 1.5	mg/L	Taste threshold

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Certificate of Analysis

Courtney Browne
3 Mamaku Lane
Christchurch 8022
Attention: Coterra, Wanaka
Phone: 03 942 7946
Email: okb4u8@gmail.com

Lab Reference: 24-20408
Submitted by: Matt Suddaby/ Jack Lister
Date Received: 27/06/2024
Testing Initiated: 2/07/2024
Date Completed: 2/07/2024
Order Number:
Reference:

Sampling Site: Rocky Point

Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories (or at the subcontracted laboratories, when applicable). Samples were in acceptable condition unless otherwise noted on this report.

LOR = Limit of Reporting.

MAV = Maximum acceptable value for compliance per *Water Services (Drinking Water Standards for New Zealand) Regulations 2022*.
Where N/A, a MAV is not outlined in the Drinking Water Standards for New Zealand document.

Total Silica in Water

			Client Sample ID	Rocky Point
			Date Sampled	25/06/2024
Analyte	Unit	*LOR*	*MAV*	24-20408-1
Total Silica*	g/m^3	*0.1*	*N/A*	5.65

Method Summary

Total Silica Samples were analysed as received by the laboratory using ICP-MS. (US EPA method 200.8 - Modified - Unfiltered aliquot).

Thara Samarasinghe, B.Sc.
Technician

Aesthetic Values for Drinking Water Notice 2022

Analyte	MAV	Guideline Value	Unit	Comment
Aluminium	1	< 0.1	mg/L	Above this value, complaints of depositions or discoloration may arise
Ammonia	N/A	< 1.5	mg/L	Odour threshold (alkaline conditions)
Calcium	N/A	N/A	N/A	See 'Hardness'
Chlorine (contingent on the supply being chlorinated)	5	0.3 - 1.0	mg/L as Cl_2	Free available chlorine Taste and odour threshold (pH dependant) Disinfection must not be compromised in trying to avoid taste and odour complaints
2-Chlorophenol	N/A	< 0.0001	mg/L	Taste threshold
		< 0.01		Odour threshold
Colour	N/A	< 15	TCU	Appearance
Copper	2	< 1	mg/L	Staining of laundry and sanitary ware
1,2-Dichlorobenzene	1.5	< 0.0003	mg/L	Odour threshold
		< 0.006		Taste threshold
2,4-Dichlorophenol	N/A	< 0.0003	mg/L	Taste threshold
		< 0.04		Odour threshold
Ethylbenzene	0.3	< 0.002	mg/L	Odour threshold
		< 0.08		Taste threshold
Hardness (total) (Ca + Mg) as CaCO3	N/A	< 200	mg/L	Scale deposition, scum formation (pH and alkalinity dependent) Low hardness (<100) may be more corrosive
		100–300		Taste threshold (Ca; counter ion dependent)
Hydrogen sulphide	N/A	< 0.05	mg/L	Taste and odour threshold
Iron	N/A	< 0.3	mg/L	Staining of laundry and sanitary ware
Magnesium	N/A	N/A	N/A	See 'Hardness'
Manganese	0.4	< 0.04	mg/L	Staining of laundry
		< 0.10		Taste threshold
Monochlorobenzene	N/A	< 0.01	mg/L	Taste and odour threshold
pH	N/A	7.0–8.5		Ideally 7.4 – 8.0. Most water with a low pH has a high plumbosolvency. Water with a high pH has a soapy taste and feel. A pH less than 8 is preferable for effective disinfection with chlorine
Sodium	N/A	< 200	mg/L	Taste threshold (counter ion dependent)
Styrene	0.03	< 0.004	mg/L	Odour threshold
Sulphate	N/A	< 250	mg/L	Taste threshold
Taste and odour	Acceptable to most consumers	Acceptable to most consumers		
Temperature	< 15°C	< 15°C		
Toluene	0.8	< 0.03	mg/L	Odour threshold
		< 0.04		Taste threshold
Total dissolved solids	N/A	< 1000	mg/L	Taste may become unacceptable from 600–1200 mg/L
Trichlorobenzenes (total)	See below	See below		
1,2,3-Trichlorobenzene	N/A	< 0.01	mg/L	Odour threshold
1,2,4-Trichlorobenzene	N/A	< 0.005	mg/L	Odour threshold
1,3,5-Trichlorobenzene	N/A	< 0.05	mg/L	Odour threshold
2,4,6-Trichlorophenol	0.2	< 0.002	mg/L	Taste threshold
		< 0.3	mg/L	Odour threshold
Turbidity	N/A	< 5	NTU	Appearance
Xylene	0.6	< 0.02	mg/L	Odour threshold
Zinc	N/A	< 1.5	mg/L	Taste threshold

Appendix 3 Taumata Arowai – Drinking Water Acceptable Solution for Mixed-Use Rural Water Supplies

The attached document specifies the pre-requisites, monitoring and quality assurance required for the water supply.

Drinking Water Acceptable Solution for Mixed-use Rural Water Supplies

October 2022

This Drinking Water Acceptable Solution for Mixed-use Rural Water Supplies is issued under section 50 of the Water Services Act 2021.

Contents

1. Introduction

1.1. Purpose

Drinking water Acceptable Solutions are regulatory instruments made under the Water Services Act 2021 (**the Act**).[1] They offer practical ways for drinking water suppliers to provide safe drinking water that are proportionate to the scale, complexity, and risk profile of the relevant type of supply.

A drinking water supplier that chooses to adopt and comply with an Acceptable Solution must, for the purposes of the Act, be treated as having complied with the legislative requirements to which the Acceptable Solution relates (other than the duties to provide safe drinking water that complies with Drinking Water Standards under sections 21 and 22).[2]

Drinking water suppliers who comply with the entirety of this Acceptable Solution will be deemed to comply with the requirements arising under the following sections of the Act:

- Duty to take all reasonably practicable steps to supply aesthetically acceptable drinking water (section 24).
- Duty to protect against risk of backflow (section 27).
- Duty to have a drinking water safety plan (section 30).
- Duty to prepare and implement a source water risk management plan (section 43(1)).
- Duty to comply with the Drinking Water Quality Assurance Rules (section 49(3)).

A drinking water supplier who complies with this Acceptable Solution does **not** need to prepare a drinking water safety plan (including a source water risk management plan) or provide a copy to Taumata Arowai.

Drinking water suppliers adopting this Acceptable Solution must also comply with their other obligations under the Act and any other relevant legislation.

[1] Section 50 of the Act provides that Taumata Arowai may, by notice, issue a drinking water Acceptable Solution for use in establishing compliance with the legislative requirements.

[2] Water Services Act, section 51(1).

1.2. Scope

The scope of this Acceptable Solution is limited to drinking water supplies that meet the criteria specified below.

1.2.1. Eligible drinking water supplies

a) An eligible drinking water supply is a mixed-use rural supply when the following criteria are met:
   i. A drinking water supplier (as defined in section 8 of **the Act**) provides water via a network to consumers' properties; and
   ii. Not less than 50% of water supplied is intended for agricultural or horticultural purposes, for example stock water and irrigation, and not more than 50% is used for domestic purposes, including drinking water.[3]

b) A mixed-use rural drinking water supplier must ensure all water intended for drinking, is treated by an end point treatment system[4]. The supplier is responsible for ensuring these treatment systems are installed, operated, and maintained according to this Acceptable Solution.

c) There is no upper or lower limit to the total population served by the mixed-use rural water supply. However, Section 1.2.2 applies a population limit per end-point treatment system.[5]

1.2.2. Building and base population limits for end-point treatment systems

a) Each end-point treatment system must only provide drinking water to three or fewer buildings within the boundaries of one property.

b) The base population for a single building served by an end-point treatment system must not exceed 500 people.

c) The base population for two or three buildings served by a single end-point treatment system must not exceed 100 people.
   i. Due to the lack of a chlorination requirement in this Acceptable Solution, the base population limit for multiple buildings supplied by an end-point treatment system via a limited pipe network, is more restrictive than for a single building.

1.2.3. Allowed exceedance of base population limits

a) The population supplied by each end point treatment system may exceed its base population limit:

---

[3] The water supplier is responsible for estimating this ratio of use over the course of a year, and this should be reassessed on an annual basis.

[4] Refer to section 28.

[5] For a mixed-use rural water supply where the base population is less than 25 people, the Drinking Water Quality Assurance Rules – Very Small Community module offers an alternative compliance pathway.

i. For a total of no more than 60 days in any 12-month period; and

ii. Is subject to the water supply having the capacity to supply treated water for these periods; and

iii. Is subject to additional monitoring requirements as stated in the table below.

	Number of buildings downstream of end point treatment system	
Criteria Description	One building	Two or three buildings
Base population limit	500 people	100 people
Monitoring and testing conditions when the population **exceeds** the base population limit	MR6 (see table in Section 4)	MR7 (see table in Section 4)

1.3. Commencement

The commencement date of this Acceptable Solution is 14 November 2022.

2. Mixed-use rural drinking water requirements

This Acceptable Solution may be adopted by a drinking water supplier where all the following requirements (except those specifically identified as recommendations) are met:

2.1. General use criteria

a) All end-point treatment systems are designed, configured, and installed according to this Acceptable Solution.

b) Water provided for flushing toilets and outdoor use may be untreated but must be marked as non-potable in accordance with the Building Code.[6]

c) Backflow prevention devices must be installed on all connections to the mixed-use rural water supply.

i. The location of the device must be after the point of supply and before any untreated storage tanks or the treatment system.

ii. The minimum requirement is for non-testable double check valves.

[6] Clause G12.3.4, Schedule 1 of the Building Regulations 1992.

iii. A testable backflow prevention device must be installed if there is a medium or high backflow risk. Testable backflow prevention devices must be inspected and tested annually.

d) If the source of the mixed-use rural water supply is a spring or bore, the spring or bore water and the system used to collect this water must comply with the following sections and requirements in the Drinking Water Acceptable Solution for Spring and Bore Drinking Water Supplies:
   i. Section 2.4. Bore and spring water collection system requirements.

2.2. Prerequisite monitoring requirements

a) Before this Acceptable Solution can be adopted, the drinking water supplier must test the source water for a range of parameters to ensure the safety of the water but also to determine the suitability for cartridge filtration and UV disinfection. Samples must be collected and analysed according to condition MR1 in Section 4.

b) The pre-requisite source water monitoring must meet the following requirements:
   i. Results from source water monitoring must not exceed the limits that manufacturers indicate for use of their equipment (including, but not limited to, the limits in the table below).
   ii. If a chemical determinand from source water monitoring exceeds a MAV or testing indicates that the source water is unsuitable for cartridge filtration and/or UV disinfection, the drinking water acceptable solution cannot be used without additional pre-treatment as discussed in Section 2.3.
   iii. Samples must represent a range of different environmental conditions such as heavy rainfall and dry periods to ensure that treatment is suitable when water quality is most likely to be at its worst.[7]
   iv. Source water testing must include at least three (3) samples for the parameters in the following table:

[7] The supplier is responsible for determining the range of environmental conditions during which samples are taken.

Parameter[8]	Limit
Iron	Must not be at a level which compromises the effectiveness of the UV disinfection unit based on the manufacturer's specifications/ guidelines.
Manganese	Must not be at a level which compromises the effectiveness of the UV disinfection unit based on the manufacturer's specifications/ guidelines. Must be below the MAV.
Nitrate, Arsenic, and Boron	Must be below the MAV.
Silica	Must be at a level which is suitable for cartridge filtration with or without additional pre-treatment and meet the manufacturer's specifications/guidelines.[9]
Hardness	Must not be at a level which compromises the effectiveness of the UV disinfection unit based on the manufacturer's specifications/guidelines.
UV transmittance	Must not be at a level which compromises the effectiveness of the UV disinfection unit based on the manufacturer's specifications/guidelines.
***E. coli* and total coliforms**	Presence of *E. coli* and total coliforms indicates that the source water has some microbiological contaminants in it which must be controlled by the treatment system.
Turbidity	Must be at a level that can be treated by cartridge filtration with or without additional pre-treatment to meet the specifications/guidelines of the UV disinfection unit's manufacturer.[10]

2.3. Pre-treatment requirements

a) A drinking water supplier may install pre-treatment (headworks, back-washable filters, aeration, etc) to make the source water suitable for cartridge filtration and UV disinfection, or to reduce a chemical determinand to below its respective MAV.

[8] Unless changes have occurred, which could reasonably be expected to have changed the source water quality, results from samples taken within the last 5 years may be used. Note: The supplier is still responsible for ensuring a range of environmental conditions are represented when samples were taken.

[9] High levels of silica can decrease the lifespan of cartridge filters.

[10] High turbidity can decrease the lifespan of cartridge filters.

b) If pre-treatment is installed, the water supplier is responsible for ensuring that water leaving the pre-treatment system(s) is suitable for the end-point treatment in Section 2.6.

2.4. Untreated water storage requirements

a) Inlets, overflows, and any other small gaps in tanks must be screened to be secure from contamination by vermin, birds, faecal material, or other material.

b) Lids on all storage tanks are secured to prevent contamination by vermin, birds, faecal material, or other material.

2.5. Untreated water storage recommendations

a) Where beneficial to reduce turbidity of raw water, a calmed bottom inlet and floating outtake are installed for untreated water storage tanks.

b) The quantity of untreated water storage is sufficient to support the ordinary drinking water needs of consumers served by the supply for an identified period of time. A minimum of 96 hours average demand of untreated storage is recommended.[11]

2.6. End-point treatment system requirements

a) Each component of the end-point treatment system must be installed:
   i. To meet the peak instantaneous demand for treated drinking water.
   ii. In accordance with the manufacturer's instructions and requirements.

b) The end-point treatment system and all associated pipework and associated fixtures must comply with the Building Act 2004 and the Building Code if relevant.

c) The design and construction of the water treatment system must prevent backflow, being the unplanned reversal of flow of water or mixtures of water and contaminants into the water supply system.

d) Each UV disinfection unit must be validated to at least one of the following standards:
   i. Ultraviolet Disinfection Guidance Manual (USEPA 2006b).
   ii. DVGW Technical Standard W294 (DVGW 2006).
   iii. öNORM M 5873-1: 2020 01 01.[12]
   iv. NSF/ANSI 55 Class A (NSF, ANSI n.d).

e) Where a UV disinfection unit has been installed before 17 October 2022 and written evidence is available from the manufacturer (e.g., manufacturer's website, instruction manual, etc) that the unit delivers a minimum UV reduction equivalent dose of 40mJ/cm^2 then the unit is not required to meet the UV validation requirements set out above at 2.6(d).

f) Each end-point treatment system must (as a minimum):

   i. Have two stage cartridge filtration with 20 micron and 5 micron or less, nominal pore sizes.

[11] This recommended minimum may not be appropriate for areas that are subject to droughts.

[12] UV reactors installed before 1 January 2020 can be certified to öNORM M5873 (Osterreichisches Normungsinstitut 2001).

ii. Have a UV disinfection unit that delivers a minimum reduction equivalent dose of 40 mJ/cm^2 as measured by a UVI or UV dose sensor.
iii. Monitor UV dose continuously and generate a local onsite alarm if the UV dose is below 40 mJ/cm^2 or outside the limits specified by the manufacturer.
iv. Have flow control to ensure water flow is within the specification of the UV unit and be designed to shutdown automatically on a low UVI or UV dose.
v. Have a lamp status indicator if a UV disinfection unit contains more than one lamp.
vi. If applicable, not allow flow of water during a UV disinfection unit's lamp warm-up period until the required UVI or UV dose is achieved (an automatic control valve or start/stop of the pump must be used to control flow during the warm-up period).
vii. Have an air release valve(s) to allow air to be removed from the system on start up.
viii. Have manual isolation valves fitted upstream and downstream of the treatment system to allow for maintenance.
ix. Be sized to ensure flow rates comply with clause G12.3.7(a) (Water supplies) of the Building Code and are adequate for the correct functioning of fixtures and appliances within the building.[13]

2.7. Alternative source for water supply

a) Treated water from a water carrier registered with Taumata Arowai can supplement the mixed-use rural water supply and can be delivered to a treated water storage tank (if there is one) or an untreated water storage tank.

b) Rainwater collected from roof surfaces that is used to supplement a mixed-use rural water supply must be delivered into an untreated water storage tank so that all drinking water provided to the building(s) served by the supply passes through the end-point treatment system. Rainwater collected by roof surfaces and the system used to collect this water must comply with the following sections and requirements in the Drinking Water Acceptable Solution for Roof Water Supplies:

    i. Section 2.2. Roof water collection system requirements.[14]
    ii. RF3 in Section 4. Monitoring and testing.

c) Surface water not tested in accordance with Section 2.2 by the drinking water supplier (excluding rainwater collected from roof surface) or water from a water carrier that is not registered with Taumata Arowai cannot be used to supplement the mixed-use rural water supply.

d) Surface water or water from an unregistered water carrier cannot be used to supplement the roof supply.

[13] Probable instantaneous flow rates for dwellings can be found in AS/NZS 3500.1:2021.

[14] Note that there are also recommendations for roof water collection systems in Section 2.3 of the Drinking Water Acceptable Solution for Roof Water Supplies.

2.8. Treated water tank requirements

If a treated water tank is included as part of the drinking water supply:

a) It must be secure against the ingress of rainwater and surface water.
b) Inlets, lids, overflows, and any other small gaps in tanks must be secure from contamination by vermin, birds, animals, faecal material, or other material.

3. Operation and maintenance

a) The operation and maintenance of the mixed-use rural water supply, including all treatment systems under this Acceptable Solution, is the responsibility of the drinking water supplier.

b) The drinking water supplier must provide information about the drinking water supply to the consumers at the properties connected to it and communicate whether the consumers are required to maintain or test the end-point treatment system. This must include a process to ensure all new consumers are informed of any maintenance or testing requirements.

c) The drinking water supplier must keep and maintain documentation that supports the ongoing operation and maintenance of the whole of the mixed-use rural water supply. This must include (but is not limited to):

    i. A description of the drinking water supply and key components.
    ii. A supply diagram that shows the components of the supply system, including sources, backflow devices, valves, pumps, treatment components, connections, and bypasses.
    iii. Incident and emergency response procedures.a)
    iv. Key contacts, including details for operators, manufacturers, suppliers, regulators, property owners, and consumers.
    v. Maintenance and inspection schedules and associated procedures that meet the drinking water supplier's and/or manufacturer's requirements for equipment used in the supply (e.g., end-point treatment system equipment, any additional pre-treatment systems for example iron and manganese removal, etc).
    vi. Schedule and procedures for inspecting the headworks, untreated and treated storage tanks (e.g., storage tanks are intact to prevent access of vermin or ingress of contaminants) and associated infrastructure.
    vii. Good hygienic practices, including prohibition of people working on a water system who are experiencing any gastrointestinal illness, protection of work sites, materials, and tools from contamination, and minimising the entry of contamination into the water supply during any activity.

d) The drinking water supplier must ensure maintenance and inspections (see Sections 3(c)(v) and 3(c)(vi)) are undertaken at a suitable frequency to ensure the water supply is providing safe drinking water.

e) All activities undertaken according to the maintenance and inspection schedules must be recorded and the documents retained for at least five (5) years to demonstrate the activities have been completed.

f) Operations and maintenance documentation must be consistent with any operation or maintenance requirements provided by the manufacturers of any equipment used as part of the drinking water supply.

4. Monitoring and testing

a) The drinking water supplier must undertake water quality testing and keep records in accordance with the conditions in the following table (the drinking water supplier may choose to carry out additional testing and associated record-keeping):

Mixed-use rural supply monitoring requirements

Condition	Requirement
MR1	All water samples that are used to demonstrate compliance with this Acceptable Solution must be: 1. Analysed by a laboratory accredited by IANZ for the type of analysis being undertaken. 2. Collected according to any instructions and specifications provided by the laboratory.
MR2	Drinking water suppliers must take all reasonably practicable steps to ensure that samples to be tested for *E. coli*, total coliforms, or other microbiological contaminants are delivered to a laboratory within 24 hours of the sample being collected, and where practical at a water temperature that is no higher than the water temperature at the time of sampling but above zero degrees Celsius.

MR3	Water samples must be collected downstream of any pre-treatment system(s) but before end-point treatment and monitored for the following determinands: a) once every 3 months for: i. Nitrate ii. pH iii. UV Transmittance (@ 254 nm) iv. Turbidity v. *E. coli* and total coliforms b) and once every 12 months for: i. Arsenic ii. Boron iii. Silica iv. Hardness v. Iron vi. Manganese.
MR4	If a monitoring result for a chemical determinand (see MR3) exceeds 50% of the MAV in the Water Services (Drinking Water Standards for New Zealand) Regulations 2022, additional monitoring must be undertaken on a monthly basis until four (4) consecutive results are less than 50% of the MAV.
MR5	Water samples must be collected from treated water leaving at least one end-point treatment system once every 3 months for: • Turbidity • *E. coli* and total coliforms. The drinking water supplier is responsible for determining the sampling schedule and locations to be sampled from (e.g., rotating the properties to be sampled from). Samples must be geographically representative of the supply. Turbidity results must not exceed the limits specified by the manufacturer of the UV disinfection unit of the end-point treatment system being sampled from. If the limit specified for the UV disinfection unit is exceeded, the drinking water supplier must investigate and remedy the cause of the elevated turbidity.

MR6	For end point treatment systems serving one building: Samples for *E. coli* and total coliforms must be taken from treated water leaving the end-point treatment system **in the week prior, or otherwise as soon as reasonably practicable,** to the population exceeding 500 people and **twice each week** (with at least three (3) days between samples) until the population no longer exceeds 500 people.
MR7	For end point treatment systems serving two or three buildings: Samples for *E. coli* and total coliforms must be taken from treated water leaving the end-point treatment system **in the week prior, or otherwise as soon as reasonably practicable,** to the population exceeding 100 people and **twice each week** (with at least three (3) days between samples) until the population no longer exceeds 100 people.
MR8	For mixed-use rural supplies which use surface water sources as their primary source: Each month between October and May (inclusive), the water and area within 50 metres of a surface water intake, must be visually inspected for the presence of benthic cyanobacteria mats and planktonic cyanobacterial growth. If there is evidence of cyanobacterial growth, steps must be taken to evaluate the cyanotoxin risk to consumers. If there is a risk of supplying water with cyanotoxins that exceed MAVs, then the drinking water supplier must follow their incident and emergency management procedures as required in Section 5.

5. Incident and emergency management

a) The drinking water supplier must have documented incident and emergency management procedures to ensure the supply of a sufficient quantity of safe drinking water.

b) The drinking water supplier must have a plan to undertake a managed response according to their procedures. The plan must:

i. Outline reasonably anticipated incidents or emergencies (e.g., *E. coli* detection, total coliform detection, power failure, interruption to supply, consumer complaint/illness, sample exceeds a MAV in the Water Services (Drinking Water Standards for New Zealand) Regulations 2022, cyanobacteria present in source, etc.).

c) For the incidents or emergencies identified in 5(b)(i), confirm how the drinking water supplier intends to:

   i. Take immediate action to ensure that the health of water consumers is protected and remedy the situation.

   ii. How water consumers will be communicated with and when it is appropriate to issue boil water notices or do not drink notices.

   iii. Investigate the source or cause of the incident and address it as soon as possible.

   iv. Notify Taumata Arowai that the drinking water is or may be unsafe.

   v. Identify and implement measures required to ensure that the problem does not reoccur.

   vi. Outline what additional laboratory testing will be undertaken for each incident and emergency and if necessary, detail alternative drinking water sources (e.g., bottled water, water carrier, etc).

d) Suppliers must review incident and emergency response plans after every major incident and update the plans based on learnings from the review.

e) All incidents and emergencies must be recorded, and records retained for five (5) years to demonstrate the activities have been completed.

6. Training

a) People who maintain or operate the mixed-use rural water supply must be competent to undertake the tasks necessary to ensure the system provides safe drinking water.

b) The person responsible for the mixed-use rural water supply must have a good understanding of:

   i. the emergency and incident management procedures
   ii. how to comply with this Acceptable Solution.

7. Definitions

Term	Definition
Act	The Water Services Act 2021.
Building Code	Schedule 1 of the Building Regulations 1992. The Building Code is contained in regulations under the Building Act 2004.
benthic cyanobacteria mat	A collective mass of cyanobacteria that forms on the bottom surface of a water body.
calmed bottom inlet	An inlet to a storage tank that delivers water to the bottom of the tank through a U-bend or similar feature, minimising any disturbance of sediment at the bottom of the tank.
cyanobacteria	A major group of micro-organisms capable of photosynthesis, sometimes referred to as blue-green algae.
cyanotoxin	A toxin produced by cyanobacteria.
determinand	A substance or characteristic that is determined or estimated in drinking water.
domestic dwelling	As defined in section 10(2) of the Act: Domestic dwelling means a building that is used as a single household unit, whether it is— (a) tenanted on a long- or short-term basis; or (b) occupied permanently or temporarily (for example, a holiday home) 'Household unit' has the meaning given to it by section 7 of the Building Act 2004.[15] Examples of a 'domestic dwelling' in the Act include a single property with tenants on a lease, or a single holiday house that is rented to tourists on a short-term basis. Examples that are not 'domestic dwelling' in the Act include a multi-dwelling building (for example, multiple separate apartments contained in a single building), or a marae, wharekai (dining hall), or community hall, or a café building.

[15] 'Household unit' is defined (section 7 Building Act 2004) as a building or group of buildings, or part of a building or group of buildings, that is—
(a) used, or intended to be used, only or mainly for residential purposes; and
(b) occupied, or intended to be occupied, exclusively as the home or residence of not more than 1 household; but
(c) does not include a hostel, boardinghouse, or other specialised accommodation

domestic self-supply	Means a stand-alone domestic dwelling that has its own supply of drinking water. As defined in section 10 of the Act.
Drinking Water Quality Assurance Rules	The Drinking Water Quality Assurance Rules 2022, made by Taumata Arowai under section 49 of the Act.
drinking water supplier	As defined in section 8 of the Act: Unless the context otherwise requires, drinking water supplier— (a) means a person who supplies drinking water through a drinking water supply; and (b) includes a person who ought reasonably to know that the water they are supplying is or will be used as drinking water; and (c) includes the owner and the operator of a drinking water supply; and (d) includes a person described in paragraph (a), (b), or (c) who supplies drinking water to another drinking water supplier; but (e) does not include a domestic self-supplier.
drinking water supply	As defined in section 9 of the Act: Unless the context otherwise requires, drinking water supply— (a) means the infrastructure and processes used to abstract, store, treat, transmit, or transport drinking water for supply to consumers or another drinking water supplier; and (b) includes— a. the point of supply; and b. any end-point treatment device; and c. any backflow prevention device; but (c) does not include a temporary drinking water supply provided for under sections 33 or 34 of the Act or a domestic self-supply.
end-point treatment	Treatment of drinking water at the final point of the supply at which the consumer can consume, use, or collect drinking water.
floating outtake	An outlet from a storage tank through a flexible pipe attached to a float, allowing water to be drawn from the top of the tank.
headworks	The infrastructure located near to the extraction point for source water. For groundwater, the headworks will be the bore, the bore head and the pump infrastructure required to extract the water.
maximum acceptable value or MAV	The maximum acceptable value of a determinand that is permitted in drinking water. The full range of MAVs for relevant determinands is set out in the Water Services (Drinking Water Standards for New Zealand) Regulations 2022.

networked supply	A drinking water supply that provides drinking water via a distribution system at a pressure and volume to meet consumer demand, or at a restricted flow and volume. These supplies may include storage facilities within the network to buffer demand. As defined in the Drinking Water Quality Assurance Rules.
operations and maintenance manual	A hardcopy or electronic document that outlines how to operate and maintain the drinking water supply under this drinking water acceptable solution.
planktonic cyanobacteria	Cyanobacteria which are freely floating in a body of water.
roof water	The rainwater collected from the roof of a building or structure.
surface water	A body of water that is open to atmosphere, whether running (streams and rivers) or quiescent (lakes, reservoirs, impoundments and ponds). Surface water does not include spring or bore water.
Taumata Arowai	The New Zealand water services regulator, established under the Taumata Arowai–the Water Services Regulator Act 2020.
total base population	Total base population of the mixed-use rural water supply is the population that is normally supplied drinking water by all end-point treatment systems regardless of any seasonal or temporary increases.
treatment system	A treatment system that complies with this drinking water acceptable solution.
UV	Ultraviolet light.
UVI	The intensity of UV radiation, usually measured in mW/cm2.
Water Services (Drinking Water Standards for New Zealand) Regulations 2022	The Water Services (Drinking Water Standards for New Zealand) Regulations 2022 made under section 47 of the Water Services Act 2021.

Appendix 4 Soil Testing – Communal Disposal Area

To: Infracon Ltd

Date: 02 July 2024

Re: Further testing of soils
Rocky Point
Bendigo Loop Road, Cromwell

This letter is regarding additional testing of soils at Rocky Point.

A further four test pits (TP08 – TP11) and one borehole with infiltration testing were undertaken along the southern extent of the proposed development (as per plans by Baxter Design ref 4371 - SK128, dated 05 June 2024). The location is in the area of the proposed lots 19, 20 & 21 of those plans.

The area is reasonably flat with a mix of bare grass and kanuka with a slope to the west which gets steeper further to the west. The hills along the south drain towards this area, however, the catchment is minimal in the overall aspect of the area. The small valley to the east of the site is intercepted near the eastern end of the flatter area and drains back towards the north via an overland flow path through a shallow saddle in the ridge which forms the northern side of the area.

Investigations in the area show that the soils are consistent within that area and are also reasonably consistent with other parts of the proposed development. While only one infiltration test was undertaken in the area it is considered that this area should have similar infiltration rates.

The measured infiltration rate at the location of BH22 was 26mm/hr *±2mm/hr* (0.62m/day *±0.05* or 7.22 x 10^{-6}m/s *± 0.55 x10^{-6}*). This is slightly higher than other areas measured across the proposed development but still considered to be consistent with the know soils of the area. The testing method for the infiltration was done using the falling head method. This differs from other testing across the proposed development (which was a constant head test) due to equipment failure on the day of fieldwork.

The use of a different method is unlikely to compromise consistency of the test results as these two methods have been compared by Mt Iron Geodrill in the past across different soil types and showed good correlation in results.

The equation used for the falling head was:

$$I_t = \frac{\Delta H 60 r}{\Delta t(r + 2H_{avg})}$$

Where:

- I_t = Tested Infiltration Rate
- ΔH = Change in Head 260mm
- r = Radius of Hole 50mm
- Δt = Time Interval 38 minutes
- H_{avg} = Average Head Height of Time Interval 370mm

The H_{avg} was calculated by:

$$H_{avg} = (\frac{H_t - H_o}{H_t - H_f})/2$$

Where:

- H_o = Initial Height of Water at Start of Time Interval 0mm (ground level)
- H_f = Final Height of Water at End of Time Interval 260mm
- H_t = Total Hole Depth 500mm

The soil category, as per AS/NZS 1547:2012 table 5.1 is Category 4 “Weakly structured Clay Loams”.

Mapping of the overland flow paths (by others) suggests that there is very little uphill catchment area directed to this area. The upslope catchment should be able to be managed with the use of small swales and/or berms if required.

Further investigation would be required to confirm soils at the time of final design, however, based on what is known about the area at this point, it is considered that this location should be suitable for onsite wastewater disposal for both the section proposed and also for a collective system disposal area.

Gavin Tippett
Engineering Geologist
B.Sc (Geol), P.G.Dip.Eng.Geol, M.Sc (Eng.Geol), MEngNZ

ENGINEERING NEW ZEALAND OFFICIAL MEMBER

MT IRON GEODRILL	**Project:** Infracon Bendigo Geotech Bendigo Hills Bendigo	**Client:** Infracon	**Drawing Title:** Site investigation Plan June 2024 Fieldwork	**Scale:** As shown **Job No.** GXXXXX	**Drawing Number** Figure 1 **Revision:** 02/07/2024

TP08

TEST PIT LOG

CO-ORDINATES:	366067	JOB NUMBER:	G23068	EQUIPMENT	
	5022371	PROJECT:	Infracon Bendigo Geotech	TYPE & MODEL:	SK20SR
± m:	6m	LOCATION:	Bendigo Hills	COMPANY:	Heavy Trax Hire
ELEVATION:	342		BENDIGO	OPERATOR:	Stu
GPS DATUM:	UTM	DATE:	04 June 2024	PIT DIMENSIONS:	
HEIGHT DATUM:	NZVD16	LOGGED BY:	G Tippett	Wide: 0.5m	Long: 2.4m

METHOD	DEPTH (m)	BLOWS/50mm	WATER	SAMPLES	GRAPHIC	DESRIPTION: Soil Name, Plasticity or Particle Characteristics, Colour, Secondary Components & Minor Components	MOSITURE	CONSISTENCY DENSITY	Structure and Additional Observations Geological / Depositional	DEPTH (m)
E	0	Scala Not Undertaken	N			TOPSOIL: brown organic rich silt loam.	D-M	F	TOPSOIL	0
						SILT: yellow brown, high dilatancy silt; trace fine sand.		St-VSt	AEOLIAN	
	1					Gravelly SILT: yellow grey high dilatancy silt; fine to medium grained, sub-rounded to angular, well graded gravel; minor to some fine to coarse grained, well graded sand.	D	VSt	ALLUVIUM	1
	2					Hole ends 0.6m				2
	3									3
	4									4

METHOD:
- **N** Natural Exposure
- **X** Existing Excavation
- **E** Excavator
- **HA** Hand Auger

SAMPLES:
- **U50** Undisturded Sample 50mm Diameter
- **D** Disturbed Sample
- **V** Vane Shear (kPa)
- **Bs** Bulk Disturded Sample
- **E** Environmental Sample
- **INF** Infiltration test

MOISTURE:
- **D** Dry
- **M** Moist
- **W** Wet
- **S** Saturated

CONSISTENCY / DENSITY:

VS	Very Soft	VL	Very Loose
S	**Soft**	L	Loose
F	**Firm**	MD	Medium Dense
St	**Stiff**	D	Dense
VSt	**Very Stiff**	VD	Very Dense
H	**Hard**		
Fb	**Friable**		

NOTE:
A scala result of 2.5 blows per 50mm is equivelent to a geotechnical ultimate bearing capacity of 300kPa in accordance with NZS 3604-2011, Section 3.3.7.

WATER:
- ◁ Water Inflow
- ▼ **Standing Water Level**
- ▽ **Estimated High Water Level**
- **N** **Nil Water Observed**

TP09

TEST PIT LOG

CO-ORDINATES:	366019 5022354	JOB NUMBER:	G23068	EQUIPMENT TYPE & MODEL:	SK20SR
± m:	6m	PROJECT:	Infracon Bendigo Geotech	COMPANY:	Heavy Trax Hire
ELEVATION:	341	LOCATION:	Bendigo Hills BENDIGO	OPERATOR:	Stu
GPS DATUM:	UTM	DATE:	04 June 2024	PIT DIMENSIONS:	
HEIGHT DATUM:	NZVD16	LOGGED BY:	G Tippett	Wide: 0.5m	Long: 2.4m

METHOD	DEPTH (m)	BLOWS/50mm (0 5 10)	WATER	SAMPLES	GRAPHIC	DESRIPTION: Soil Name, Plasticity or Particle Characteristics, Colour, Secondary Components & Minor Components	MOSITURE	CONSISTENCY DENSITY	Structure and Additional Observations Geological / Depositional	DEPTH (m)
E	0	Scala Not Undertaken	N			TOPSOIL: brown organic rich silt loam.	D-M	F	TOPSOIL	0
						SILT: yellow brown, high dilatancy silt; trace fine sand.		St-VSt	AEOLIAN	
						Gravelly SILT: yellow grey high dilatancy silt; fine to medium grained, sub-rounded to angular, well graded gravel; minor to some fine to coarse grained, well graded sand.	D	VSt	ALLUVIUM	
	1					Hole ends 0.7m				1
	2									2
	3									3
	4									4

METHOD:
- N Natural Exposure
- X Existing Excavation
- E Excavator
- HA Hand Auger

SAMPLES:
- U50 Undisturded Sample 50mm Diameter
- D Disturbed Sample
- V Vane Shear (kPa)
- Bs Bulk Disturded Sample
- E Environmental Sample
- INF Infiltration test

MOISTURE:
- D Dry
- M Moist
- W Wet
- S Saturated

CONSISTENCY / DENSITY:

VS	Very Soft	VL	Very Loose
S	Soft	L	Loose
F	Firm	MD	Medium Dense
St	Stiff	D	Dense
VSt	Very Stiff	VD	Very Dense
H	Hard		
Fb	Friable		

NOTE:
A scala result of 2.5 blows per 50mm is equivelent to a geotechnical ultimate bearing capacity of 300kPa in accordance with NZS 3604-2011, Section 3.3.7.

WATER:
- ◁ Water Inflow
- ▼ Standing Water Level
- ▽ Estimated High Water Level
- N Nil Water Observed

TP10

TEST PIT LOG

CO-ORDINATES:	365922 5022325	JOB NUMBER:	G23068	EQUIPMENT TYPE & MODEL:	SK20SR
± m:	6m	PROJECT:	Infracon Bendigo Geotech	COMPANY:	Heavy Trax Hire
ELEVATION:	329	LOCATION:	Bendigo Hills BENDIGO	OPERATOR:	Stu
GPS DATUM:	UTM	DATE:	04 June 2024	PIT DIMENSIONS:	
HEIGHT DATUM:	NZVD16	LOGGED BY:	G Tippett	Wide: 0.5m	Long: 2.4m

METHOD	DEPTH (m)	BLOWS/50mm	WATER	SAMPLES	GRAPHIC	DESRIPTION: Soil Name, Plasticity or Particle Characteristics, Colour, Secondary Components & Minor Components	MOSITURE	CONSISTENCY DENSITY	Structure and Additional Observations Geological / Depositional
E	0	Scala Not Undertaken	N			TOPSOIL: brown organic rich silt loam.	D-M	F	TOPSOIL
						SILT: yellow brown, high dilatancy silt; trace fine sand.	D	St-VSt	AEOLIAN
	1					Gravelly SILT: yellow grey high dilatancy silt; fine to medium grained, sub-rounded to angular, well graded gravel; minor to some fine to coarse grained, well graded sand.		VSt	ALLUVIUM
	2					Hole ends 0.6m			
	3								
	4								

METHOD:
- **N** Natural Exposure
- **X** Existing Excavation
- **E** Excavator
- **HA** Hand Auger

SAMPLES:
- **U50** Undisturded Sample 50mm Diameter
- **D** Disturbed Sample
- **V** Vane Shear (kPa)
- **Bs** Bulk Disturded Sample
- **E** Environmental Sample
- **INF** Infiltration test

MOISTURE:
- **D** Dry
- **M** Moist
- **W** Wet
- **S** Saturated

CONSISTENCY / DENSITY:

VS	Very Soft	VL	Very Loose
S	Soft	L	Loose
F	Firm	MD	Medium Dense
St	Stiff	D	Dense
VSt	Very Stiff	VD	Very Dense
H	Hard		
Fb	Friable		

NOTE:
A scala result of 2.5 blows per 50mm is equivelent to a geotechnical ultimate bearing capacity of 300kPa in accordance with NZS 3604-2011, Section 3.3.7.

WATER:
- ◁ Water Inflow
- ▼ **Standing Water Level**
- ▽ **Estimated High Water Level**
- **N** **Nil Water Observed**

TP11

TEST PIT LOG

CO-ORDINATES:	365882	JOB NUMBER:	G23068	EQUIPMENT	
	5022290	PROJECT:	Infracon Bendigo Geotech	TYPE & MODEL:	SK20SR
± m:	4m	LOCATION:	Bendigo Hills	COMPANY:	Heavy Trax Hire
ELEVATION:	324		BENDIGO	OPERATOR:	Stu
GPS DATUM:	UTM	DATE:	04 June 2024	PIT DIMENSIONS:	
HEIGHT DATUM:	NZVD16	LOGGED BY:	G Tippett	Wide: 0.5m	Long: 2.4m

METHOD	DEPTH (m)	BLOWS/50mm	WATER	SAMPLES	GRAPHIC	DESRIPTION: Soil Name, Plasticity or Particle Characteristics, Colour, Secondary Components & Minor Components	MOSITURE	CONSISTENCY DENSITY	Structure and Additional Observations Geological / Depositional	DEPTH (m)
E	0	Scala Not Undertaken	N			TOPSOIL: brown organic rich silt loam.	D-M	F	TOPSOIL	0
						SILT: yellow brown, high dilatancy silt; trace fine sand.	D	St-VSt	AEOLIAN	
	1					Gravelly SILT: yellow grey high dilatancy silt; fine to medium grained, sub-rounded to angular, well graded gravel; minor to some fine to coarse grained, well graded sand.		VSt	ALLUVIUM	1
	2					Hole ends 0.6m				2
	3									3
	4									4

METHOD:
- **N** Natural Exposure
- **X** Existing Excavation
- **E** Excavator
- **HA** Hand Auger

SAMPLES:
- **U50** Undisturded Sample 50mm Diameter
- **D** Disturbed Sample
- **V** Vane Shear (kPa)
- **Bs** Bulk Disturded Sample
- **E** Environmental Sample
- **INF** Infiltration test

MOISTURE:
- **D** Dry
- **M** Moist
- **W** Wet
- **S** Saturated

CONSISTENCY / DENSITY:

VS	Very Soft	VL	Very Loose
S	**Soft**	L	Loose
F	**Firm**	MD	Medium Dense
St	**Stiff**	D	Dense
VSt	**Very Stiff**	VD	Very Dense
H	**Hard**		
Fb	**Friable**		

NOTE:
A scala result of 2.5 blows per 50mm is equivelent to a geotechnical ultimate bearing capacity of 300kPa in accordance with NZS 3604-2011, Section 3.3.7.

WATER:
- ◁ Water Inflow
- ▼ **Standing Water Level**
- ▽ **Estimated High Water Level**
- **N** **Nil Water Observed**

BH22

BOREHOLE LOG

CO-ORDINATES: 365063
5022381
± m: 4m
ELEVATION (m): 342
GPS DATUM: UTM
HEIGHT DATUM: NZVD16

JOB NUMBER: G23068
PROJECT: Infracon Bendigo Geotech
LOCATION: Bendigo Hills
BENDIGO
DATE: 04 June 2024
LOGGED BY: G Tippett

EQUIPMENT TYPE & MODEL: Hand Auger
COMPANY: Mt Iron Geodrill
OPERATOR: G Tippett

BOREHOLE DIAMETER: 100mm

METHOD	DEPTH (m)	BLOWS/50mm	WATER	SAMPLES	GRAPHIC	DESRIPTION: Soil Name, Plasticity or Particle Characteristics, Colour, Secondary Components & Minor Components	MOSITURE	CONSISTENCY DENSITY	Structure and Additional Observations Geological / Depositional
HA	0	Scala Not Undertaken	N			TOPSOIL: brown organic rich silt loam.	D-M	F	TOPSOIL
				INF		SILT: yellow brown, high dilatancy silt; trace fine sand.	D	St-VSt	AEOLIAN
						Gravelly SILT: yellow grey high dilatancy silt; fine to medium grained, sub-rounded to angular, well graded gravel; minor to some fine to coarse grained, well graded sand.		VSt	ALLUVIUM
	1					Hole ends 0.5m			
	2								
	3								
	4								

METHOD:
- **AS** Auger screwing
- **AD** Auger drilling
- **RR** Roller/Tricone
- **CB** Claw / Blade bit
- **TC** TC bit
- **HA** Hand auger

SAMPLES:
- **U50** Undisturded Sample 50mm Diameter
- **D** Disturbed Sample
- **V** Vane Shear (kPa)
- **Bs** Bulk Disturded Sample
- **E** Environmental Sample
- **INF** Infiltration Test

MOISTURE:
- **D** Dry
- **M** Moist
- **W** Wet
- **S** Saturated

for cohesive soils moisture can be further related to:
- **LL** Liquid Limit
- **PL** Plastic Limit

CONSISTENCY / DENSITY:

VS	Very Soft	VL	Very Loose
S	Soft	L	Loose
F	Firm	MD	Medium Dense
St	Stiff	D	Dense
VSt	Very Stiff	VD	Very Dense
H	Hard		
Fb	Friable		

NOTE:
A scala result of 2.5 blows per 50mm is equivelent to a geotechnical ultimate bearing capacity of 300kPa in accordanc with NZS 3604-2011, Section 3.3.7.

WATER:
- ◁ Water Inflow
- ▼ **Standing Water Level**
- ▽ **Estimated High Water Level**
- **N** **Nil Water Observed**

BOREHOLE FALLING HEAD

Equation $I_t=(\Delta H*60*r)/(\Delta t(r+2H_{avg}))$

Where:
I_t = Tested Infiltration Rate
ΔH = Change in Head
r = Radius of Hole
Δt = Time Interval
H_{avg} = Average Head Height of Time Interval

H_o = Initail Height of Water at Start of Time Interval
H_f = Final Height of Water at End of Time Interval
H_t = Total Hole Depth

Time Interval	38	Min
Hole Diameter	100	mm
Hole Radius	50	mm
Intail depth to water	0	mm
Final depth to water	260	mm
Total depth of hole	500	mm

H_o	500	mm
H_f	240	mm
ΔH	260	mm
H_{avg}	370	mm

Equation $H_{avg}=((H_t-H_o)/(H_t-H_f))/2$

I_t	**25.98**	**mm/hr**
	0.62	m/day
	7.22E-06	m/s

Appendix 5 Site Photos

Figure 7: View of site from Bendigo Loop Road (14/12/23)

Figure 8: Example of slopes on site (14/12/23)

Figure 9: View of Clutha River from Lot 1, looking north. (14/12/23)

Figure 10: Existing header tanks supplied by Chinamans Terrace Scheme (4 x 25,000L) (14/12/23)