Otago Regional Council

Document Id: **A1367286**

MEMORANDUM

To: **Kirstyn Lindsay**

From: **Sarah McCrorie**

Date: **17/07/2020**

Re: **RM20.003 - WM1363 historical water use analysis**

This memorandum is in relation to application RM20.003 to replace 98526.V1 from the Parkburn for the purpose of irrigation and frost fighting. Abstraction of water under this permit occurs through water meter WM1363. Deemed Permit 98527.V1 was surrendered in March 2020 but will need to be included as was current during most of the period covered by this analysis. Deemed Permit 93177 is also measured via water meter WM1363, the application states it has not been exercised for some time so will be ignored for this analysis.

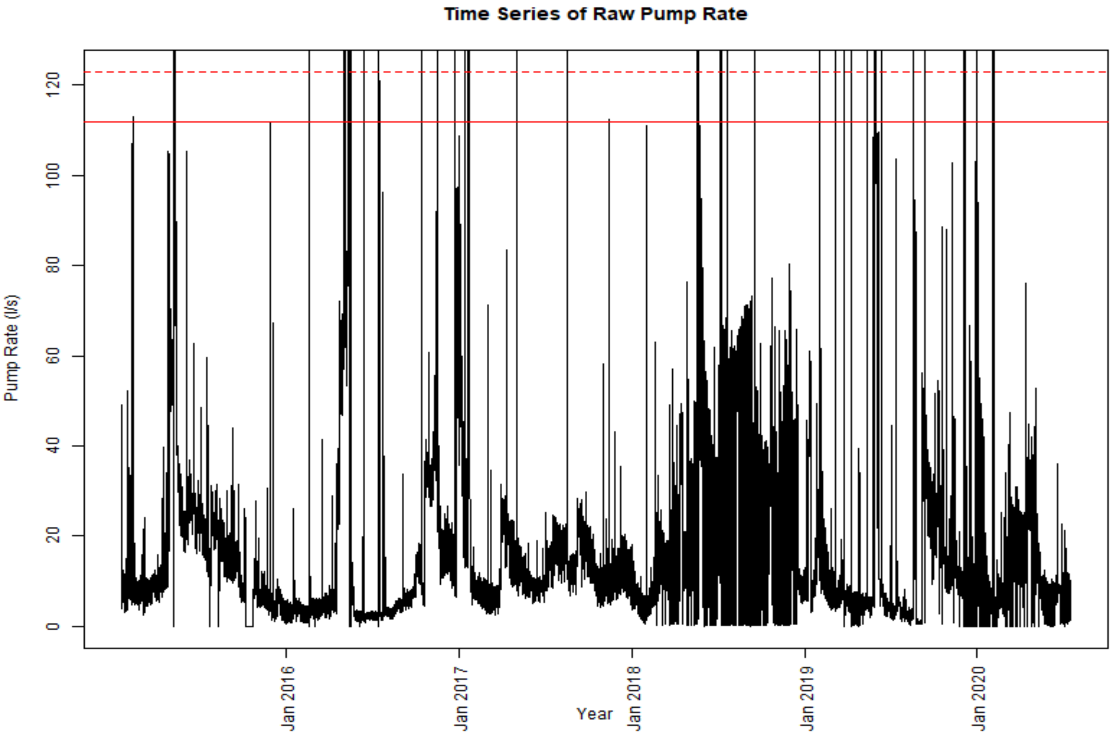
All analyses, graphs, and calculations were performed using RStudio version 1.2.5033 and RGui version 3.6.3.

Data taken through WM1363 extends from 17 January 2015 to 16 July 2020 with a total of 48,178 hourly measurements.

In addition to analysing the raw data, the following steps were taken:

- Rates less than, or equal to zero were set to NA.
- The maximum average rate of take authorized by the permit this application seeks to replace is 112 l/s and water is taken through an open channel or other type of meter. A 10% margin of error was applied to this and rates in excess of 123 l/s were set to NA.
- Rates between 112 l/s and 123 l/s were set to 112 l/s.
- The resultant data set had 46,937 hourly measurements.

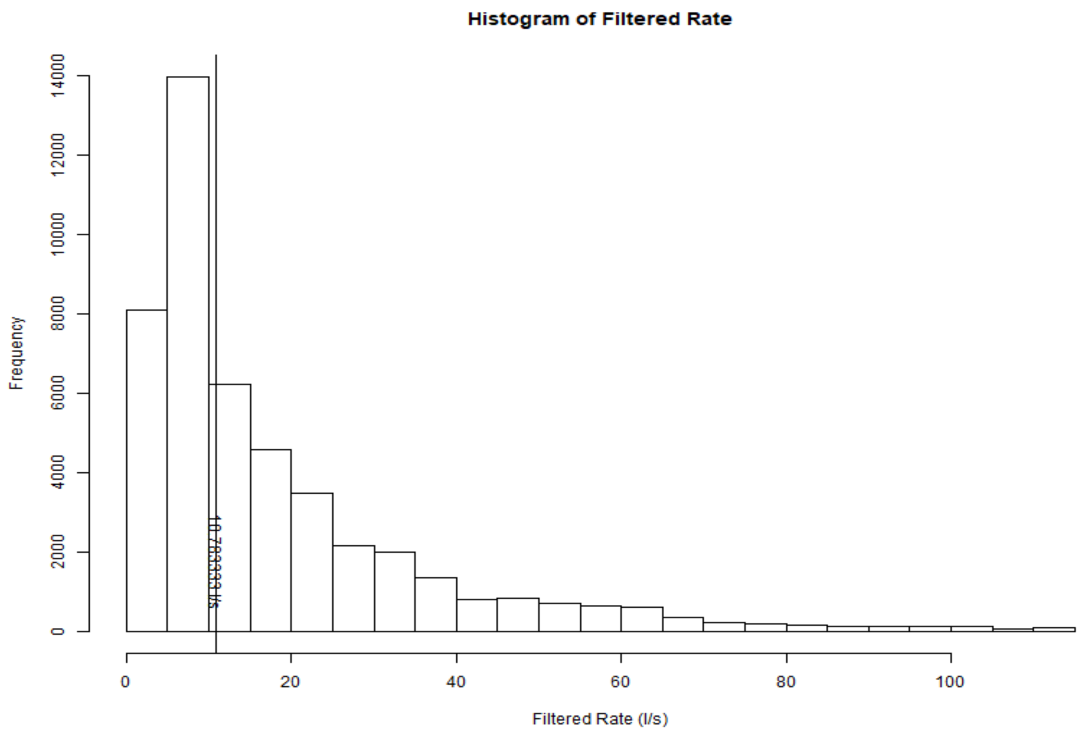
A time series showing the pump rate, the maximum consented rate, and the upper error limit is presented below:



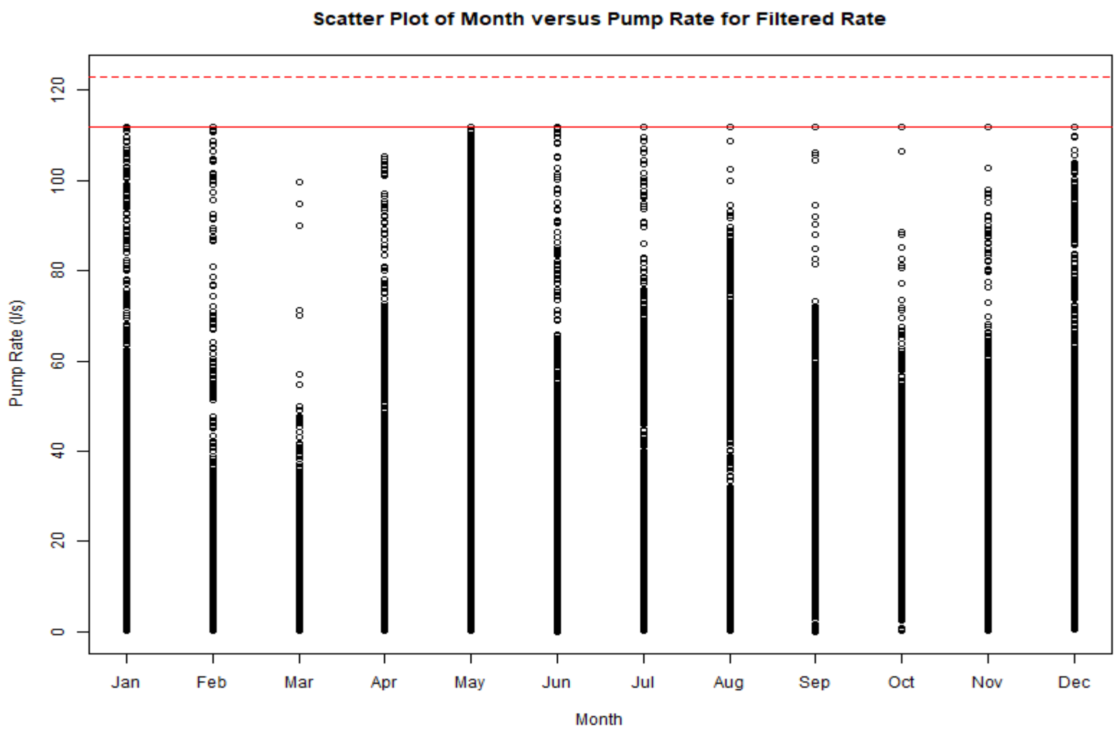
The solid red line represents the consented maximum rate of 112 l/s, and the broken red line represents 112 l/s + 10% (123 l/s).

The filtered data set contains 46,937 measurements with an average take of 18.1 l/s, a median rate of take of 10.8 l/s, and a modal (most common) rate of take of 112 l/s.

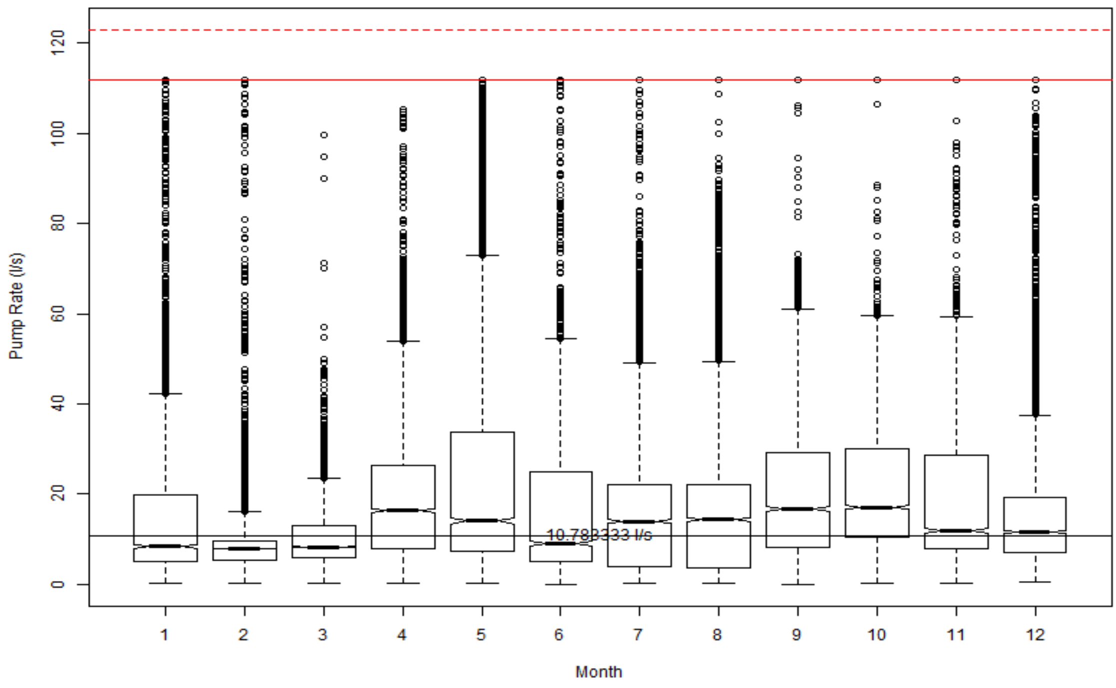
The histogram below shows a large peak between 5-10 l/s, this accounts for 30% of the measurements. This could be consistent with taking for storage or a small irrigation system.



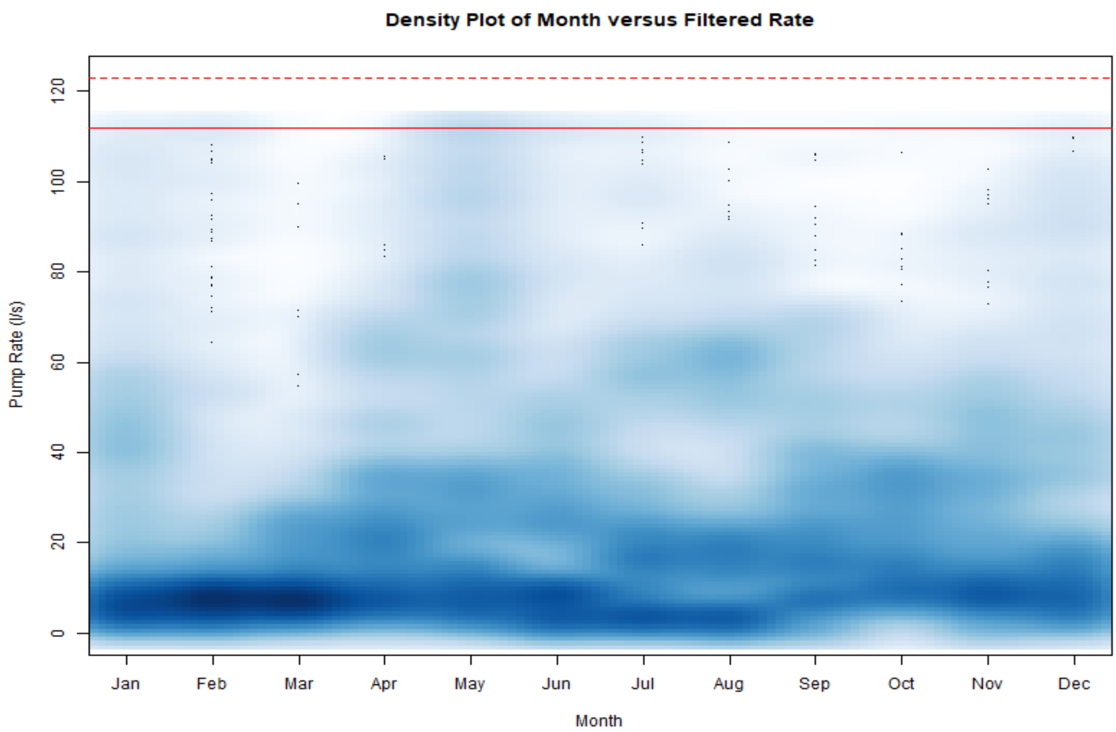
There appears to be a continuous small take of taking, which would be consistent with taking for storage. Rates of take increase in winter meaning the open channel may be affected by water availability. The water is used for frost fighting so could explain the increase rate of taking during winter.



Above average rates are more likely to occur during winter, this would be consistent with taking for storage while there is available water.



The density plot below shows the continuous taking between 5-10l/s, which is consistent with taking for storage. There are increased rates during winter which could mean taking more while the water is available or taking for frost fighting.



The high use data set was selected by filtering for those months in which the median usage exceeded the median for the filtered data set. The mean for the high use data set is 20.7l/s, the median is 14.5 l/s and the modal value is 112 l/s.

Percentiles are not a percentage of the maximum rate, but rather the rate that is exceeded x% of the time. Percentiles are calculated by ranking the data from lowest to highest and taking the weighted average of the nth highest and the n+1th highest values. The 80th percentile is the pump rate that is exceeded 20% of the time. The 90th percentile is the pumping rate that is exceeded 10% of the time. The 95th Percentile is exceeded 5% of the time. What this means in terms of the analysis is that if the applicant is pumping at the maximum consented rate more than 5% of the time, the 95th percentile will equal the maximum consented rate. If they are pumping at the maximum consented rate more than 10% of the time, the 90th percentile will equal the maximum consented rate. If they are pumping at the maximum consented rate more than 20% of the time, then the 80th percentile will equal the maximum consented rate. In practical terms if the applicant is pumping 24 hours/day and 2160 hours for a 90-day season then:

- The 80th percentile is the rate that is exceeded for 5 hours per day, or 432 hours per season.
- The 90th percentile is the rate that is exceeded for 2.5 hours per day, or 216 hours per season.
- The 95th percentile is the rate that is exceeded for 1.5 hours per day, or 108 hours per season.

What this means is that if a consent holder is consistently using their maximum consented rate for more than 5%, 10%, or 20% of the time they are pumping, it will show up in the table of percentiles.

The 80th, 90th, and 95th percentiles for the flow rate were calculated, without modelling the distribution, for the raw data set, the filtered data set, and the high rate data set. The results are presented to three significant figures below.

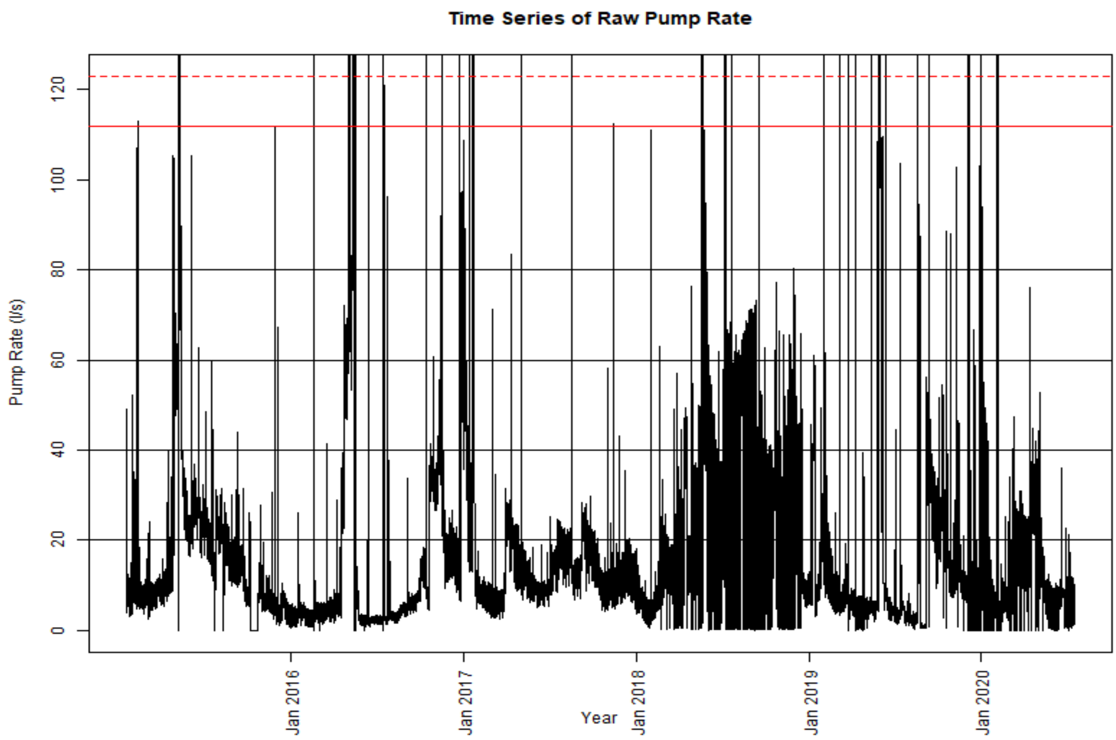
	80th %ile	**90th %ile**	**95th %ile**
Raw rate	27.8	43.8	60.6
Filtered rate	27.6	42.2	58.3
High use rate	31.9	48.9	62.8

A summary of rates and volumes for the period 1 July 2012 to 30 June 2017, prepared according to proposed Method 10.A.4 is presented below:

V1	**Max Take Rate**	**Max Daily Volume**	**Max Monthly Volume**	**Max Annual Volume**
2012/2013	NA	NA	NA	NA
2013/2014	NA	NA	NA	NA
2014/2015	112	2,400	49,300	158,000
2015/2016	112	2,400	49,700	237,000
2016/2017	112	2,400	55,000	296,000

V1	Max Take Rate	Max Daily Volume	Max Monthly Volume	Max Annual Volume
Mean	112	2,400	51,300	230,000

A time series with reference lines at 20 l/s, 40 l/s, 60 l/s, & 80 l/s is presented below to provide context for the percentiles and where they sit in relation to the history of taking by the resource consent holder.



The number of days in each month of the historical record that the 80th, 90th, and 95th percentiles have been exceeded for all three data sets is presented below:

27.8 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	2	5	0	9	24	19	10	5	4	1	2	1
2016	0	2	2	17	15	1	4	0	1	16	17	9
2017	21	0	5	6	2	0	0	2	3	0	3	2
2018	1	4	5	16	31	29	31	31	30	31	30	16
2019	12	5	2	3	5	9	4	9	26	21	9	15
2020	14	5	6	19	4	1	0	NA	NA	NA	NA	NA

43.8 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	2	2	0	5	12	4	4	0	1	0	1	1
2016	0	2	0	10	15	1	3	0	0	2	6	9
2017	14	0	1	1	1	0	0	1	0	0	2	0
2018	1	2	2	8	16	14	27	31	21	8	22	13
2019	9	4	2	2	4	7	3	8	9	6	4	11
2020	12	3	1	3	2	0	0	NA	NA	NA	NA	NA

60.6 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	0	2	0	5	12	3	0	0	0	0	1	1
2016	0	2	0	10	13	1	3	0	0	2	2	9
2017	11	0	1	1	1	0	0	1	0	0	1	0
2018	1	2	0	2	13	3	20	26	13	4	7	2
2019	2	3	2	1	4	5	2	5	2	3	1	9
2020	2	3	0	1	0	0	0	NA	NA	NA	NA	NA

27.6 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	2	5	0	9	24	19	10	5	4	1	2	1

27.6 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	0	2	2	17	15	1	4	0	1	16	17	9
2017	21	0	6	8	2	0	0	2	3	0	3	2
2018	1	4	5	17	31	29	31	31	30	31	30	16
2019	12	5	2	3	5	9	4	9	26	21	9	15
2020	14	5	6	19	4	1	0	NA	NA	NA	NA	NA

42.2 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	2	2	0	5	13	4	4	0	1	0	1	1
2016	0	2	0	10	15	1	3	0	0	2	8	9
2017	14	0	1	1	2	0	0	2	0	0	3	0
2018	1	3	2	9	17	16	27	31	23	9	23	13
2019	9	4	2	2	4	7	3	8	11	6	5	11
2020	12	3	1	3	2	0	0	NA	NA	NA	NA	NA

58.3 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	0	2	0	5	12	3	1	0	0	0	1	1
2016	0	2	0	10	13	1	3	0	0	2	2	9
2017	11	0	1	1	1	0	0	1	0	0	1	0
2018	1	2	0	2	13	3	22	30	13	5	8	2
2019	5	3	2	2	4	5	2	5	2	3	1	10
2020	2	3	0	1	0	0	0	NA	NA	NA	NA	NA

31.9 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	2	5	0	8	20	10	4	0	1	0	1	1
2016	0	2	2	16	15	1	4	0	1	14	17	9
2017	20	0	2	1	2	0	0	2	0	0	3	2
2018	1	4	5	14	31	28	31	31	30	30	29	16
2019	9	5	2	3	5	9	4	8	23	12	8	15

31.9 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	14	5	3	16	2	1	0	NA	NA	NA	NA	NA

48.9 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	2	2	0	5	12	4	2	0	0	0	1	1
2016	0	2	0	10	14	1	3	0	0	2	6	9
2017	12	0	1	1	1	0	0	1	0	0	2	0
2018	1	2	2	4	15	8	27	31	18	8	17	6
2019	8	4	2	2	4	6	2	6	6	6	2	10
2020	8	3	0	2	1	0	0	NA	NA	NA	NA	NA

62.8 l/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	0	2	0	5	10	3	0	0	0	0	1	1
2016	0	2	0	10	13	1	3	0	0	1	2	9
2017	11	0	1	1	1	0	0	1	0	0	1	0
2018	1	2	0	2	13	1	17	21	12	3	4	2
2019	1	2	2	1	4	5	2	5	2	3	1	9
2020	2	3	0	1	0	0	0	NA	NA	NA	NA	NA

A summary of daily volumes, in m³, filtered for a maximum daily take of 2400 m³ and then rounded to three significant figures is presented below:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	143	200	325	236	195	173	185	71.5	74.4	502	342	161
Mean	733	724	911	1,250	1,080	978	1,010	982	1,310	1,430	1,130	939
Median	608	675	723	1,190	888	754	1,150	1,030	1,290	1,260	923	917
80%	892	878	1,390	1,880	1,830	1,940	1,720	1,640	2,020	2,140	1,620	1,340
90%	1,360	1,200	1,780	2,160	2,330	2,260	1,910	1,840	2,330	2,330	2,080	1,600
95%	1,970	1,410	2,000	2,390	2,400	2,400	2,060	2,130	2,400	2,400	2,300	1,760
Max	2,400	2,400	2,400	2,400	2,400	2,400	2,300	2,400	2,400	2,400	2,400	2,400

A summary of monthly volumes, based on daily volumes that have been filtered for a maximum daily take of 2400m³ and then rounded to three significant figures is presented below.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	11,900	23,300	22,200	26,100	25,700	49,300	49,700	49,400	35,200	13,000	18,500	13,300
2016	10,600	8,340	13,400	9,120	8,380	7,780	13,300	10,700	18,000	20,600	25,700	35,100
2017	16,600	19,100	24,600	55,000	33,800	23,600	44,900	40,000	49,800	32,500	27,800	33,700
2018	15,800	20,500	36,600	33,200	22,800	29,000	6,350	11,200	22,000	41,500	29,800	18,900
2019	29,500	26,500	23,000	17,200	14,500	17,500	11,100	6,570	28,000	48,700	31,900	19,200
2020	13,800	18,800	48,000	45,200	32,000	20,500	11,600	NA	NA	NA	NA	NA

In summary:

- The rate of taking appears consistent with taking for storage and possibly frost fighting.
- There are two additional deemed permits that share water meter WM1363.
- Deemed permit 98527.V1 has been considered in this analysis as it was only surrendered in March 2020, its consented rate of 84l/s has been included in the total consented rate applied to this analysis.
- Deemed permit 93177 has not been included as according the RM20.003 application it has not been exercised for some time.
- The average maximum rate of take assessed in accordance with Method 10.A.4 of the Regional Plan: Water for Otago is 112 l/s.
- The average maximum daily volume assessed in accordance with Method 10.A.4 of the Regional Plan: Water for Otago is 2,400 m^3/day.
- The average monthly volume assessed in accordance with Method 10.A.4 of the Regional Plan: Water for Otago is 51,300 m^3/month.
- The average annual volume assessed in accordance with Method 10.A.4 of the Regional Plan: Water for Otago is 230,000 m^3/year.
- The applicant has applied for 28 l/s ±10%.
- The highest rate at which water can be taken and still in the range 28 l/s ±10% is 25.5 l/s.
- As the applicant has applied for less than the average maximum rate of take calculated under Method 10.A.4, this method can not be applied.