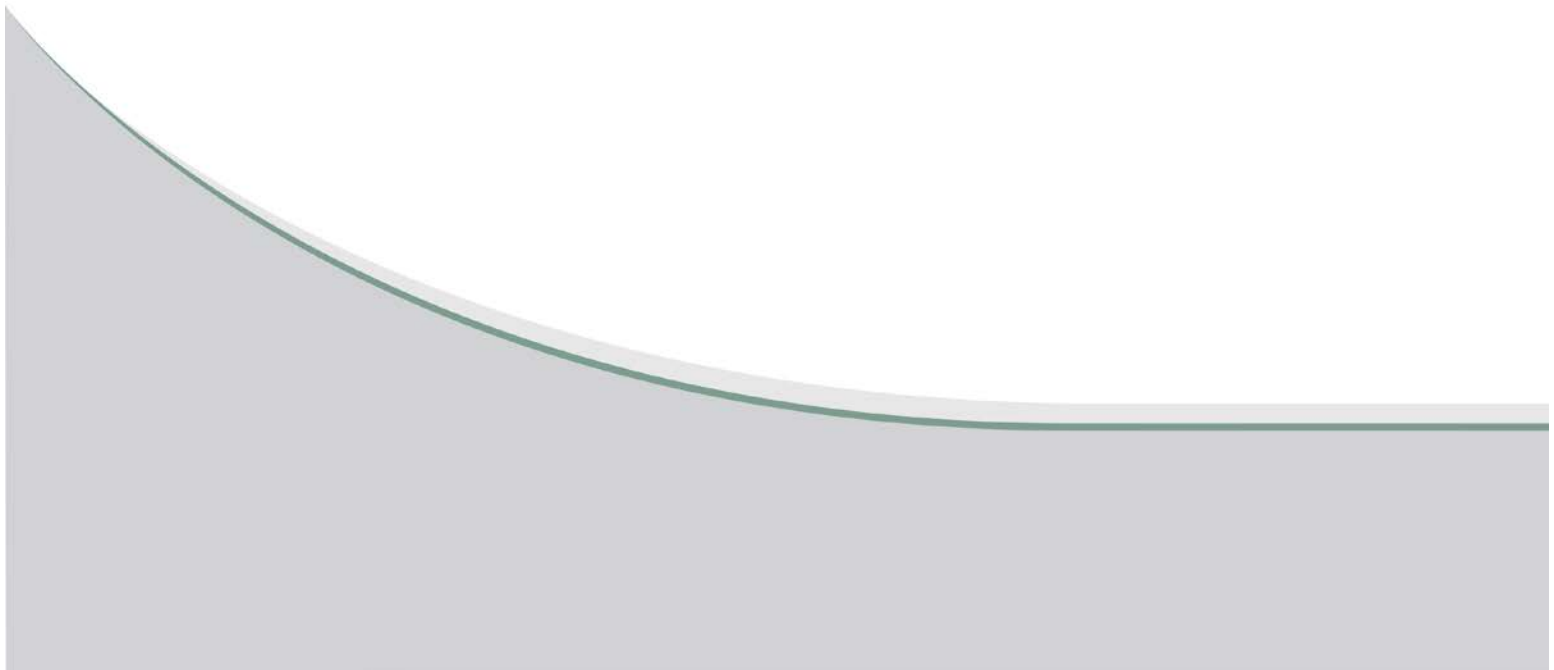


APPENDIX B

REVIEW OF LANDOWNER PROPOSAL PLAN B





June 30, 2016

File No. 15-0673-009

Water Security Agency
400-111 Fairford Street East
Moose Jaw, Saskatchewan
S6H 7X9

ATTENTION: Mr. Clinton Molde, P.Eng.
A/Executive Director, Integrated Water Services

RE: Quill Lakes Flood Mitigation Study
Review of Landowner Plan B, DRAFT – Rev B

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Dear Mr. Molde:

This letter is our review of the Quill Lakes Project Plan B which was concept developed by local landowners as an alternative to the Kutawagan Creek Diversion Project that was considered by WSA in the summer of 2015. Our review is based on the 2 page summary that was provided by WSA and attached to this letter as Appendix A.

The concept, as described, is similar to Option 3 developed by Golder Associates in their review of Flood Mitigation Alternatives (Golder, 2015). The concept consists of constructing a channel along Kutawagan Creek from Big Quill Lake at Highway 16 to the drainage basin divide into Saline Creek (Nokomis Spill Point). The channel would be used to convey water from the Quill Lakes to Saline Creek, as opposed to the Kutawagan Creek Diversion project that would not divert any Quill Lakes water. A control structure would be constructed near the outlet at Highway 744 to regulate outflows from the Quill Lakes.

Our understanding is that the channel is proposed to be mainly operated in the winter to “draw down” the Quill Lakes to provide storage volume for the spring freshet without causing additional water level rises or additional flooding on the Quill Lakes. The proposal also indicates that outflows could be released during spring runoff to maximize optimum fresh water mixing.

As previously indicated by WSA and as documented in previous flood mitigation reports (Golder 2015), there are several environmental concerns with transferring water from the Quill Lakes into Saline Creek and Last Mountain Lake due to high salinity levels and concentrations of total dissolved solids (TDS). The proposal acknowledges these concerns and proposes to address this issue only allowing operation, as much as possible, during the winter months as indicated above. The proposal suggests that operating in the winter months will reduce the level of TDS transferred to Last Mountain Lake due to a reduction in stratification within the Quill Lakes.

The proposal provides no support to this hypothesis nor has KGS Group been able to find any data confirming that stratification on the Quill Lakes would show variations in the TDS or on salinity concentrations in the lake. Detailed analyses and monitoring of the water quality and stratification in the Quill Lakes in the winter would be necessary to confirm whether this hypothesis and that the proposed operating strategy would be effective to reducing TDS transferred downstream. These analyses would require measurements of salinity concentrations with lake depth in the winter when an ice cover is present on the lake to prove that the water quality release from Quill Lakes would be better in the winter than during open water conditions.

During our review of this proposal, WSA indicated that under ice salinity is typically greater than summer (open water conditions) because the ice formation excludes salts (i.e. resulting in more salt content in the water and as a result a higher concentration in the water under the ice). If the water volume within the lake under an ice cover is relatively large, then the difference in salinity is minor, if not immeasurable. In Houghton Lake, which is quite shallow, there have been observations of large increases in salinity under ice. The critical period that WSA considered on Houghton Lake for releasing fresher water was immediately after the ice-off when the less saline freshwater from ice melt and the less saline inflows resulted in a temporary stratification (i.e. fresher on top, more saline below). The period of time is short lived and was dependent on mixing (i.e. by wind) but generally varied between hours and days.

Should the operation of the Plan B be modified to only operate during this period of temporary stratification, it would be difficult to operate the outlet for a long enough time period immediately after the ice-off period to effectively reduce the lake levels given the fetch length on Big Quill Lake and the volume of water requiring release.

WSA has indicated that the proposal of operating in the winter months to divert water with a lower TDS due to stratification has concerns due to their experience on Houghton Lake. We concur with WSA concerns and recommend that if this proposal is advanced towards implementation that baseline studies be carried out during the winter months to confirm this phenomenon.

In addition to concern with the water quality on the Quill Lakes, there would also be concerns with the water quality in the receiving water body during the winter months. Similar to the Quill lakes, Last Mountain Lake would also be in an ice covered condition. Under an ice covered condition, there would be minimal mixing of inflowing water. This would lead to the more saline inflowing water from the Quill lakes forming a distinct saline layer in the receiving water body.

During the open water period from April to November, the Plan B proposal consists of operating the channel strategically to maintain the same water quality that would have overflowed naturally without the outlet by mixing the surface runoff from the Kutawagan Creek drainage area with the higher TDS flow released from Quill Lakes. This would require extensive monitoring of the water quality in order to ascertain that the water quality goals would be achieved. This proposal would also likely require considerable fluctuations in the flow releases and ongoing operations of the control structure.

Similar to the Kutawagan Creek diversion channel, the channel referenced in this proposal would have to be approximately 40 km long, extending from Big Quill Lake to Hwy 744, of which approximately 30 km would require excavation to provide the required discharge capacity. Upgrades to thirteen culvert crossings would also be required. The channel alignment would follow the existing water course comprised of many lakes, ponds and channels to minimize excavation quantities. Of importance is to note that the channel would have to be constructed

with sufficient depth to provide the flow capacity during winter with an ice cover. This would require the channel to be deeper and longer than that proposed for the Kutawagan Creek Diversion Project.

The total volume of water that would be diverted from the Quill Lakes and the effect on the water level on the lakes would depend on the channel design capacity and the adopted operating strategy. The required capacity of the diversion channel would have to be sufficient to maintain or lower the level on the Quill Lakes. For our conceptual review of the proposal, we have selected a channel that would have flow capacity of approximately 4 m³/s during winter ice period with the Quill Lakes at elevation 520.5 m. This capacity is similar to the capacity that was considered by KGS Group for the Kutawagan Creek Diversion Project in the fall of 2015. However, since this proposal considers that the channel would have to effectively convey flow below the ice, the channel size for the Plan B proposal would have to be larger and deeper than that adopted for the Kutawagan Creek Diversion. To convey the above noted flow rate and be large enough to flow during the winter months, a trapezoidal shaped diversion channel with a base width of approximately 15 m with an invert elevation of 517.6 m would be required. This is approximately 0.9 m lower than the channel considered for the Kutawagan Creek diversion project. This would result in a higher excavation cost than that estimated for the channel portion of the Kutawagan Creek Diversion Project. In addition to the constructed diversion channel to the Nokomis Spill Point, the channel capacity of Saline Creek to Last Mountain Lake would have to be improved to ensure that the winter flows could be conveyed without causing flood damages along the creek.

As part of our review, a high level assessment on the performance of the diversion channel was completed. This assessment assumed that the channel could be successfully operated in the winter and that there would be no concerns associated with water quality on the receiving water bodies. The assessment considered an operating strategy in which the channel was operated at full design flow conditions during the winter period from December through March and at a reduced capacity during the period from April to November (i.e. 25% of capacity). An autoregressive model was used to compute the estimated change in average Quill Lakes water level due to operation of the Plan B channel. The results showed that the average Big Quill Lake level would be approximately 0.16 m lower over the next 5 years and approximately 0.44 lower over the next 50 years compared to the base case condition of letting the lakes water level fall and rise naturally. However, there would still be a risk that the water level could rise and exceed the flood elevation for Highway 6. Within the next 5 years, 80% of the simulated Big Quill Lake water levels were below El. 520.98, and 88% within the next 50 years.

Further detailed hydrologic and hydraulic studies would have to be completed to optimally size the diversion channel and determine the potential hydraulic effects associated with the channel operation both on the Quill Lakes and on the receiving water bodies.

This option is being assessed in our study of Flood Mitigation Options for the Quill Lakes. This study includes a high level review of a number of options in relation to their effect on the Quill Lakes. A detailed water balance model was developed to simulate the response of the Quill Lakes water levels to a number of flood mitigation options, including Plan B.

In summary, based on our review we have identified the following concerns with the proposed Plan B that could lead to the proposal not being feasible, pending further detailed analyses.

- The hypothesis that the water quality in the Quill Lakes would be less saline and have less TDS due to stratification under ice covered conditions need to be confirmed with field

measurements. Experience of WSA on another lake system has shown this not to be the case. If the water quality under the ice on the Quill Lakes is no better, if not worse, than the open water condition then the fundamental objective of the operation of this diversion channel is flawed.

- The magnitude of the diversion channel (i.e. dimensions, depth, and length) would results in a very expensive capital construction cost. The estimated cost for the Kutawagan Creek Diversion channel, without any of the control structures or culvert crossings was approximately \$28 million. The channel required for Plan B would be notably greater. Although KGS Group did not assess any potential economic benefits associated with Plan B, it is possible that the construction costs, as well as annual operation and maintenance costs associated with the implementation of Plan B would likely far exceed the economic benefits associated with its implementation.

Should you have any questions, please do not hesitate to contact the undersigned.

Prepared by,

Reviewed by,

Brian Bodnaruk, P. Eng.
Senior Water Resources Engineer

David S. Brown, P.Eng.
Project Manager

BB/ama
Enclosure

APPENDIX A
DESCRIPTION OF QUILL LAKES PROJECT PLAN B

DRAFT

Quill Lakes Project Plan B

For consideration as an alternative to building a dam to flood the people of the Quill Lakes...

A simple dam won't guarantee little more than highway infrastructure. It will guarantee economic losses in hundreds of millions to provincial, municipal and private infrastructure upstream. Immediate losses to the region will be compounded by economic losses to region and the province by multiple millions, for decades. Once this path is taken it has historically led to escalating costs to continue to fix the initial mistake.

Solution

Build a control gate at the Nokomis Grid. It must be built for multiple drain option standards to meet different requirements at different times. It must meet control standards to allow winter runoff to maintain the current levels of water as a peak. Build it high enough to hold water back to the natural spill-point only as a protection for people downstream. The only way we can insure uncontrolled overflow is to insure adequate draw-down as in any dam structure to make room for exceptional spring runoff or massive rain events. Building the control structure right the first time is the most cost effective.

Install control flow ditch from the Nokomis spill-point to highway 16, to a depth that will allow winter release rates without freezing. This will allow winter spills to reduce the level of tds due to reduction in stratification. Maintain water level goal of 521.6 or lower with a draw down as necessary, to act as any dam would be utilized, to prepare for next runoff event.

Use the Kutawagan flow through area to act as a mixing area for spring runoff and a mixture of lake water to mimic a natural overflow quality, and provide the most flexibility in tds control. These numbers can be measured and monitored by WSA.

This will change as annual overflows in water will cause a reduction in tds in the main water body, and allow more thorough mixing of Big and Little Quill Lakes to also reduce TDS.

This will buy enough time to Test downstream capacity, and repair and or replace infrastructure to meet expanded needs, with the ultimate goal to keep the water levels safe for highway and rail infrastructure at its current levels, and protect expanded upstream flooding and loss of economic capacity. Test flows of water will be monitored for flow and for salinity loading. An emergency team will be in charge and dedicated specifically to control monitoring as often as necessary to insure safety to downstream water levels and environmental integrity. These must be in place to minimize impacts of downstream resources and property.

Main flow periods will be preferred during winter months to reduce salinity transfer, and during availability during spring runoff to maximize optimum fresh water mixing. The goal is a combination of property, infrastructure, and environmental considerations, with the plan to minimize or prevent losses

Salinity levels leaving the lake will be highest in the first year, at a time when the receiving water system is at an all-time low. As years progress the flushing of the system will continue to contain less salinity.

In years of low runoff less water will be needed to be released with an eventual shutdown of release when this cycle stops.

Downstream structure must be addressed immediately. All structures must be assessed and repaired or rebuilt to handle a specific flow rate without allowing localized flooding. If done properly this will help everyone that has or is being affected by flooding right now. (If questioned most stakeholders will claim priority over flooding issues before water quality if given a choice.)

We are dealing with a once in a 2000 year natural event. We can make every effort to preserve fish habitat integrity. If we can't restocking and recovery will be a lot faster and inexpensive than the loss of the economic upstream infrastructure that will pay for downstream mitigation.

Summary

- This will be the most economical long term plan.
- It is the safest method of insuring minimum losses to the entire runoff system
- Retain some control of water levels before they hit critical elevations
- Protect and preserve the maximum amount of private, public, properties and infrastructure
- Is flexible to meet uncertain future events
- The best emergency protection plan for public safety.
- Avoid high mitigation costs

Opportunity

- This is an opportunity to fix all of the downstream flooding problems in the Qu'Appelle chain... alleviating the flood problems that exist today
- By seizing the opportunity of a natural disaster, is there not ability to gain federal funding support?
- In the middle of a natural disaster following a natural disaster of record forest fires, no one can blame this administration for a temporary deficit.

