MEMORANDUM

TO:	Waitaki District Council	Job No.:	000442
ATTENTION:	Michael Goldingham	Date:	17 May 2019
FROM:	Melanie Stevenson	Page 1 of 11	
SUBJECT:	Ohau Water Supply Upgrade – Further Information (DRAFT)	Reference:	*MEMO 19-05-17 MKS 000442 (Draft)*

1.0 Introduction

This memorandum is in response to a request from the Waitaki District Council to provide:

- review of the design demand figures and the basis of the design flows
- the cost versus scale for options
- risks associated with the various identified locations for water supply bores

2.0 Basis of Design Flow

2.1 General

As presented in the Ohau Village Water Supply – Issues and Options Report (dated 21 November 2018), peak daily demand calculations are the most critical when determining water source requirements and sizing water treatment processes, while instantaneous flows are used to size treated water storage and pipework leaving reservoirs and in the reticulation.

Various methods are used to determine water demand for water supply. These are from actual data (when available) and/or design assumptions (when data isn't available).

Design assumptions often used are those provided in New Zealand Standards such as:

- NZS 4404:2010 Land Development and Subdivision Infrastructure, which state:
  - a minimum daily consumption of 250L/person/day
  - A peak daily flow of 2 x the average daily flow
  - A peak instantaneous flow (hourly) of 5 x the peak daily flow
- AS 3500.1:2015 Plumbing and Drainage Part 1: Water Services, which specify probable simultaneous flow for the number of connections.
- AS/NZS 1547:2012 Onsite Domestic Wastewater Management which gives design flow allowances from domestic and commercial premises (such as campgrounds).

Also taken into consideration is the type of supply:

- Is it a restricted supply? This is an allocated flow supplied to a tank over a 24 hour period. Variations between average and peak flows are limited.

- Or is it an on-demand supply? This is a connection that allows water to be supplied as and when required directly to the consumer from the piped network. Peak flow through the network can be 10 x the average flows.

For estimating Ohau water demand, a combination of actual flow data and calculated flow from design assumptions was used.

A more detailed description of the water demand assessment is provided below.

2.2 Current Demand (Actual)

Current Demand was based on actual data (20 min intervals) collected from a flowmeter sited at the outlet of the storage tanks during 2016 to 2017. The data is presented in the graph below.

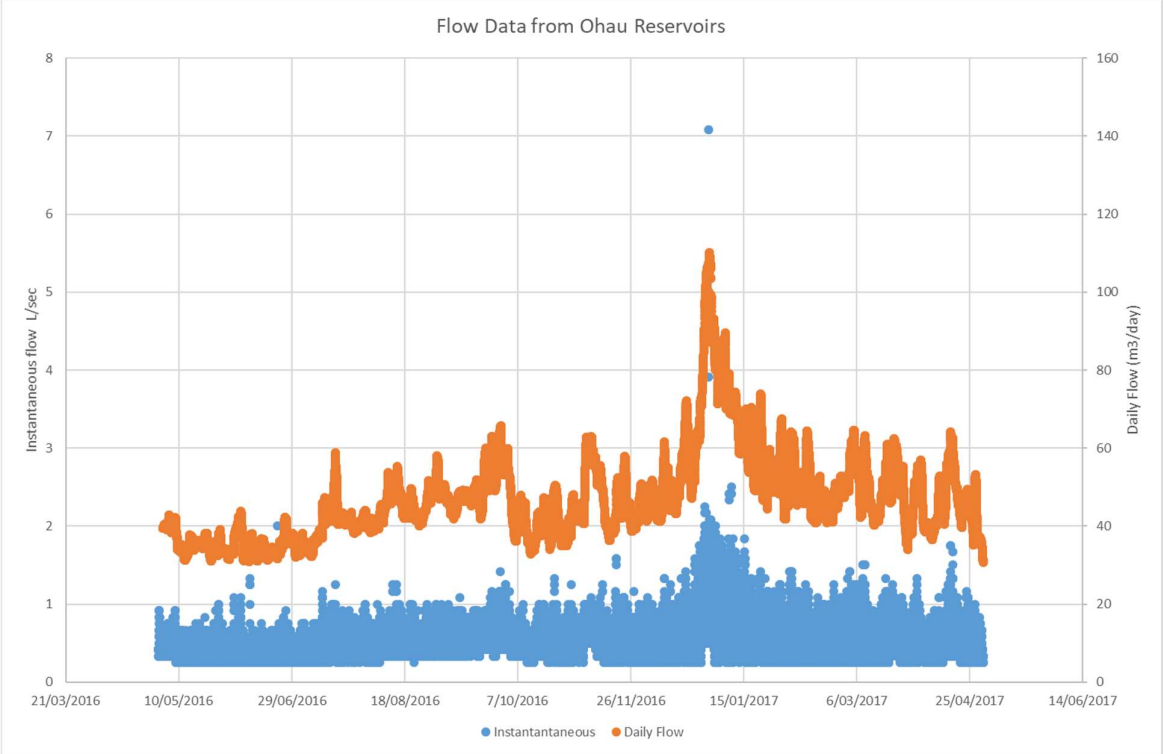

Figure 2.1: Ohau Water Demand 2016/2017

Flow data covers the period 1 May 2016 to 30 April 2017. Results indicate:

- Average daily flow is 47m^3/day
- Peak daily demand is 110m^3/day (occurred over New Year 2016/17)
- Peak instantaneous flow was recorded as 7L/s with a peak hourly average of 4L/sec (30 December 2016).

A more recent analysis of data collected from 2018/19 shows a similar trend.

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It should be noted that current demand is from:

- 61 connections
- 14 residents
  - 10 on-demand
  - 4 restricted
- 47 holiday homes
  - 24 on-demand
  - 23 restricted
- Waitaki Boys Lodge – on demand flow to Lodge (2 showers, 3 toilets and basic kitchen facilities) and cabin that can accommodate up to 30 people. Peak daily demand is estimated to be 2.4m^3/day[1] and an instantaneous flow of 0.37L/sec. It is used by the school during the first and 4th school terms. At other times it is only typically used for small groups using the lodge.
- Campground (5 x toilets and 2 x Taps) – on-demand flow that is reported to have up to 66 sites occupied (estimated 132 people) at peak summer. Peak daily demand is calculated to be 9m^3/day[2] and an instantaneous flow of 0.34L/sec.

Water consumption from the current restricted connections should be a maximum of 600L/connection per day.

To get an idea of average water consumption from on-demand connections water use data during the middle of the week in May 2016 was analysed. This was period was selected as it is off peak season when the campground toilets are shut down and there are no school groups using Waitaki Boys. During this time the average daily flow was 35.4m^3/day. The minimum flows recorded during 2016/2017 were around 31m^3/day.

From the off-peak flow, estimated leakage (unaccounted for water) and restricted water use was subtracted, resulting in 1.1m^3/day water usage per on-demand. A summary is provided below.

Off peak water use	35.4m^3/day
Minus leakage [3]	21.6m^3/day
Therefore, water consumed	13.8m^3/day
Minus residents on restrictors	2.4m^3/day (4 no. x 0.6m^3/day)
Therefore, residents on demand	11.4m^3/day (10 no.)

With 10 residential on demand users, each resident is calculated to use on average 1.1m^3/day.

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[1] 6 people x 130L/p/day and 24 people x 65L/p/day (AS/NZS 1547 for fully serviced and recreational type camp grounds)
[2] 132 people x 65L /p/day (AS/NZS 1547 for recreational type camp grounds)
[3] Leakage is though pipework and to the oxidation pond to maintain levels in the pond. This is estimated to be 21.6 m^3/day and is calculated from an assessment of night flows during off peak times.

In comparison to design standards, the Ohau average water usage is elevated but is not considered to be out of the ordinary.

The average domestic use per connection under design standards NZS4404 is 750L/day.

The average daily flow per connection used in South Hill, Oamaru is 1,000L/day.

2.2.1 Peaking Factors

To get the peak daily flow used by on-demand connections, the NZS 4404:2010 standards were used which recommends a peaking factor of 2 x the average daily flow to get a peak daily flow (for populations less than 2,000). For smaller populations the peaking factors are typically higher.

2.2.2 Check of Design Assumptions

To check the calculated on-demand water use of 1.1m^3/day and the peaking factor of 2, a spreadsheet was developed to determine whether expected flows were what was recorded during peak holidays. It was assumed that:

- 80% of holiday houses were occupied
- The camping ground and lodge were fully utilised

Table 2.1 below provides the information below.

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Table 2.1: Calculated Flows based on Estimated Design Assumptions

	Description	Qty	Rate (L/day)	Average Daily Flow (m^3/day)	Peak Daily Flow (m^3/day)	Peak Instantaneous (L/sec)	Comment
Residents	Restricted Units	4	600	2.40	2	0.03	Consistent flow
	On Demand Connections	10	1100	11.0	22	1.7	2 peaking factor used for peak daily demand. Peak instantaneous is from Probable simultaneous flow calculation in NZS/AS 3500.1.
Holiday Makers	Restricted Units	23	600	3	11	0.2	Assumes 25% occupancy of holiday homes for average and 80% occupancy for peak demand.
	On Demand Connections	24	1100	7	42	3.0	Assumes 25% occupancy of holiday homes for average and 80% occupancy for peak demand. 2 peaking factor used for peak daily demand. Peak instantaneous is from Probable simultaneous flow calculation in NZS/AS 3500.1.
Other	Leakage/Flow to Oxidation Pond			21.6	21.6	0.25	rom flow meter – nightime flow during off peak.
	Waitaki Boys Lodge			1	2.5	0.37	Based on information supplied by Waitaki Boys (max 30 people).
	Camping Ground	132	65	1	9	0.3	Based on data from DoC regarding no. of sites. Average is 10% of peak.
Total Calculated				**47**	**110**	**5.8**	
Actual 2016/17				**47**	**110**	**4L/sec (hourly average)**	

A comparison of actual flow data versus calculated flow using design assumptions looked reasonable and were therefore used to estimate future demands.

2.3 Future Demand

The future demand assessment assumed two different supply scenarios:

1. All restricted connections with a supply of 1,000L/day[4] per connection
2. All on-demand connections

The base future demand scenario assumed:

- All available 136 Lots are connected to the water supply comprising 50 permanent residents and 86 holiday makers. This was calculated based on current ratios.
- That there is 100% occupancy during peak times (this is to ensure design allows for the worst case scenario).
- The DoC camping ground maintains its existing connection.

[4] 1,000L/day is considered a reasonable allocation for Ohau based on the current average on-demand usage and design standards of 250L/day per person assuming a 4 people per household. The volume needs to be adequate to meet demand during peak times.

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- Leakage and flow to the oxidation pond has a constant supply to it of 0.25L/sec (21.6m^3/day).
- The average daily demand from the on-demand connection is 1,100m^3/day with a peaking factor of 2.

Also calculated was 20 additional restricted connections (outside village boundary). These were added under request from the WDC to allow for potential connections.

Future demand calculations results are presented below in the following sections. It should be noted that simply scaling up current demand for future flow was not a viable option as it is currently a combination of restricted and on-demand flows and either fully restricted or fully on demand flow demand scenarios were required.

2.3.1 Future Demand (Restricted -1000 L/day)

Table 2.2: Future demand for Restricted Flow

	Description	Qty	Rate (L/day)	Average Daily Flow (m^3/day)	Peak Daily Flow (m^3/day)	Peak Instantaneous (L/sec)	Comment
Residents	Restricted Units	50	1000	50.0	50.0	0.6	Consistent flow
Holiday Makers	Restricted Units	86	1000	22	86	1.0	Assumes 25% occupancy of holiday homes for average and 80% occupancy for peak demand.
Other	Leakage/Flow to Oxidation Pond/Sewer			21.6	21.6	0.25	From flow meter – nightime flow during off peak.
	Waitaki Boys Lodge	2	1000	2	2	0.0	Based on provision of a restricted supply and meeting demand requirements.
	Camping Ground	8	1000	1	8	0.1	Based on provision of a restricted supply and meeting demand requirements.
Total Calculated				**96**	**168**	**1.9**	
Future connections		20	1000	5	20	0.2	Allowance for 20 connections outside the village.
Total Calculated (with additional connections)				**101**	**188**	**2.2**	

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2.3.2 Future Demand (all on demand)

Table 2.3: Future Demand – On Demand

	Description	Qty	Rate (L/day)	Average Daily Flow (m^3/day)	Peak Daily Flow (m^3/day)	Peak Instantaneous (L/sec)	Comment
Residents	On Demand Connections	50	1100	55	110	4.7	Consistent flow
Holiday Makers	On Demand Connections	86	1100	24	189	6.8	Assumes 25% occupancy of holiday homes for average and 100% occupancy for peak demand.
Other	Leakage/Flow to Oxidation Pond/Sewer			21.6	21.6	0.25	From flow meter – nightime flow during off peak.
	Waitaki Boys Lodge			1	2.5	0.37	Based on information supplied by Waitaki Boys (max 30 people).
	Camping Ground	132	65	1	9	0.3	Based on current data from DoC regarding no. of sites. Average is 10% of peak.
Total Calculated				**102**	**332**	**12.5**	
Future connections		20	1000	5	20	0.2	Allowance for 20 connections outside the village.
Total Calculated (with additional connections)				**107**	**352**	**12.7**	

2.4 Design Flows

For design purposes it is essential that future demand is accounted for as it is cost effective to allow for growth during design and construction rather than adding on later. This is particularly true for key infrastructure such as electrical, treatment works, and pipework which are expensive to upgrade later if required. Allowing for future growth during the planning stages, also allows for staging of the works.

It is therefore recommended that design flows are as presented in Table 2.4 below.

Please note that there has been some minor modification to flows presented in the initial Issues and Options Report (November 2018), due to refinement of some of the data and a slight reduction in the peaking factor for on-demand usage.

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Table 2.4: Design Flows

Description	Unit	Current	Without Allowance for Future Connections		With Allowance for Future Connections	
			Restricted	On-demand	Restricted	On-demand
Average daily flow	m^3/day	47	96	102	101	107
Peak daily flow	m^3/day	110	168	332	188	352
Instantaneous flow	L/sec	5.8	1.9	12.5	2.2	12.7

As shown in Table 2.4, the water use on average is similar for both restricted and on-demand, however, during peak conditions, the on-demand flow is substantially greater. This is due to the uncontrolled nature of on-demand flows combined with peak periods, such as during the Christmas/New Year times. This impacts on the sizing of some of the infrastructure, however it does not necessarily make a significant change to costings, as discussed in the following sections.

3.0 Cost Versus Scale for Options

Cost estimates, as presented in the Issues and Options Report (November 2018) and subsequent memorandums, were developed based on design flows for restricted versus on-demand connections. The difference in costs between the two shows that systems for on-demand costs are only 9 to 14% more even though the peak daily demand has doubled.

The reason for the relatively minor increase in costs is because for both flow scenarios, Ohau remains a small system and that there is a minimum size for many items. For instance, treatment costs do not vary significantly when 1 cartridge unit will treat up to 5L/sec and the chlorine dosing system is able to treat from very low to very high flows. The UV reactors are also similar with a minimal change to the size of the reactor between different flow rates.

Also, no matter what the flow is, the following costs remain similar or the same:

- Consent application and fees
- Drilling costs and headworks for the bores
- Monitoring equipment
- Electrical and control
- Installation and labour costs
- Building costs
- Landscaping and access
- Power supply upgrade (minimum supply)
- Design fees

Cost differences between high and low flows mostly relate to the storage requirements, the number of bores and the pumps. These works however, can be staged to meet demand which reduce the impact on the current ratepayers.

Staging of the works could include the construction of:

- One or two bore/s[5] initially to meet current demand with additional bore/s being constructed later,
- Only some of the storage tanks to meet current demands, with others being added later, and/or
- Connection of pumps required for current demand with allowance in manifold for others to be added in the future.

4.0 Bore Location

There has been much discussion about the location of the water treatment plant and the water supply bores.

The initial Issues and Options report (November 2018) identified a bore supply adjacent Lake Ohau. This site had been identified in a previous report prepared by Environmental Associates as a potential reliable source.

Subsequent to the Issues and Options Report, other potential bore locations have been investigated to assess potential yield, bore depth and water quality. The potential bore locations are presented in Figure 4.1 and findings reported by the hydrogeologist – Environmental Associates, are summarised below.

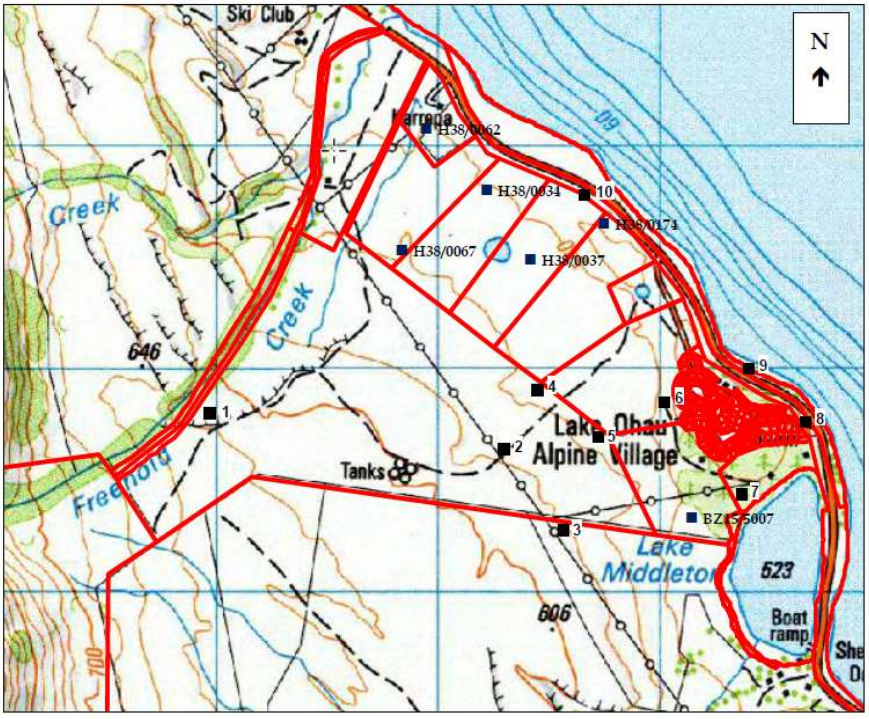

Figure 4.1: Potential bore Location as Presented to the Hydrogeologist

[5] The number of bores required will depend upon yield of bore. This will not be realised until the bores are fully developed. <2L/sec per bore has been indicated by drillers and the hydrogeologist.

Most favourable well yields are likely to be where the depth to the water table is least and there is a hydraulic connection, between Lake Ohau and the bore, or Freehold Creek and the bore.

- Bore 1 is likely to be hydraulically connected to Free Hold creek and may be well suited to provide the required water.
- Bores located adjacent Lake Ohau (8, 9 and 10) would need to be 15-24m deep and are likely hydraulically connected with the lake. These sites present the most potentially reliable well yield.
- Bores (2-6) would need to be 22-35m deep and are not hydraulically connected to a water source. Likely yields are 0-2L/sec. Site 6 provides the most potential yield out of these wells.
- Bore 7 would need to be about 17m and is likely to be hydraulically connected to Lake Middleton. This site may be subject to greater variability in water quality due to seasonal lake activities.

Based on Groundwater Protection Zoning of the Canterbury Water and Land Plan, Environmental Associates did not identify any potential contamination sources that occur with the relevant protection zoning for each site. However, the siting of any well would have to ensure that there is no discharge of wastewater to land (including septic tanks) within the protection zone. The default groundwater protection zone is a 200m radius around the bore and 1000m upgradient of the bore. This protection zone is likely to affect some landowners adjacent the village that have septic tanks and a more thorough analysis of the protection zone is required. It should be noted here that the level of treatment installed is a factor in determining the protection zone.

The only way to determine the availability and yield of groundwater at Ohau is to construct exploratory test bores. Depending on the location and likely water table depth, these are estimated to cost $16,000 to $20,000 for each test bore.

To establish the necessary equipment at each site, the drill equipment requires a working platform of 21 x 8m and a truck accessible road. Any sites with poor access will require likely require the development of an access track adding cost to exploratory testing. If no or minimal water is found at these locations, then these costs are sunk. Sites 2,3, 4 and 5 are away from a hydraulic connection with a water body and have difficult access. These sites are therefore considered the highest risk for further investigation/development and are not recommended on this basis.

5.0 Way Forward

Following feedback from the Ohau Community, there is a preference to keep any infrastructure away from the front of the village, near Lake Ohau. With this in mind, the development of a bore supply behind the village (near site 6) is a feasible option worth further investigation. A preliminary concept design has been prepared for this site and is discussed in a separate memorandum (ref:MEMO 19-05-17 FG 000442). Costings are very similar to options where the bores are located adjacent the lake.

While bores near site 6 are not as likely to produce the same yield as other sites adjacent water courses it may be adequate to meet demand with 2 or 3 bores. As the yield will not be known until test bores are drilled, it is recommended that a site is selected near site 6 (following a more detailed assessment of the water protection zone) and a test bore is drilled.

If the exploratory bore is successful, then it is recommended that a new treatment facility is constructed in the area behind the village where there is easy access, and close proximity to power and existing pipework.

If adequate well yield is not obtained at this site, other sites will need to be explored. The next best option in terms of cost and likely well yield is adjacent Lake Ohau. Any bore in this area will need to be 500m laterally away from the oxidation pond. The impact of any upgradient septic tanks also needs to be further assessed by a hydrogeologist. Depending on the location of this bore, the Waitaki Boys Lodge and the Camping Ground septic tank system may need to be pumped to the Ohau village waste network to help reduce any risk of contamination.

While the development of a bore near Freehold Creek would likely give a good yield with low risk of contamination, it is one of the most expensive options for the community and has opposition from the landowner.

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