Inference Questions for Lake Onslow lake levels model

Scenarios:

The below outlines the scenarios being considered for the RM18.004 application. The focus of the inference questions below are Scenarios B and C.

A. Lake levels and lake management based on the current operating regime and current consent conditions (i.e. actual lake levels based on how the consents have been exercised with a 0.2 m per 7-day draw down) – This is the grey line in the model graph.

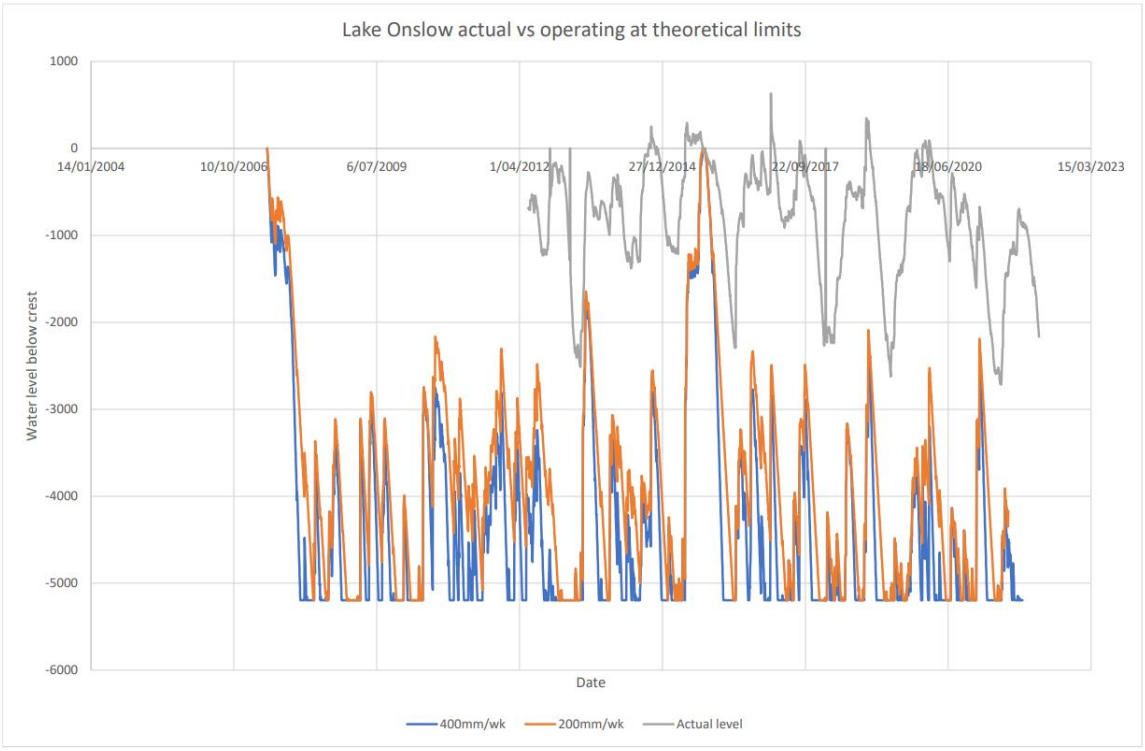
B. Lake levels and lake management based on the current consents being exercised to their fullest extent (i.e. theoretical lake levels based on a 0.2 m per 7-day draw down). – This is the orange line in the model graph.

C. Lake levels and lake management based on the proposed consents being exercised to their fullest extent (i.e. theoretical lake levels based on a 0.4 m per 7-day draw down) – This is the blue line in the model graph.

D. Lake levels and lake management based on changes to the current operating regime with the proposed consent conditions (i.e. potential actual lake levels based on a 0.4 m per 7-days draw down). The applicant has explained that modelling this is too difficult because of all the variables but indicates that the line on the graph would likely be between the grey and orange lines.

Lake Onslow lake levels model

The Lake Onslow lake levels model was provided as further information on 23 March 2022. The output from the model is reflected in the graph below.



An updated model was provided on 24/5/2022. This model included additional actual lake level data from the historic record for the period Nov 2006. This model also included the functionality to scale the simulated inflow to check sensitivity. The inflow can be scaled by adjusting cell B5 in tab "Specific flow"

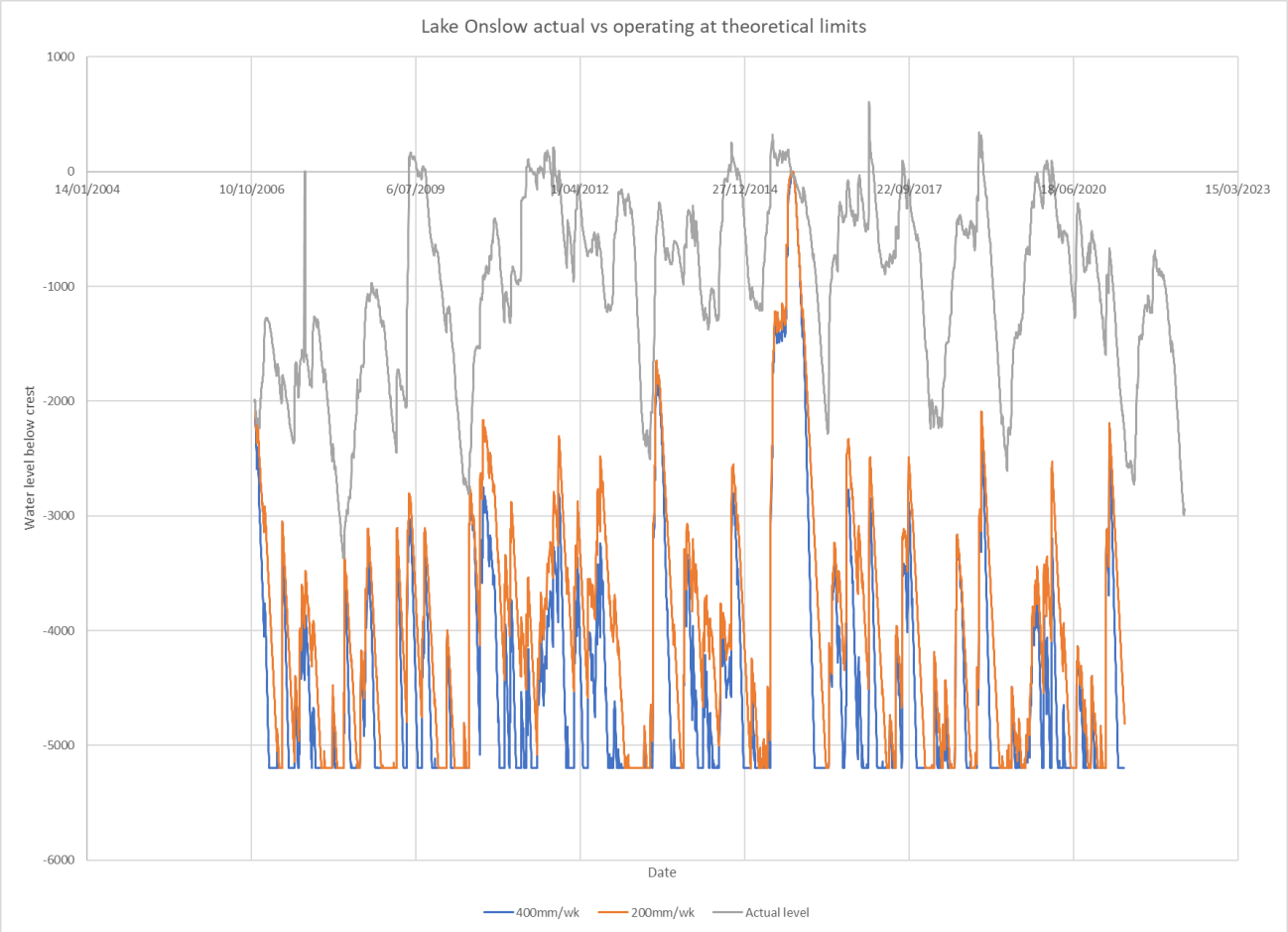


Figure 1 Lake Onslow Simulated lake level under Scenario B & C at Base Inflow.

Questions:

1. The percentage of time that the Lake Onslow water level would have been below 2.5 m below crest and below 3 m below crest (i.e. between 2.5/3 m and 5.2 m) for Scenarios B and C since the 2001.475 and 2001.476.V3 consents were exercised (It is understood that data commences from June 2007).

The inflow data has been provided by NIWA, courtesy of MBIE. This data has been calculated to support the NZ Battery Project. It is our understanding that the data is based on a scaled time series data set for the Taieri River at Canadian Flat. For sensitivity in calculating the relative levels I have included responses for 2scenarios: Taieri-derived base inflows as received, +10% within the model inflow can be scaled by adjusting cell B5 in tab "Specific flow"

Percentage of Time level below -2.5m & -3.0m

	Base inflow	+10%
-2.5m @200mm	92%	81%
-2.5m @400mm	95%	90%
Change	3%	9%
-3m @200mm	84%	66%
-3m @400mm	85%	77%
Change	1%	11%

2. The percentage of time that the Lake Onslow water level would have been at the lowest lake level (i.e. 5.2 m below crest) for Scenarios B and C since the consent was implemented (June 2007).

   In exercising of consents 2001.475 and 2001.476.V3 Lake Onslow would not be drawn below 5.2m as this is below the minimum operating limit. A more practical approach is to analyse the percentage of time that the lake would theoretically be drawn below 5.19m.

Percentage of time lake at lowest levels

	Base inflow	+10%
% below 5m @200mm	14%	8%
% below 5m @400mm	39%	30%
Change	25%	24%

3. The average and maximum time (days) that the lake would have been held at the lowest lake level (i.e. 5.2 m below crest) for Scenarios B and C since the consent was implemented (June 2007) for:
   a. Maximum for total time period (June 2007 until June 2021)

   Theoretical maximum continuous days held at below 5.19m

	Base inflow	+10%
Max days empty @200mm	92	54
Max days empty @400mm	93	80

b. Average duration for total time period (June 2007 until June 2021)
This is difficult to calculate with the modelling tools used

c. Maximum duration within each year (i.e what was the maximum duration within each year that the lake was held at 5.2 below crest).
See below

d. Average duration within each year (i.e what was the average duration for each year that the lake was held at 5.2 m below crest)
The table below shows the calculated theoretical days each calander year that the lake would have been at the minimum operating level under Scenario B & C

Theoretic days Lake below -5.19m by year for scenario B & C				
	Base		10%	
Year	200	400	200	400
2006	0	0	0	0
2007	60	200	16	155
2008	151	231	94	194
2009	118	209	93	181
2010	94	150	86	120
2011	3	96	0	79
2012	9	168	0	81
2013	164	227	87	195
2014	0	101	0	66
2015	65	120	0	92
2016	24	134	18	85
2017	52	185	0	141
2018	147	203	88	175
2019	125	211	80	170
2020	116	233	65	196
2021	0	44	0	37
Total	1128	2512	627	1967
Average per year	71	157	39	123

4. A comparison of the frequency of lake level fluctuations between Scenario B and C. Would Scenario C have more fluctuations in lake levels then Scenario B and, if so, can this be quantified and described (i.e. at what lake level do these occur).
There is not simple means of calculating lake level fluctuations. I believe it is fair to say that the lake tends to either trend upwards or downwards over a period of days to months. Increase in lake level is associated with increase in inflows which is a function of weather, i.e. rainfall or snow melt.

5. Explanation for why graph is to 5.2 m below crest.
5.2 m because that is the operating range of the lake. The spillway is 685.115m and the minimum is 679.9m. (5.215m range)

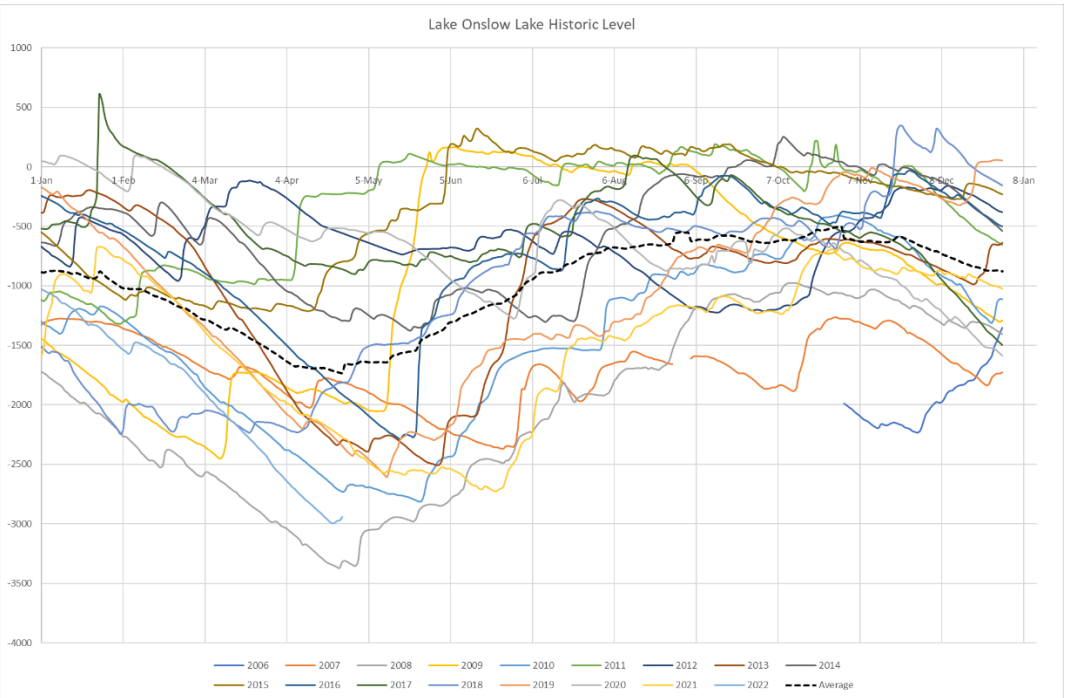
6. The calendar years since the consent was implemented where the lake was between 2.5 m and 5.2 m below crest for the entire year for Scenarios B and C.

	Base Flow	+10%
-2.5m @200mm	2007, 2008, 2009, 2014, 2019, 2020	2007, 2008,
-2.5m @400mm	2007, 2008, 2009, 2010, 2011, 2012, 2014, 2017, 2019, 2020	2007, 2008, 2009, 2019, 2020

7. The calendar years since the consent was implemented where the lake was between 3 m and 5.2 m below crest for the entire year for Scenarios B and C.

	Base Flow	+10%
-3.0m @200mm	2008	Nil
-3.0m @400mm	2007, 2008, 2009, 2012, 2017, 2019, 2020	Nil

8. The months in the year where there are the highest lake levels (i.e. between 0 and 3 m below crest) in Scenarios B and C
   Theoretical lake levels under scenarios B & C appear to follow the actual recorded lake levels recorded over the period. The actual record for each year and the long term average is provided in the chart below.



9. A description of the discharge from the dam to the Teviot River when Lake Onslow is at 5.2 m below the crest. Would the discharge be limited to the residual flow of 345 L/s, required by Condition 4 of 2001.476.V3?
   At the minimum level the outflows would be the lesser of 345l/s or the actual inflows.

10. The average and maximum difference in speed at which Lake Onslow would reach 5.2 m below crest between Scenarios B and C (e.g. in the description to the model on 23 March 2022 – question 4 - it was stated that the lowest lake level would be reached approximately 3 weeks sooner under Scenario C)

Theoretically it will take 26 weeks to draw the Lake down from full to 5.2m below crest under a 200mm/wk operating regime assuming. At 400m/wk that would reduce to 13 weeks.
However, under Scenarios B & C the lake seldom fills and will have a different "starting" depth an each change from a filling period to a draining period. The difference in time taken to drain the lake to minimum levels is proportional to the "starting" depth. Therefore, it is not possible to state the relative time to empty as there is not a common starting point, without making some fairly large assumptions

NOTE on inflow confidence.
A check on the validity of the Synthetic inflows derived from the Tiaeri River have been carried out to confirm if they are generally in agreeance or realistic with actual lake inflows. To validate the inflows the period from 1/6/2013 to 1/8/2013 have been selected as this period coincides with a period of inflow that did not cause the lake to overflow.

On the 1/6/2016 the lake level was -2.500 witha stored volume of approximately 24,000,000m^3. Over the period 1/6/13 to 1/8/13 the lake level rose to a level of -0.300m, with an approximate volume of 43,000,000m^3. The Net increase over that period was approximately 19,000,000m^3. However, if a variance of +/-10% is considered in terms of accuracy of storage volume for a particular depth this change in volume could range from 12,000,000m^3- 26,000,000m^3

The calculated inflow over that period based on the synthetic hydrograph was approximately 47,000,000m^3. This was calculated by multiplying the daily average inflow for each day over the period by 86,400 seconds and summing.

The approximate outflow from the lake between 1/6/13 to 1/8/13 was varied between 2m^3/s and 3m^3/s. It has been assumed that the average outflow for the period was 2.5m^3/s. This results in an calculated outflow of approximately 13,000,000m^3.

Theoretically the change in lake volume should be equal to Inflow – outflow. (47,000,000 – 13,000,000 = 34,000,000m^3). As the calculated change in volume (34,000,000m^3) is larger than the actual change in volume (19,000,000m^3) it can be concluded that the inflow hydrograph likely estimates the inflows into Lake Onslow.

Given the range of uncertainty in the actual volume change over the period considered it has been concluded that the Synthetic inflows derived from the Taieri River likely has an uncertainty of +/-10%. An error of +/-10% is considered reasonable for a hydrograph derived from historical record of an adjacent catchment. Considering the number of assumptions and the highly theoretical nature of the analysis carried-out interms of scenario B & C the inflow data is considered to be reasonable.