Report

Review of the Matahina Dam Flood Management Procedures

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Prepared for

Bay of Plenty Regional Council

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Table 1 shows the main hydraulic features (levels and flows) of Matahina reservoir.

Below, Figure 1 shows the stage-volume curve for Matahina reservoir.

Figure 1-2 shows the maximum discharge capacity as per lake level.

Table 1-1 Hydraulic Features of Matahina Reservoir

LEVELS	MSL Moturiki Datum	
Dam Crest	79.25	M
Core Level	77.72	M
Design Flood	76.8	M
Top of Spillway Gates	76.5	M
Top of Spillway Crest	64.008	M
Dewatering Facility Invert	36.58	M
Normal Operation Maximum	76.2	M
Normal Operation Minimum	73.15	M
Extreme Operating (top of intake flare)	71.63	M
OUTLETS		
Flow of Full load	135	Cumecs
Spillway Gates	3 @ 8.53m wide	
Dewatering Facility	1 tunnel 3.66 dia.	

1 Current Flood Management Operation

Figure 1-1 Matahina Reservoir Stage-Storage Curve

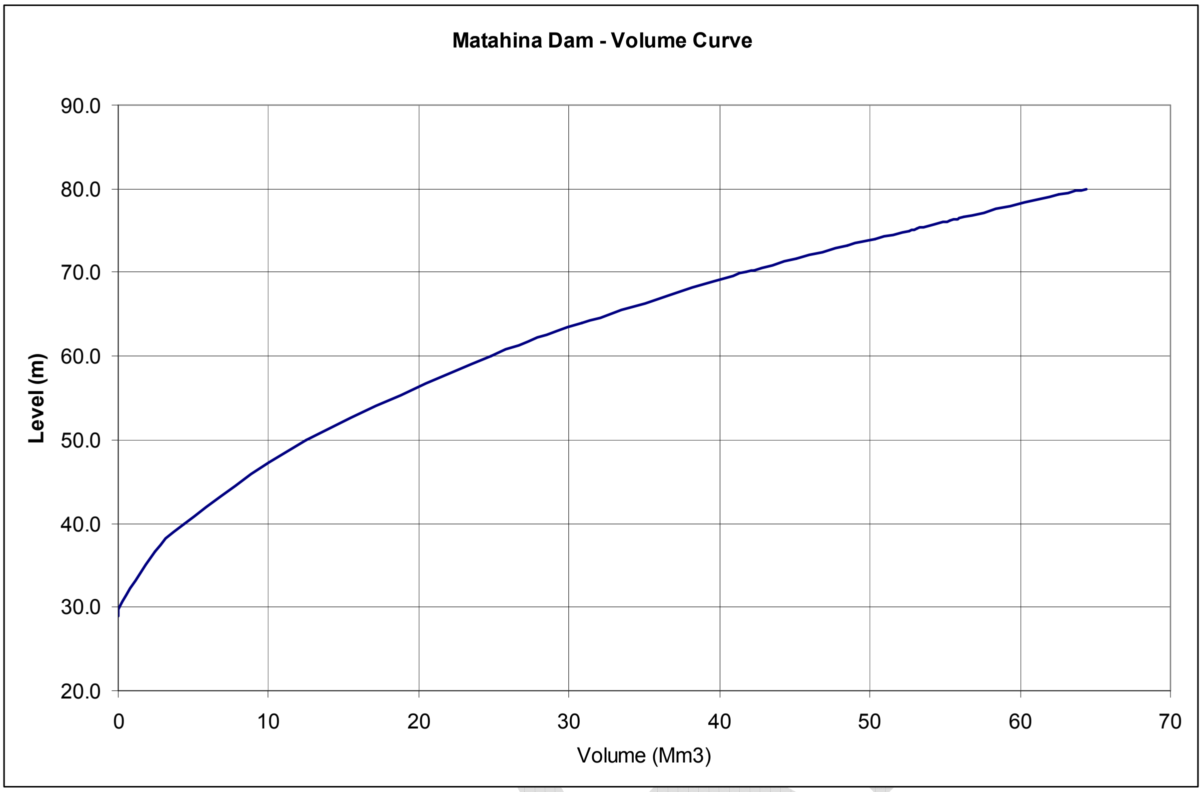
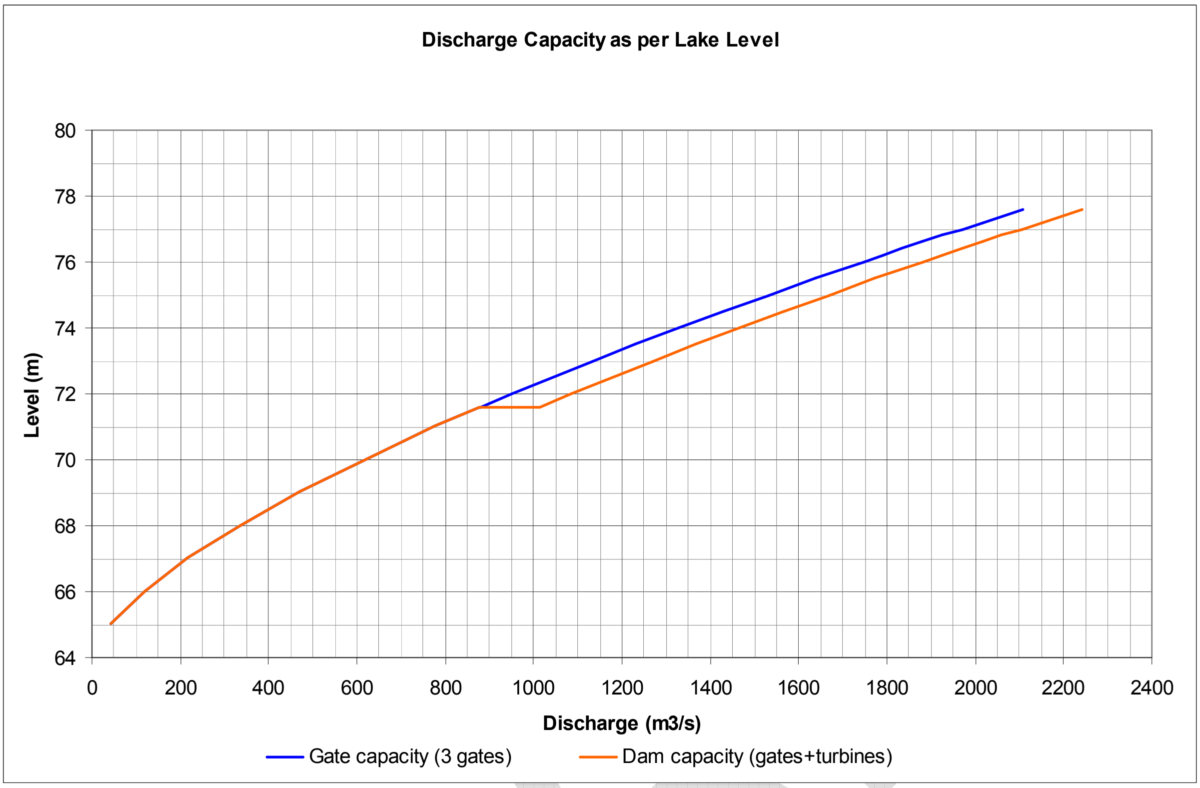


Figure 1-2 Matahina Reservoir Discharge Capacity as per Level



1.2 Dam Operational Rules

Currently there are three operational stages as defined in “MAT Flood Management Procedure”:

Stage 1 - Normal operation

Dam operation maximizes power generation. It is the normal operation for base flows and minor storms. Under this scenario the dam operation does not offer any flood control as floods are not expected. Lake Levels range from 73.15m to 76.2m and flows are usually no greater than the flow rate required for maximum power generation of 135 cumecs. If lake levels exceed 76.4m, then Figure 1-2 is followed to calculate total discharge (refer below).

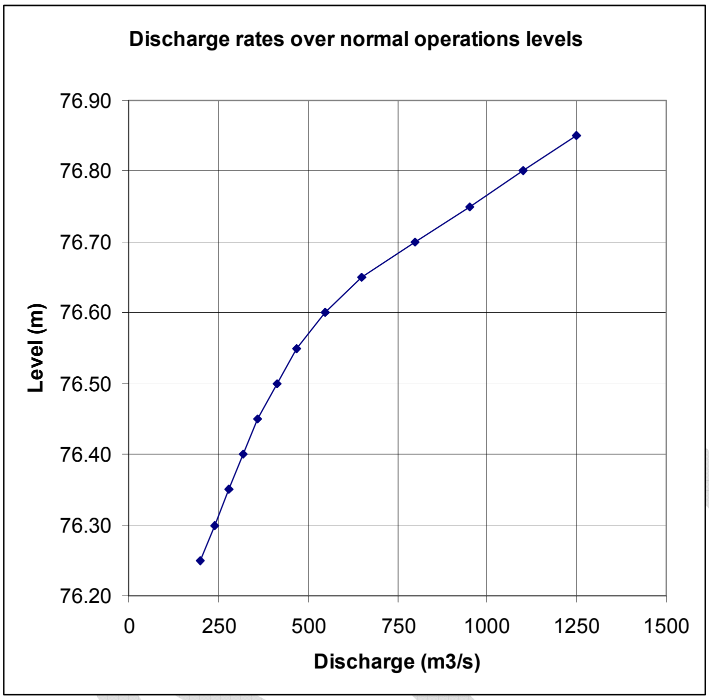
Stage 2 – Inflow less than 500 cumecs without lake drawdown

The dam operates when a flood less than 500 cumecs is expected and no request is received from BOPRC to lower lake level or external communication with station is lost. Operation in this stage waits for the peak flow at a level of 76.4 m with a full load of 135 cumecs. In general, for flows over 135 cumecs there is not flood control.

If lake level goes over 76.4 m, the following table is used to calculate the total flow. Total outflow can be increased to 755 cumecs if required.

Figure 1-3 Total discharge above normal operating levels

Lake Level	Discharge
m	Cumecs
76.25	200
76.30	240
76.35	280
76.40	320
76.45	360
76.50	415
76.55	470
76.60	550
76.65	650
76.70	800
76.75	950
76.80	1100
76.85	1250



Stage 3 – Inflow greater than 500 cumecs with lake drawdown

The dam operates when reservoir inflow is expected to be greater than 500 cumecs and a request is received from BOPRC to reduce the lake level.

This scheme basically waits for the peak of the flow from the storm with the lake level as close to 71.6m is possible with a maximum total discharge of 550 cumecs.

The maximum total discharge can be increased up to 600 cumecs if lake levels are rising to fast or are above 76.2 m. Discharge will also exceed 550 cumecs above level 76.6 m with the total discharge following the relates schedule detailed in Figure 1-3.

Review of operational performance

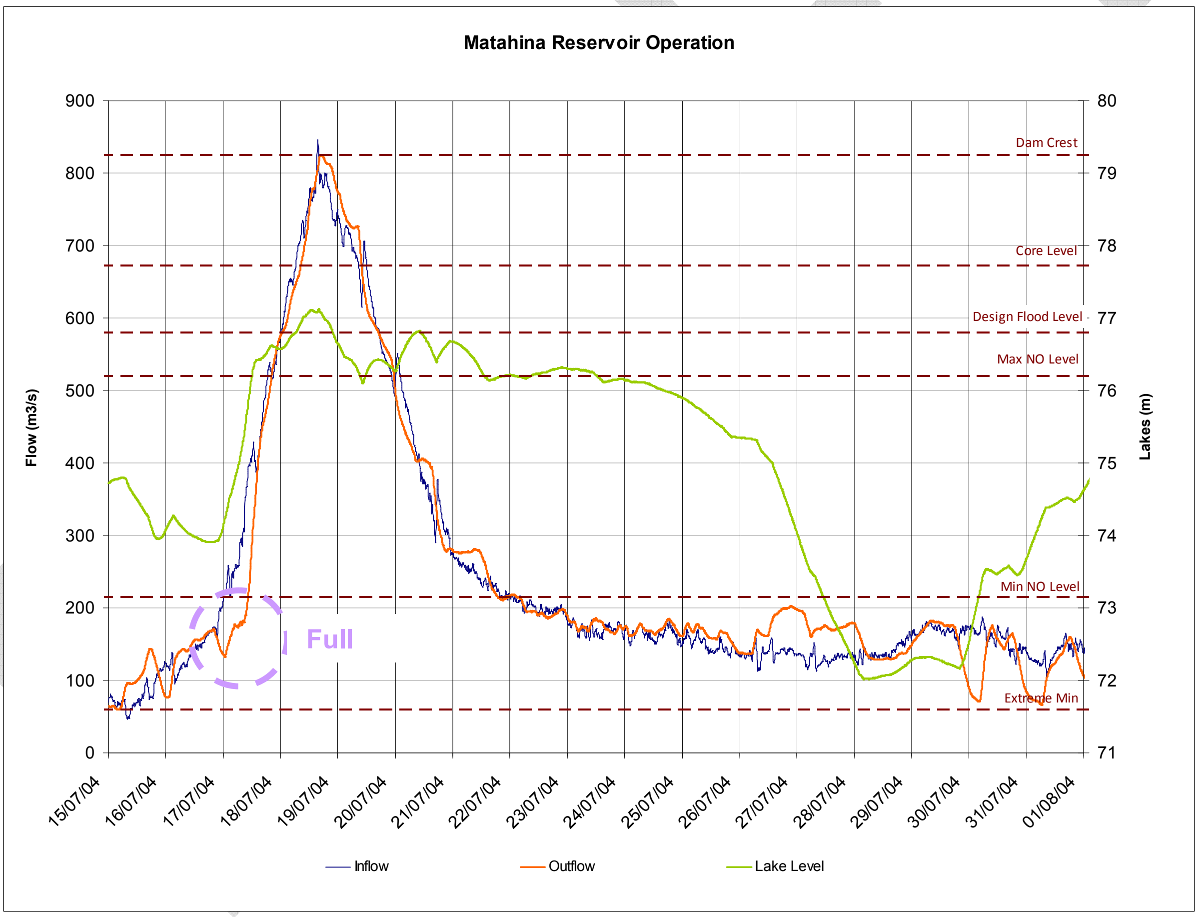
2.1 July 2004 Storm Event

2.1.1 Actual performance - July 2004 event

The July 2004 storm is estimated to be approximately the 100-year AEP. Due to this and the availability of data it is a good case study to test the published dam flood management rules.

Figure 2-1 shows the inflow, outflow and level records at Matahina reservoir during the 2004 flood. The levels were directly recorded. The outflows were estimated from Te Teko records. The inflows were estimated using two methods: the current InfoWork RS (IWRS) model calibrated for the storm of July 2004, and using a mass balance based on known levels and outflows at the dam. The graph shows inflows from the IWRS model.

Figure 2-1 Inflows, outflows and levels of Matahina reservoir occurred in July 2004



The above graph mimics the reservoir operation during the July 2004 storm event. It demonstrates the following findings:

- The peak inflow was approximately 800 cumecs, significantly higher than the 500 cumecs threshold, at which BOPRC may request the Matahina Dam lake level be lowered to RL 71.63.
- The Lake level was reduced to about 74m before the storm event. Water levels kept rising sharply due to rapid increase of the lakes inflow.
- The inflow peak was developed in about 36 hours.

- The Matahina Dam operational rules relate closely to the lake inflow forecast.

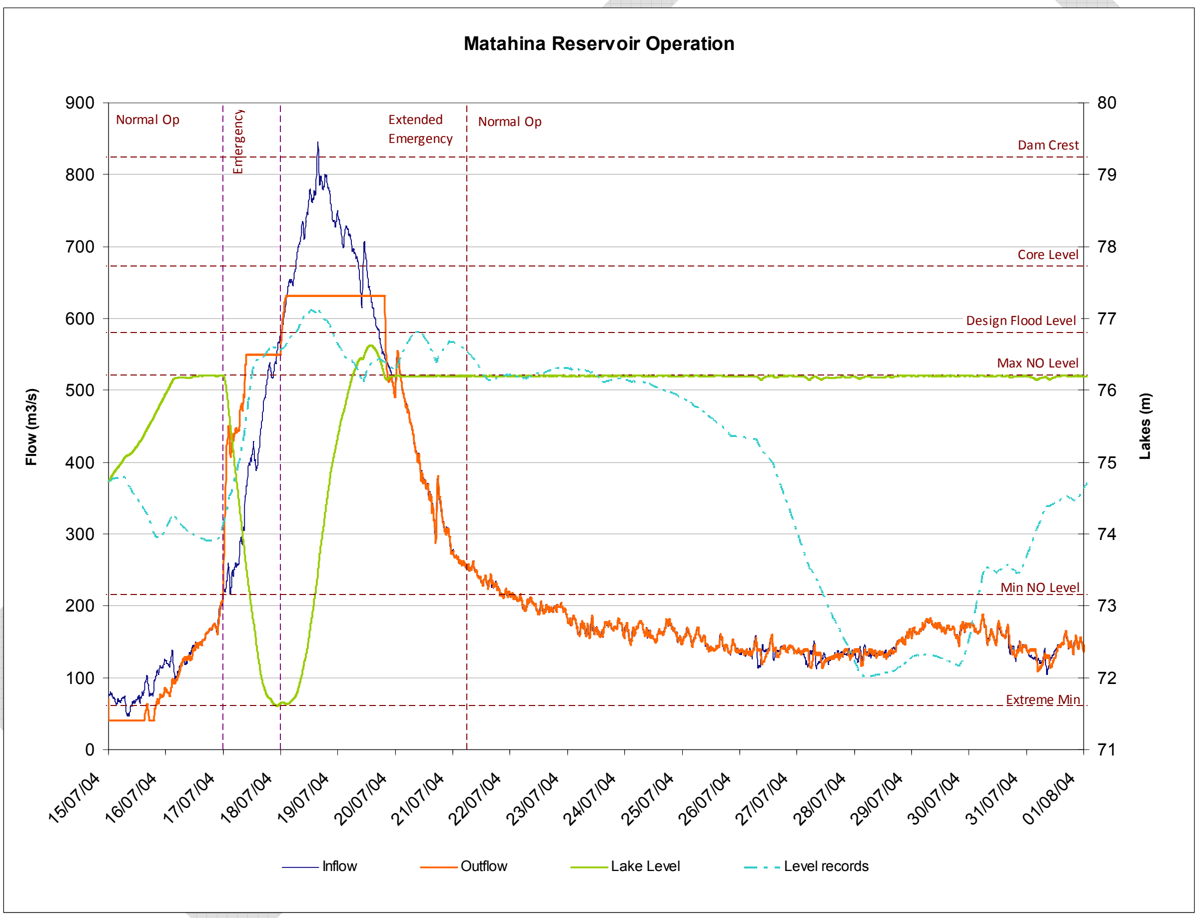
2.1.2 Optimised operation - July 2004 event

The review of the actual performance demonstrates the importance of the lake inflow forecast and the early warning time. The 2004 flood illustrated that a 36-48 hours early warning time is possible to forecast and therefore the dam outflow and levels could be optimised with the current published rules.

Figure 2-2 demonstrates the 2004 flood reservoir performance optimizing the published flood management rules. This scenario assumes that the Matahina Lake inflows were predicted 36 hours in advance. Drawdown rates adhere to the MAT Flood Management Procedure.

As shown the peak outflow of the July of 2004 event could have reduced the peak outflow by 150 cumecs than the actual peak outflow in July 2004 event.

Figure 2-2 Example of current rule operating with optimised drawdown levels and outflow



2.2 Minimum Extreme Lake Level

Current MAT Flood Management Procedure set the extreme minimum lake level at 71.6m. Further drawdown below the minimum of 71.6 m would impact production of energy and dam stability issues would also need to be considered.

The minimum reservoir level during of July of 2004 storm event was approximately 73.9 m. If the minimum extreme level had occurred and outflows were optimised the peak flood outflow would have been reduced by an additional 150 cumecs to a maximum discharge of less than 650 cumecs.

If energy production could be null for a short period and the dam can operate safely below 71.6 m, considering stability issues, then lower levels would provide better flood control. However, consideration must be given to the maximum discharge in relation to lake levels. As shown in Figure 1-2 the discharge capacity is limited by the level at the outlet structures. The optimum minimum level depends on the desired and achievable maximum discharge rate. The desired discharge rates would depend upon the forecasted storm and associated flow. Achievable discharge rates depend upon the level of the reservoir. As shown in Figure 1-2 the maximum discharge of 550 cumecs is achievable at level 69.5 m.

2.3 Tidal Control Rule

The idea of a tidal control rule for outflows from Matahina dam would be to avoid peak discharges with the peak of the tide. Tide influence is in lower Rangitaiki and extends to below the Reid's Canal spillway.

At SH2, the tide influence is already small with maximum variations of less than 10cms. A variation of 100 cumecs in flow induces variation in levels of about 0.50 m in Rangitaiki river levels at SH2 and 0.25 m at SH30. Upstream of the spillway, variation of 100 cumecs in flow generates variations of about 0.40 to 0.50 m.

If a tide based rule operate in Matahina dam to avoid peak time levels, then levels in the lower Rangitaiki River that is controlled by the tides could be reduced. However, as the tide influence decreases the benefits of this rule decreases. In fact due to the necessity of increased discharge resulting from the attenuated discharge the tidal rule could have a negative effect in the upstream areas. In other words, reductions in some downstream locations in Rangitaiki mean incremental increases of levels in some upstream areas.

Considering flows over 620 cumecs the Reid's Canal spillway would operate and the dynamics of the problem will change.

The tidal control rule would give some benefit for maximum flows less than 600 cumecs

2.4 Conclusions and Comments

The Matahina Dam July 2004 flood analysis indicates the great benefits of optimising the reservoir for flood control during large storm events. Optimising storage and associated discharge rates are achievable with an accurate reservoir inflow forecast with over 36 hours warning time. To achieve this, an effective cooperative approach is essential between BOPRC and TPL. If the dam had been optimised for the peak flow from generated from the July 2004 event a reduction of 150 cumecs downstream was achievable. That equates to a nearly 20% reduction in flow.

Reducing the Minimum Extreme Level does not seem to have much benefit to flood management; the extra storage volume by reducing the Minimum Extreme Level is marginal. When considering the flood volume and the associated achievable discharge rates limited by the reduced lake level.

MAT Flood Management Procedure (MAT/EP/001) has a clearly defined 3-stage. Dam operational rules during flooding. The main issues within these rules are the lake inflow forecast and the optimisation of discharge rates. The lake inflow forecast affects a series of critical decisions on Dam operation. The accuracy of this estimate is affecting the decision on power generation, as well as the operation for flood control, dam safety and the downstream flooding. We believe the current URS initial model has demonstrated the possibility of predicting accurate flows in order to evaluate Dam operation in real time flooding events, its impact to the downstream and the consequences to the Dam itself.

It is believed to be more critical to use the best approach to achieve optimization of the reservoir operation during flood events. The optimisation can be done using the current procedures with minor adjustments to the rules regarding the discharge rates during large storm events.

We would recommend:

- TPL and BOPRC should jointly develop a Matahina Lake Inflow forecast model. It is possible to use independent forecast model and this may be desirable depending on the needs of both parties. Regardless, each model should include at least a complete upper catchment hydrological model based on real time rainfall data and a developed hydraulic model to well represent the significant hydraulic features within the river system. The forecast model should utilise rainfall forecast model to increase forecast lead time.

- BOPRC should have a robust and accurate full catchment hydrological and hydraulic model, embedded with Matahina operational rules and a number of prepared Dam operational scenarios under many different large storm events ranging from the 40 year AEP. This model/system will help BOPRC to evaluate flood risks well in advance when large rainfall events are predicted. It will also form the basis of the Flood management strategy for the Rangitaiki River.

- BOPRC and TPL continue to strengthen their working relationship regarding flood management utilising the Matahina Dam.

Glossary

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Appendix A

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