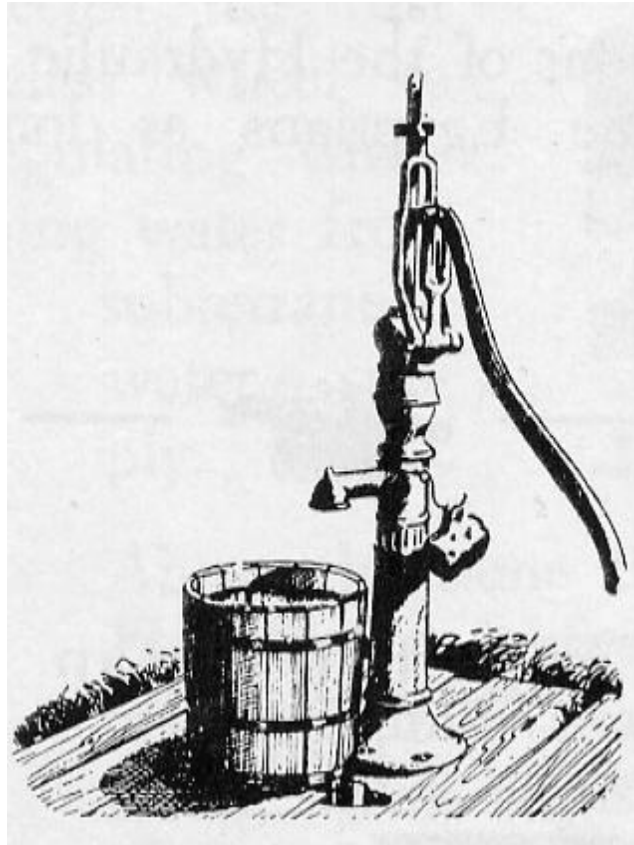


Report for
Resource Management International Inc
Regarding
Common Ground Phase 1 Proposal



Crusher's Consulting
Ron S. Crush ASCT, Mediator
(Applied Science Technologist)

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Background:

The Quill Lakes area consisting of Big Quill Lake, Mud Lake & Little Quill Lake are located within what was thought to be a closed basin estimated to be approximately 8760 KM² (3382miles²). With consistent rises in water level, and given continued current trends, it appears that the lakes may overflow. The Quill Lakes historically may have spilled naturally towards Last Mountain Lake (LML) through the Kutawagan Valley, however there have been no such recent outflows.

This system of lakes, now one, improved from saline to brackish in nature with total dissolved solids measuring from 3730(Little Quill East)mg/l to 10,100(Big Quill Lake)mg/l (WSA/Sask Research Council averages 2015). Above average fresh water inflows causing the lakes to continue to rise also lowers the TDS levels which were as low as 7600mg/l in the spring of 2017 (WSA Quills Monitoring 2017-V3 May 12-17.xlsx).

Last Mountain Lake supports a TDS on average around 1400mg/l (Quill Lakes Flood Mitigation Assessment Golder Associates, January 2015). On August 20th 2015, the WSA reported that the total dissolved salinity level of Last Mountain Lake (LML) is “normally between 1500 and 2400 mg/l”, which is also considered brackish.

A natural uncontrolled spill from The Quill Lakes system may have serious affects to the Kutawagan Valley system and the otherwise stable, relatively fresh water environment of Last Mountain Lake. The possibility of a spill in the near future is threatening and a continued wet cycle, as is being experienced, heightens this very real possibility.

The Water Security Agency has and is involved in commissioning studies and investigating problem areas within its legislative responsibilities to begin to mitigate some of the contributing factors identified with the rising water levels. The writer is aware of the following studies:

- 1) Quill Lakes Flood Mitigation Assessment – Golder Associates January 2015,
- 2) Kutawagan Creek Diversion Project design of Dyke and Channel Works Design Report - KGS Group December 2015,
- 3) Quill lakes Flood Mitigation Study Concept Design Report - KGS Group November 2016,
- 4) Common Ground Phase 1 Proposal – Resource Management International Inc May 2017(Commissioned by Quill Lakes Watershed Association Number 14) (QLWA).

Most recently RMI Inc were engaged by the QLWA to further investigate reducing inflows to the Quill Lakes basin, as a means to prevent further damages to areas surrounding the Quill lakes, and to prevent or reduce the overflow of Big Quill Lake toward Last Mountain Lake.

QLWA made a revised application for approval for Drainage Works to the Waters Security Agency on/near March 2017. RMI Inc completed its design report in May 2017. The writer is aware of responses from the Ministry of Environment (June23, 2017) and an email from Dwayne Rowlett, Water Security Agency, to Quill Lakes Watershed Association No. 14 on October 02,

2017. Both documents suggest the need for a better understanding and/or further evaluation of the hydrology related to RMI Inc's design Report.

RMI Inc subsequently contacted me to see if I would be interested in furthering along the project through my review and recommendation. I agreed to look at the proposal and provide a review and recommendations on a path forward within the context of resources available to me in my limited consulting role.

I retired from the Water Security Agency in Dec 2015, following an extensive career in drainage and water management beginning with Conservation and Development Branch of Department of Agriculture, its successor Sask Water, Sask Watershed Authority and Water Security Agency. During my public career I was primarily involved in drainage projects and its regulation covering survey, design, construction and administration of the regulatory requirements around water management as required by the governing provincial legislation. I have extensive experience in dealing directly with ratepayers and municipal officials throughout the North West Region on water management issues. Nearing the end of my public career I formed Crusher's Consulting.

I graduated in 1980 from the Saskatchewan Technical Institute in Moose Jaw as a Civil Engineering Technologist and continue as member of the Saskatchewan Applied Science Technologists and Technicians since 1984.

Preliminary Terms of Reference: (T. N. Gehlen P.Eng.)

The Terms of Reference for my report evolved from conversations with Tom Gehlen, President RMI Inc, and a site meeting and area reconnaissance completed on October 05th and 6th.

1. Review project proposal and supporting documents:
 - a. Determine within scope of resource information available and make comments / observations related to Hydrology of the QLWA's Common Ground Phase 1 Project,
 1. The Report will discuss project hydrology and estimates,
 2. Offer thoughts and evaluations of existing information aimed at assessing the need for and extent of further hydrological evaluation.
 - b. Provide recommendations on a path forward towards project approval and construction.

General:

I met with Bradford Li Pi Shan, P. Eng (Project Manager), RMI Inc on October 13 to discuss the project. I received additional documents at that time for review and consideration. Bradford was very helpful and had a good grasp on the project and its intent. I reviewed the studies provided by RMI Inc. On October 05th and 6th I'd met with Tom Gehlen and completed a site reconnaissance of the project area.

I understand the current design is not an abbreviated version of a more detailed design and proposal completed by KGS. The Water Security Agency supported further investigation of this option and hence the report by KGS regarding the Kutawagan Creek Diversion Project. It is understood that the option although favourable to WSA, in terms of flood management, faces continued public concern both in Quill Lakes, and downstream. This led QLWA to commission the RMI Inc with regards to the Common Ground Phase 1 Proposal.

Findings:

The design by RMI Inc for the QLWA, captures the partial intent of the option brought forward by Golder Associates, warranted for further investigation by WSA, and originally furthered in its design by KGS.

QLWA has stepped up as a local proponent for a project through submission of its Application for Approval for Drainage Works to WSA and engagement of RMI Inc for a grass roots solution.

The project, within the Kutawagan Valley, has been scaled back considerably from the KGS/WSA proposal and intends to lay the groundwork for a larger project to address both water quality issues as well as flood management for the stakeholders of the Qu'Appelle Valley, Last Mountain Lake and Quill Lakes Basin:

(The proposal it should be noted provides for a diversion of runoff collected from a larger relatively fresh water basin, as an alternative to a direct spill from the Quill Lakes or drainage of the Kutawagan Valley as proposed by KGS/WSA in 2015.)

- 1) The project, as a prelude to a larger overall project, will provide a Best Management Practise for a sensitive area securing important water management options on the last remaining unflooded section of the basin.
 - a. The project will provide timely construction to meet on site environmental protection goals, and an improved working area for future development of projects, if and as future works are developed.
 - b. The phase 1 project will allow management, including dilution, through managed timing and volume coordination of fresh water mixing, of existing TDS levels in the channel, to prevent and/or minimize TDS loading to Last Mountain Lake.

- 2) Control outflow via a zero grade channel from the Ducks Unlimited Pel lake structure to a controlled outlet just north of the Nokomis Grid 744 above Peter Lake.
 - a. The channel proposed is a 1m bottom with 3:1 side slopes.
 - b. Control culverts are intended to be gated 900mm culverts,
 - c. Additional culverts are proposed and all are intended to be 900mm culverts.
- 3) Reduce crown land and private land flooding throughout improved/controlled reaches,
 - a. RMI Inc are estimating a 0.5m – 0.7m reduction in flood levels throughout the improved area.
 - b. RMI Inc estimate 6 to 7 million cubic meters of water for initial diversion.
 - c. RMI Inc have estimated these volumes based on a 1:100 flood event.
 - d. Surface area of reclaimed land is not confirmed.
- 4) Reduce flooding to municipal/provincial Infrastructure.
- 5) Reduce inflows to The Quill lakes,
 - a. It is estimated and reported by others as being approximately 9% to 12% (of Total gross Drainage Area to Quill Lake),
 - b. RMI Inc estimate the proposed, scaled back, project diversion represents a 2% to 4% reduction in inflows to the Quill Lakes.

The estimated initial diversion of 7,000,000 cubic meters of water could represent a gross impact on last Mountain Lake at/near 25mm. This is based on an estimated surface area of last Mountain Lake of 215 km² and assumes the entire volume reaches Last Mountain Lake. This is likely unrealistic as natural losses are expected so it may be reasonable to estimate a 10 to 15mm affect to Last Mountain Lake.

A) Drainage Basin Characteristics:

Gross Drainage Area (GDA) – The GDA of a stream at a specified location is that area, enclosed by its drainage divide, which might be expected to entirely contribute runoff to that specified location under extremely wet conditions.

Effective Drainage Area (EDA) – The EDA is that portion of a drainage basin which might be expected to entirely contribute runoff to the main stream during periods of low precipitation, say, the one in two year flood. This area excludes marsh and slough areas and other natural or artificial storage areas which would prevent runoff from reaching the main stream in an average year.

The entire Kutawagan basin has been estimated by others to be 1104km² (426mi²) and is shown on the attached plan by KGS. The entire basin is relatively flat with little to no natural relief along the surveyed route. Existing manmade structures throughout the project area currently influence the natural rhythm of the basin.

I obtained maps produced by The Center for Topographic Information, Natural Resources Canada. The topographic maps are 1:50,000 Scale and have a 10m contour interval. I reviewed the Gross Drainage area by others and determined that it is a reasonable estimate of the gross

drainage area for the basin. The basin is so flat leaving significant room for interpretation using solely NTS mapping, more precise methods to establish an alternate Gross and/or Effective Drainage Area could be employed however are expected to produce results within and reasonable margin of error and would not have significant impact or influence on the design being proposed.

The basin is pocketed with small isolated water bodies providing in most years natural storage reducing the effective drainage area. Again because of the flat topography no estimate or differentiation was determined between the Gross and Effective drainage areas.

RMI Inc have estimated the volume of water stored and available for diversion at near 7,000,000 cubic meters. This is based on the current extent of flooding, during spring peaks and evaluated in context with intermittent survey data it collected. The estimate appears reasonable and very likely on the high side. I reviewed surface areas from NTS mapping and Google Earth producing similar area/capacity estimates. Volumes were based on the surface area with a depth of 0.6m reduced to 2/3.

Subsequent diversions would be dependent on the level of runoff experienced. It is unlikely under a managed environment that similar levels and volumes would ever be experienced.

Unit runoff values for the Quill Lakes area are provided and dependant on the probability of exceedance present a wide range of runoff values. Annual flow volumes for neighbouring hydrometric stations have also been included for consideration.

There are three Ducks Unlimited Projects along the Common Ground Phase 1 Proposal. The projects are: Pel Lake, Kutawagan A, and Kutawagan B. The approved operation for these projects is unknown. Peter Lake located downstream of Grid 744 is a controlled lake. It's understood that its proponent is Ducks Unlimited. Its planned or approved operation is also unknown. The respective approved levels of operation and impacts, of the Ducks Unlimited Projects, to the Kutawagan Valley basin are unknown.

The system eventually drains to Last Mountain Lake, there are sensitivities here both from a quantity and quality perspective.

B) Existing/Proposed Infrastructure/Culverts:

The outlet culvert through Grid 744 is a 900mm CSP. RMI Inc have indicated that 8 culverts are being proposed along the design route. Two of the culverts will be gated and are to be located at Stations 9+700 and 23+400. All culverts proposed are 900mm culverts. Controlled releases will not meet or exceed existing downstream capacities.

RMI Inc completed a field reconnaissance of the downstream infrastructure and reported the following:

- 1) Peter Lake @ SW corner SW 15-29-21-2 / 2 - Stop Log controlled 1200mm CSP,
- 2) CP Rail Crossing center of section 9-29-21-2 / Bridge (Size Unknown),

- 3) Road Crossing NE 31-28-21-2 / 1- 1200mm CSP,
- 4) Road Crossing E/W road North Bdry. 25-28-22-2 / 2-1200mm CSP,
- 5) Hwy 20 Crossing @ NE 15-28-22-2 / 3 – 2100mm CSP(approx.),
- 6) CP Crossing NE 15-28-22-2 / Bridge (Size Unknown).

The natural flow of water after passing the CP rail in NE15-28-22-2 is into the Hatfield Basin (Saline Creek) Ducks Unlimited project. It outlets via a logged cement control structure then crosses a municipal road thru a 1600mm CSP heading NW to Lanigan Creek.

Downstream infrastructure exceeds intended design capacities upstream, all culverts and/or structures field verified exceeded 900mm which is the intended outlet capacity for the Common Ground Phase 1 Proposal. The outlet for the Common Ground Phase 1 Proposal will be gated!

C) Outlet:

The reasonable point of adequate outlet presents at Grid 744. At this point it empties into Peter Lake, a controlled Lake with outlet capacity far in excess of that which it would receive from the Common Ground Phase 1 proposal.

Downstream of Peter Lake is primarily a natural channel with a varying natural flood plain. The creek/channel presents as undisturbed with native vegetation throughout, there were no noted agriculture uses outside of grazing or forage through to its confluence with Lanigan Creek. Lanigan Creek is a well-defined mature channel, capable of flows far in excess of any contribution from the Common Ground Phase 1 Proposal.

The downstream channel appears to manage the operation of Peter Lake within its natural environment (flood plain). It is expected that the proposed project releases through Peter Lake will then be managed well within the natural flood plain through to Lanigan Creek.

Conclusion:

The Gross Drainage Area for the entire Kutawagan Valley basin is reported as 1104 km² (426 mi²). This is reasonable and could not be found otherwise given the interpretation tools. The Common Ground Phase 1 project reduces the effective/contributing area significantly with a reasonable estimate of it being in the range of 25 to 33 % of the reported Gross Drainage Area. The Effective Drainage Area increases with event (Frequency) size and for a smaller basin it is reasonable to estimate the area to be at/near its Gross Drainage Area for events in excess of an F2(every other year event), estimates for this basin have not been made.

Estimates for initial diversion are considered **high**. Given the volume estimated it will require in excess of 120 days to initially dissipate.

In an open system the 900mm culvert though Grid 744 would operate at some level of head and given water levels from this spring (521.2) may develop 1.9m of head from its current spill level of 519.3. This would represent a flow of approximately 1.75m³/sec.

The design provides for a control structure upstream of Grid 744. A gated 900mm culvert will be located in the improved channel set at an elevation of 519.5m. Assuming a similar water level (521.2m) it would develop 1.7m of head and could be expected to pass 1.6m³/sec.

The reality is that given the flat grade flows of 1.0 m³/sec are more likely producing velocities of < 0.3 m/sec well below erodible velocities.

The controlled drainage project offers the ability for an immediate response to any concerns during operation. Closed operation restores the harmony of the existing natural basin. Culvert crossing installations proposed complement existing system capacities (Grid 744 culvert).

A clear understanding of the detail of any further hydrology analysis is needed should further analysis be required by the approving agency. Understanding current estimates and project intent with the approving agency should help determine the need, if any, for further hydrological review.

The proposal is not intended for flood protection to a given event it is intended solely as a water management tool in preparing for the complete Common Ground project, stabilizing storage capacity in a changing basin and improving forage and crazing capacities to ancillary crown and private lands while reducing flood pressures to municipal and provincial infrastructure.

This is the last remaining unflooded section of the natural overflow from the Quill Lakes to Last Mountain Lake. The project will allow for stabilization and management of water levels and provide an opportunity to implement best management practices aimed at restoration of naturally occurring salinity levels, while minimizing any potential downstream impacts and consequences.

It allows QLWA No. 14, in conjunction with WSA to plan, implement and coordinate water flows from the proposal area and water flows of Lanigan Creek to achieve optimum dilution levels prior to reaching Last Mountain Lake. If Quill lakes spills in the near future without a constructed downstream project concentration levels will be significant and have direct uncontrolled impacts to Last Mountain Lake.

The preliminary project will set the stage in implementing and designing future projects to prevent uncontrolled flooding of the Quill Lakes basin, manage, what could be, direct natural spills to Last Mountain Lake and improve abilities to develop options if necessary in the future.

It is expected that this being a water and land management project that the levels of Total Dissolved Solids will ultimately be improved with timed and controlled releases. RMI Inc expect that managed flow through the system will likely reduce TDS and improve the quality of natural flows into Last Mountain Lake. This hypothesis/principle could be proven and quantified with a temporary permit for operation conditional to testing requirements.

The project has significant local interest and support. It is the writers understanding that QLWA No. 14 is very interested in moving forward with the design offered by RMI Inc.

Recommendations:

- RMI Inc should entertain a meeting with WSA to establish/confirm:

- Point of Adequate Outlet,
- Need for and extent of further hydrological evaluation, if needed then;
 - Have QLWA No. 14 request WSA to provide inflow estimates for the basin to the two control points and the RMI Inc could demonstrate the proposals efficacy with respect to managing future events and expected operation times based on these estimates by WSA.
- Status of the Application for Approval for Drainage Works and confirm requirements for its issuance:
 - Is there an option on the interim for an annual license? This may provide opportunity to assess the project in real time and fine tune it for a longer-term license. Issues, should they arise, could be included in a final operation plan.
- Obtain information on approved operation of DUC projects and Peter Lake, entertain meeting with proponents. Establish conceptual working relationship for projects.
- Begin to develop a Basin Operation Plan,
 - A plan would begin to address and include relationships with the other exiting projects in the basin,
 - Identify project's expected periods of operation.
 - Downstream affects are expected to be very slight. Operation responses where required will be included in the operation plan.
- Confirm design intent and interest to proceed with QLWA No. 14.
- Revise design to meet requirements and/or expectations update cost estimates.

It appears some level of confidence in having the project meet its legislative obligations is required before proceeding further with more detailed design and/or land acquisition. A meeting and confirmation of the project requirements should be pursued with the main regulatory agency (WSA).

It is unclear to the writer as to the need for and level of detail required for further hydrological analysis, a better understanding of this would benefit RMI Inc, QLWA No. 14 and move the project closer to satisfying its regulatory obligations.

Public awareness and acceptance will continue to influence the project as it moves forward. The project upheld on its merits and presented as a Best Management Practice may begin to move public opinion.

For instance these works may be required only during wet years and in years where runoff volumes return to normal or below normal may not need active operation for the purpose intended today. The works could remain idle and maintained being available as an option during wetter cycles. The actual direction of flow release, from Kutawagan and Pel lakes, due to its flat topographic nature, could easily be reversed back to the Quill Lakes if or when necessary.

Attachments/Links:

Boundaries and Hydrometric Stations

Peak Flows and Flow Volumes Quill Lake Area

Quill Lakes GDA

Kutawagan GDA

AUR_Report_Final

<http://www.ec.gc.ca/dccha-ahccd/>