



Two Lake Scheme Alternative Flood Analysis

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1 Introduction

Cardno has been engaged by Penrith Lakes Development Corporation (PLDC) to undertake flood modelling and design of the Penrith Lakes Scheme. A detailed investigation into the flood infrastructure of the scheme was previously undertaken (Cardno, 2010).

The investigation detailed in Cardno (2010) was based on a single Main Lake. This report examines an alternate lake scheme, and in particular the differences in flood behaviour to the previous scheme discussed in Cardno (2010). The alternate scheme differs in two ways. The first is that Main Lake is divided into two separate lakes, which is referred to in this report as the "Two Lake Scheme." The second is that Quarantine Lake is reduced by 4ha to 41ha, and connected to the Regatta Lake, and is referred to as the "Small Quarantine Lake Scheme."

Each of these aspects was assessed individually so that any changes in flood behaviour could be attributed to one or the other.

2 Alternative Scheme Details

A comparison of the One Lake Scheme, as per Cardno (2010), and the Two Lake Scheme / Small Quarantine Lake Scheme is provided in **Figure 1**.



Figure 1: Comparison of the two Schemes

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Under the Two Lake Scheme, Main Lake A, located adjacent to Quarantine Lake and Regatta Lake is the larger of the two lakes, and has an operating level of 14mAHD. Main Lake B is located between Main Lake A and Wildlife Lake, and has an operating level of 12mAHD.

The two lakes are separated by a weir, with a crest set at 14mAHD, and a length of 375m.

It is noted that the Two Lake Scheme is similar to the One Lake Scheme. The primary difference is that the Main Lake B has an operational level of 12m AHD, and the presence of the weir between Main Lake A and Main Lake B.

In the Small Quarantine Lake Scheme, Quarantine Lake has been reduced from 45ha to 41ha. A connection has also been provided between Quarantine Lake and Regatta Lake so that the two water bodies are connected when at their operating level of 15mAHD.

Weir 1 and overland flowpaths between Quarantine and Regatta Lakes and Main Lake have been kept as per the One Lake Scheme (refer Cardno (2010) for details).

3 Modelling & Results

The alternatives schemes were modelled for both the 100yr and 200yr ARI events. The terrain adopted in the modelling for the Two Lake Scheme is shown in **Figure 2** and the terrain for the Small Quarantine Lake Scheme in **Figure 3**.

The model was identical to the model used previously, save for the introduction of the weir splitting Main Lake and the operational level of Main Lake B, and the reduction in Quarantine Lake volume, and the provision of a connection between Quarantine Lake and Regatta Lake. For discussion on the inflows, roughness values, boundary conditions and other model parameters, refer to the previous study (Cardno, 2010).

Difference plots comparing the peak flood levels for the 2 alternate schemes are shown in **Figure 4** and **Figure 5** for the 100yr and 200yr Two Main Lake results, and **Figure 6** and **Figure 7** for the 100yr and 200yr Small Quarantine Lake results respectively. **Table 1** and **Table 2** summarises the water levels at key points in the system for the 100yr and 200yr events respectively.

Water level time series from the Two Main Lakes Scheme for Main Lake and the Wildlife Lake are shown in **Figure 8** and **Figure 9** respectively for the 100yr ARI event. Water level time series from the Small Quarantine Lake Scheme for Quarantine Lake, Main Lake and Wildlife Lake are shown in **Figure 10** to **Figure 12** respectively.

Table 1: Difference in Water Levels between Schemes – 100yr						
Location	One Main Lake Level (mAHD)	Two Main Lake Level (mAHD)	Difference (m)	Small Quarantine Lake (mAHD)	Difference (m)	
Victoria Bridge	25.09	25.08	-0.01	25.09	0.01	
River @ Weir 1	23.57	23.56	-0.01	23.57	0.01	
Quarantine Lake	22.65			22.65	-0.02	
Regatta Lake	22.66			22.66	0.03	
Main Lake (a)	22.63	22.63	-	22.63	-	
Main Lake (b)	22.63	22.62	-0.01	22.63	-	
Wildlife Lake	20.95	20.94	-0.01	20.94	-	
Waterside Green	22.00	21.99	-0.01	21.99	-	
Cranebrook Village	Flood free	Flood Free	-	Flood Free	-	
Hunts Gully	20.36	20.34	-0.02	20.34	-	
1km Downstream of Hunts Gully	20.52	20.50	-0.02	20.50	-	

Table 2: Difference in Water Levels between Schemes – 200yr

Location	One Main Lake Level (mAHD)	Two Main Lake Level (mAHD)	Difference (m)	Small Quarantine Lake (mAHD)	Difference (m)
Victoria Bridge	25.94	25.94	-	25.94	-
River @ Weir 1	24.52	24.52	-	24.52	-
Quarantine Lake	23.50			23.50	-0.02
Regatta Lake	23.53			23.53	0.09
Main Lake (a)	23.43	23.44	0.01	23.44	-
Main Lake (b)	23.43	23.43	-	23.44	-
Wildlife Lake	22.65	22.65	-	22.65	-
Waterside Green	24.10	24.10	-	24.10	-
Cranebrook Village	24.02	24.02	-	24.02	-
Hunts Gully	22.02	22.02	-	22.02	-
1km Downstream of Hunts Gully	22.04	22.03	-0.01	22.03	-

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3.1 Two Main Lake Discussion

In the Two Main Lake Scheme, very little difference was observed between the models. The slight increase in storage in Main Lake B, due to its lower operating level, results in lowered levels in Wildlife Lake by 0.02m and downstream of the site by 0.01m for the Two Lake scheme. No changes were observed in the 200yr event, save for some minor differences around the new weir crest.

The water level time series also show that the introduction of the Main Lake Weir has a negligible impact on the filling rates and discharge rates of the lakes.

There is a slight reduction in the filling rate of the Main Lake system in the Two Lake Scheme, but this does not affect the peak level, the filling of Wildlife Lake, or the downstream water levels.

The alternate scheme did not have an effect on the overtopping velocities of Weir 6. The peak values for the One Lake and Two Lake options are summaries in **Table 3**.

Event	One Lake Weir 6 Peak Velocity (m/s)	Two Lake Weir 6 Peak Velocity (m/s)
100yr ARI	6.8	6.8
200yr ARI	7.8	7.7

Table 3: Two Main Lake Scheme Peak Weir 6 Overtopping Velocity

The slightly different filling rates of Main Lake and Wildlife Lake had only minor effects on the overtopping heights of the riverbank (refer **Table 4**). Riverbank overtopping was assessed at the same points with the same methodology as defined in the previous study (Cardno, 2010).

Location	One Lake Scheme Overtopping Height (m)	Two Lake Scheme Overtopping Height (m)	
Upstream Main Lake	0.98	0.89	
Middle Main Lake	0.52	0.53	
Downstream Main Lake	0	0	
Upstream Wildlife Lake	1.22	1.29	
Downstream Wildlife Lake	0.73	0.83	

Table 4: Two Main Lake Riverbank Overtopping Height

3.2 Small Quarantine Lake Discussion

The small Quarantine Lake alternative scheme produced only minor differences compared to the original model. By connecting Quarantine Lake and Regatta Lake together, they effectively function as a single body of water, and provide additional storage upstream of Main Lake, even with the reduction in size of Quarantine Lake.

This storage slows the initial filling of Main Lake. However, the two models reach a similar level by the time Main Lake levels reach 21mAHD and Weir 6 activates, resulting in no change to the filling rates of Wildlife Lake.

Peak levels both upstream and downstream of Quarantine Lake did not change.

The alternate scheme did not have an effect on the overtopping velocities of Weir 6. The peak values for the One Lake and Two Lake options are summaries in **Table 5**.

Event	Small Lake Weir 6 Peak Velocity (m/s)	Large Lake Weir 6 Peak Velocity (m/s)
100yr ARI	6.8	6.8
200yr ARI	7.8	7.7

Table 5: Small Quarantine Lake Peak Weir 6 Overtopping Velocity

The slightly different filling rates of Main Lake and Wildlife Lake had negligible effects on the overtopping heights of the riverbank (refer **Table 6**). Riverbank overtopping was assessed at the same points with the same methodology as defined in the previous study (Cardno, 2010).

Table 6: Riverbank Overtopping Height

Location	Small Lake Scheme Overtopping Height (m)	Large Lake Scheme Overtopping Height (m)	
Upstream Main Lake	0.86	0.89	
Middle Main Lake	0.50	0.53	
Downstream Main Lake	0	0	
Upstream Wildlife Lake	1.22	1.29	
Downstream Wildlife Lake	0.82	0.83	

4 Conclusion

The analysis showed that the Two Lake Scheme and the Small Quarantine Lake Scheme resulted in only slight changes to the flood behaviour over a Single Lake Scheme. The minor changes in filling rates and overtopping heights would have no significant impact on flood levels or extents.

As a result, the information contained in the previous flood infrastructure investigation (Cardno, 2010) detailing the flooding behaviour, is equally applicable to the alternative Two Lake Scheme and Small Quarantine Lake Scheme.

5 References

Cardno (2010). *Penrith Lakes Scheme: Flood Infrastructure Concept Design*, prepared for Penrith Lakes Development Corporation, Final, 27 May 2010.