# 5.0 NUMERICAL MODEL ASSESSMENT OF FLOOD MITIGATION OPTIONS

The water balance model, described in Section 2.1, was used to simulate all of the flood mitigation options, excluding the legislative policy options which were not modelled. Generally, the same water balance model and runoff sequences were used to simulate all of the options. However, alterations were made as required to reflect the assumptions made for each option, including reducing input runoff volumes (e.g. diversion and storage options) and adding an additional outflow to the model (e.g. removal of water from Quill Lakes options).

One of the main modelling assumptions was that water would be removed, diverted, or stored upland regardless of the water level on the Quill Lakes. This assumption was made in order to quantify the maximum possible benefits of each mitigation option. However, it is possible that operation policies could be developed that mandate that mitigation measures are only to be utilized once the lake level reaches a particular threshold. This will help ensure that the lake level remains within a desirable range.

Similar to the existing conditions or base case simulations described in Section 3.1, the water balance model was used to simulate the one thousand 50 year sequences of runoff, evaporation, and precipitation and compute the corresponding resulting Quill Lakes water levels. The series of computed outflows for each option were analyzed similar to those for the existing condition, as described in Section 3.1, and statistical water level graphs and frequency curves were developed. The results for all of the flood mitigation options plots are shown in Plates 6-27.

The model results were also analyzed and quantified based on the water level, probability, and volume metrics that are described in Section 3.1. Tables 7 and 8 provided a summary of the model results for all of the flood mitigation options considered in this study.

Table 7 shows a comparison of modelled water levels in Big Quill Lake and Little Quill Lake for all of the flood mitigation options. The model results indicate that the short term (5 year) average reduction in water level on Big Quill Lake between the base case and the various options ranged between 0 m and 0.42 m, with about half of the options only having a minor overall reduction of 0.06 m or less. The reduction in long term (50 year) average water level on Big

Quill Lake between the base case and the various options ranged between 0.08 m and 3.84 m. The option of blocking the natural outlet produced an average increase of 0.15 m in Big Quill Lake water level.

Table 8 shows a comparison of the likelihood that the Big Quill Lake Level will remain below key elevations within the basin. It is acknowledged that currently the lakes have reached El. 520.7 m. Therefore the percentages shown in Table 8 need to be considered as the likelihood of the lake levels either remaining or receding to the given elevation at the given timeframe. For example, the likelihood that the water level on Big Quill Lake will recede to El. 519 m and no longer flood crop land in 10 years from now for the base case is 18%.

The model results indicate that within the next 5 years, the percentage of simulated water levels that did not exceed El. 521.47 m ranged between 86% and 96%. The long term results did not differ significantly from the short term results. Over the next 50 years, the percentage of simulated water levels that did not exceed El. 521.47 m ranged between 83% and 98%.

Table 8 also shows the likelihood that water levels will remain below the elevation of Hwy 6 (El. 520.98 m). Within the next 5 years, 67% to 88% of the simulated Big Quill Lake water levels were below El. 520.98 m. The range for the long term results was slightly higher than the short term results. Over the next 50 years, the percentage of simulated water levels that did not exceed El. 520.98 m ranged between 76% and 95%.

The percentage of simulated water levels indicating that the elevation of Big Quill Lake will not exceed the minimum cropland elevation (El. 519 m) within the next 5 years ranged from 13% to 40%. The range for the long term results was significantly higher than the short term results. Over the next 50 years, the percentage of simulated water levels that did not exceed El. 519 m ranged between 33% and 75%.

The percentage of simulated water levels indicating that the elevation of Big Quill Lake will recede to below the December 2015 water level (El. 520.45 m) within the next five years ranged from 47% and 73%. The range for the long term results was significantly higher than the short term results. Over the next 50 years, the percentage of simulated water levels that did not exceed El. 519 m ranged between 62% and 91%.

Overall, the analysis showed that the flood mitigation options will result in a range of benefits in terms of reduced lake levels, for both short and long term time horizons. However, the lake levels are largely driven by weather conditions and thus the magnitude of the benefits will be defined by weather conditions in the future. The benefits to reduced lake levels, as a whole, are realized over a long time horizon, not near term. How the lake levels respond in the next five years will be largely dependent on the weather, regardless of the option considered. As a result, the lake levels presented in Table 7 should not be considered absolutes or forecasted values. Rather, the relative benefits between the base case and the options should be evaluated when considering the effectiveness of each option.

## TABLE 7
## FLOOD MITIGATION OPTIONS COMPARISON - MODELLED WATER LEVELS

| FLOOD MITIGATION OPTION | | CHANGE OF AVERAGE WATER LEVEL IN BIG QUILL LAKE COMPARED TO BASE CASE (m) | | | | | | CHANGE OF AVERAGE WATER LEVEL IN LITTLE QUILL LAKE COMPARED TO BASE CASE (m) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 YEAR | 2 YEARS | 5 YEARS | 10 YEARS | 20 YEARS | 50 YEARS | 1 YEAR | 2 YEARS | 5 YEARS | 10 YEARS | 20 YEARS | 50 YEARS |
| **Do Nothing (Base Case) – Average Water Levels** | | 520.60 | 520.62 | 520.64 | 520.58 | 520.29 | 519.59 | 520.60 | 520.62 | 520.64 | 520.58 | 520.32 | 519.82 |
| **Hold Water in Quill Lakes** | Block Natural Outlet | 0.00 | 0.00 | 0.00 | 0.03 | 0.07 | 0.15 | 0.00 | 0.00 | 0.00 | 0.03 | 0.07 | 0.15 |
| | Isolate Little Quill Lake | -0.04 | -0.06 | -0.13 | -0.21 | -0.34 | -0.59 | 0.07 | 0.12 | 0.24 | 0.42 | 0.70 | 1.17 |
| **Diversion Options** | Ponass Lakes | -0.01 | -0.01 | -0.02 | -0.03 | -0.05 | -0.08 | -0.01 | -0.01 | -0.02 | -0.03 | -0.05 | -0.08 |
| | Kutawagan Creek | -0.03 | -0.05 | -0.10 | -0.15 | -0.22 | -0.42 | -0.03 | -0.05 | -0.10 | -0.15 | -0.19 | -0.23 |
| | Kutawagan Creek + Hwy 16 | -0.04 | -0.06 | -0.12 | -0.18 | -0.27 | -0.52 | -0.04 | -0.06 | -0.12 | -0.18 | -0.23 | -0.29 |
| | Jansen Lake | -0.01 | -0.01 | -0.03 | -0.04 | -0.07 | -0.12 | -0.01 | -0.01 | -0.03 | -0.04 | -0.06 | -0.08 |
| | Jansen Lake + Romance Creek | -0.01 | -0.02 | -0.04 | -0.07 | -0.10 | -0.20 | -0.01 | -0.02 | -0.04 | -0.07 | -0.09 | -0.13 |
| | Jansen Lake + Romance Creek + Ironspring Creek | -0.04 | -0.06 | -0.11 | -0.18 | -0.29 | -0.56 | -0.04 | -0.06 | -0.11 | -0.18 | -0.26 | -0.34 |
| | Jansen Lake + Romance Creek + Ironspring Creek + Wimmer Brook | -0.04 | -0.07 | -0.13 | -0.21 | -0.34 | -0.66 | -0.04 | -0.07 | -0.13 | -0.21 | -0.30 | -0.40 |
| **Storage Options** | Ponass Lakes | -0.01 | -0.02 | -0.04 | -0.06 | -0.09 | -0.15 | -0.01 | -0.02 | -0.04 | -0.06 | -0.09 | -0.15 |
| | Other Storage | -0.06 | -0.09 | -0.14 | -0.20 | -0.29 | -0.46 | -0.06 | -0.09 | -0.14 | -0.21 | -0.35 | -0.61 |
| **Removal of Water from Quill Lakes** | Landowner Proposal | -0.04 | -0.08 | -0.16 | -0.26 | -0.37 | -0.44 | -0.04 | -0.08 | -0.16 | -0.26 | -0.35 | -0.38 |
| | Deep Well Injection (Q = 0.47 $m^3/s$) | -0.01 | -0.02 | -0.04 | -0.08 | -0.15 | -0.32 | -0.01 | -0.02 | -0.04 | -0.08 | -0.12 | -0.17 |
| | Deep Well Injection (Q = 4.4 $m^3/s$) | -0.09 | -0.18 | -0.42 | -0.85 | -1.83 | -3.24 | -0.09 | -0.18 | -0.42 | -0.72 | -0.99 | -1.11 |
| | Pump Water to another Watershed (Q = 0.47 $m^3/s$) | -0.01 | -0.02 | -0.04 | -0.08 | -0.15 | -0.32 | -0.01 | -0.02 | -0.04 | -0.08 | -0.12 | -0.17 |
| | Pump Water to another Watershed (Q = 4.4 $m^3/s$) | -0.09 | -0.18 | -0.42 | -0.85 | -1.83 | -3.24 | -0.09 | -0.18 | -0.42 | -0.72 | -0.99 | -1.11 |
| | Withdraw Water for BHP Jansen Lake Mine | 0.00 | -0.01 | -0.02 | -0.04 | -0.07 | -0.14 | 0.00 | -0.01 | -0.02 | -0.04 | -0.06 | -0.08 |
| | Withdraw Water for Karnalyate Potash Mine | -0.01 | -0.01 | -0.03 | -0.05 | -0.09 | -0.18 | -0.01 | -0.01 | -0.03 | -0.04 | -0.07 | -0.10 |
| **Reduce Inflows** | Restoration of 5,000 $dam^3$ of Drained and Partially Drained Wetlands | -0.01 | -0.01 | -0.02 | -0.03 | -0.05 | -0.10 | -0.01 | -0.01 | -0.02 | -0.03 | -0.05 | -0.08 |
| | Restoration of 15,000 $dam^3$ of Drained and Partially Drained Wetlands | -0.02 | -0.03 | -0.06 | -0.09 | -0.16 | -0.31 | -0.02 | -0.03 | -0.06 | -0.09 | -0.15 | -0.24 |
| | Closure of Drainage Works | -0.01 | -0.01 | -0.03 | -0.11 | -0.39 | -1.69 | -0.01 | -0.01 | -0.03 | -0.11 | -0.38 | -1.34 |

**Note:** 1 m = 3.28 ft

**TABLE 8**

**FLOOD MITIGATION OPTIONS COMPARISON – LIKELIHOOD OF BIG QUILL LAKE LEVEL REMAINING AND/OR RECEDING BELOW KEY ELEVATIONS**

| Flood Mitigation Option | | Percentage of Simulated Water Levels not Exceeding Point of Natural Overflow from Big Quill Lake to Last Mountain Lake (El. 521.47 m) | | | | | | Percentage of Simulated Water Levels not Exceeding Highway 6 Elevation (El. 520.98 m) | | | | | | Percentage of Simulated Water Levels not Exceeding Minimum Elevation of Cropland (El. 519 m) | | | | | | Percentage of Simulated Water Levels not Exceeding December 2015 Water Level El. 520.45 m) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 Year | 2 Years | 5 Years | 10 Years | 20 Years | 50 Years | 1 Year | 2 Years | 5 Years | 10 Years | 20 Years | 50 Years | 1 Year | 2 Years | 5 Years | 10 Years | 20 Years | 50 Years | 1 Year | 2 Years | 5 Years | 10 Years | 20 Years | 50 Years |
| **Do Nothing (Base Case)** | | >99% | 97% | 87% | 82% | 83% | 86% | 92% | 70% | 67% | 67% | 70% | 76% | <1% | 10% | 13% | 18% | 24% | 34% | 22% | 45% | 47% | 50% | 56% | 64% |
| **Hold Water in Quill Lakes** | Block Natural Outlet | >99% | 97% | 86% | 82% | 81% | 83% | 92% | 70% | 67% | 67% | 69% | 73% | <1% | 10% | 13% | 18% | 24% | 33% | 22% | 45% | 47% | 50% | 55% | 62% |
| | Isolate Little Quill Lake | >99% | 99% | 93% | 90% | 91% | 93% | 95% | 84% | 78% | 77% | 81% | 86% | <1% | 14% | 18% | 25% | 33% | 47% | 27% | 54% | 57% | 60% | 66% | 76% |
| **Diversion Options** | Ponass Lakes | >99% | 98% | 88% | 84% | 85% | 87% | 92% | 73% | 69% | 69% | 72% | 77% | <1% | 10% | 14% | 19% | 25% | 36% | 22% | 46% | 49% | 52% | 57% | 66% |
| | Kutawagan Creek | >99% | 99% | 92% | 88% | 88% | 89% | 94% | 82% | 76% | 75% | 78% | 82% | <1% | 13% | 17% | 23% | 30% | 42% | 24% | 52% | 55% | 58% | 64% | 72% |
| | Kutawagan Creek + Hwy 16 | >99% | 99% | 93% | 89% | 89% | 90% | 94% | 84% | 77% | 76% | 79% | 84% | <1% | 13% | 18% | 23% | 32% | 44% | 24% | 53% | 56% | 60% | 65% | 73% |
| | Jansen Lake | >99% | 98% | 88% | 84% | 85% | 88% | 92% | 74% | 70% | 69% | 72% | 78% | <1% | 10% | 14% | 19% | 26% | 36% | 22% | 47% | 49% | 52% | 58% | 66% |
| | Jansen Lake + Romance Creek | >99% | 98% | 89% | 85% | 86% | 88% | 93% | 76% | 71% | 71% | 73% | 79% | <1% | 11% | 15% | 20% | 27% | 38% | 22% | 48% | 50% | 54% | 59% | 68% |
| | Jansen Lake + Romance Creek + Ironspring Creek | >99% | 99% | 93% | 89% | 90% | 92% | 94% | 83% | 77% | 76% | 79% | 84% | <1% | 13% | 17% | 23% | 31% | 44% | 24% | 53% | 56% | 59% | 65% | 74% |
| | Jansen Lake + Romance Creek + Ironspring Creek + Wimmer Brook | >99% | 99% | 94% | 90% | 90% | 92% | 95% | 84% | 78% | 77% | 81% | 86% | <1% | 14% | 18% | 24% | 33% | 46% | 24% | 54% | 57% | 61% | 66% | 75% |
| **Storage Options** | Ponass Lakes | >99% | 98% | 88% | 85% | 85% | 88% | 93% | 75% | 70% | 70% | 73% | 78% | <1% | 11% | 15% | 19% | 26% | 37% | 23% | 48% | 50% | 53% | 59% | 67% |
| | Other Storage | >99% | 98% | 91% | 87% | 88% | 90% | 94% | 82% | 75% | 74% | 77% | 83% | <1% | 15% | 19% | 25% | 33% | 45% | 31% | 53% | 56% | 59% | 64% | 72% |
| **Removal of Water from Quill Lakes** | Landowner Proposal | >99% | 98% | 94% | 92% | 93% | 94% | 93% | 85% | 80% | 81% | 84% | 88% | <1% | 14% | 18% | 23% | 30% | 41% | 42% | 57% | 60% | 64% | 70% | 77% |
| | Deep Well Injection (Q = 0.47 $m^3/s$) | >99% | 98% | 88% | 85% | 86% | 88% | 92% | 75% | 70% | 70% | 74% | 79% | <1% | 12% | 16% | 21% | 28% | 40% | 25% | 48% | 51% | 54% | 60% | 68% |
| | Deep Well Injection (Q = 4.4 $m^3/s$) | >99% | 99% | 96% | 95% | 96% | 98% | 95% | 90% | 88% | 88% | 91% | 95% | <1% | 34% | 40% | 48% | 60% | 75% | 52% | 71% | 73% | 78% | 84% | 91% |
| | Pump Water to another Watershed (Q = 0.47 $m^3/s$) | >99% | 98% | 88% | 85% | 86% | 88% | 92% | 75% | 70% | 70% | 74% | 79% | <1% | 12% | 16% | 21% | 28% | 40% | 25% | 48% | 51% | 54% | 60% | 68% |
| | Pump Water to another Watershed (Q = 4.4 $m^3/s$) | >99% | 99% | 96% | 95% | 96% | 98% | 95% | 90% | 88% | 88% | 91% | 95% | <1% | 34% | 40% | 48% | 60% | 75% | 52% | 71% | 73% | 78% | 84% | 91% |
| | Withdraw Water for BHP Jansen Lake Mine | >99% | 97% | 87% | 83% | 84% | 87% | 92% | 72% | 69% | 69% | 72% | 77% | <1% | 11% | 15% | 19% | 26% | 37% | 23% | 47% | 49% | 52% | 58% | 66% |
| | Withdraw Water for Karnalyte Potash Mine | >99% | 97% | 88% | 84% | 85% | 87% | 92% | 73% | 69% | 69% | 72% | 78% | <1% | 11% | 15% | 20% | 27% | 37% | 24% | 47% | 49% | 53% | 58% | 67% |
| **Reduce Inflows** | Restoration of 5,000 $dam^3$ of Drained and Partially Drained Wetlands | >99% | 97% | 87% | 83% | 84% | 87% | 92% | 72% | 68% | 68% | 71% | 77% | <1% | 11% | 14% | 19% | 26% | 36% | 23% | 46% | 49% | 52% | 57% | 66% |
| | Restoration of 15,000 $dam^3$ of Drained and Partially Drained Wetlands | >99% | 98% | 88% | 85% | 86% | 88% | 92% | 75% | 71% | 71% | 74% | 79% | <1% | 13% | 17% | 22% | 29% | 40% | 25% | 49% | 51% | 54% | 60% | 68% |
| | Closure of Drainage Works in All Quill Lakes Watershed | >99% | 97% | 88% | 85% | 88% | 93% | 92% | 74% | 70% | 72% | 78% | 88% | <1% | 14% | 19% | 26% | 38% | 59% | 23% | 49% | 52% | 57% | 65% | 80% |