



September 2, 2021
File: 123221863

Attention: Government of Yukon Southern Lakes Flood Incident Management Team
60 Norseman Road
Whitehorse, YT
Y1A 0M7

Dear Government of Yukon Southern Lakes Flood Incident Management Team,

Reference: Southern Lakes Flooding 2021 – Stantec Recommended Actions Ahead of Freeze-Up

The southern region of the Yukon has been experiencing severe flooding since May of 2021. The flooding has largely been attributed to high snowpack accumulation in south/central Yukon over the winter of 2020/2021. The first phase of flooding (“phase 1”) consisted of local snowmelt and site drainage flooding and occurred in May/June. The second phase of flooding (“phase 2”), which began in late June and is currently ongoing, has consisted of elevated water levels in the larger waterbodies/watercourses – specifically, in the reservoir lakes south of Whitehorse (Southern Lakes) and the downstream Yukon River.

Stantec Consulting Ltd. (Stantec) has provided the Government of Yukon (YG) with ongoing technical support since the start of phase 1 (early May). Our Whitehorse-based professionals have provided hydrotechnical/water resources, civil, buildings, and structural engineering assistance and recommendations for several flooding incidents (Gem Haven, Carmacks, Teslin). Additional technical experts within Stantec’s network were engaged for specific challenges (e.g., coastal erosion and wastewater treatment). Our technical support role has continued through phase 2, where we have provided hydrotechnical/water resources, civil, survey, geotechnical, and planning support for YG on the Southern Lakes Flooding Incident (the Incident).

In our technical support role on the Incident, we have provided recommendations for future initiatives, studies, or information gathering. These recommendations have been framed in the context of five main periods, each of which have their own challenges and approaches:

- i. **Period 1** is from present until freeze up.
- ii. **Period 2** is through the winter of 2021-2022.
- iii. **Period 3** is during low elevation snowmelt in the spring of 2022 (phase 1 of flooding, occurs at the site scale for properties).
- iv. **Period 4** is during the summer of 2022 when higher elevation snowpack has contributed melt to the Southern Lakes resulting in lake rise (phase 2 of flooding).
- v. **Period 5** is the long-term flood management plan development for the Southern Lakes, and for the Yukon overall.

On Wednesday, August 25, 2021, the Incident Management Team (IMT) requested that Stantec prepare a deliverable containing a summary of recommendations specific to Period 1 (present until freeze-up). This document presents these recommendations in Table 1 in the context of:

- i) What we have observed and/or anticipate,
- ii) What we recommend, and
- iii) How the recommendation will help YG in future periods.

We have developed these recommendations based on our familiarity with the Incident and our experience in flood mitigation and management across Canada.

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We acknowledge the below regarding the recommendations in Table 1:

- In alignment with the specific request from YG from August 25, these Period 1 recommendations do not constitute a comprehensive plan for the short or long term. Rather, they may represent select, strategic components of a comprehensive plan or provide the information needed for that plan to be developed.
- It is possible that YG may be currently completing one or more of our recommendations; however we have included the full list for records.
- Stantec has previously communicated a subset of the recommendations Table 1 to YG in email correspondence. These previously communicated recommendations are noted in Table 1.
- The recommendations are not listed in any order of priority.

At YG's request, we are able to provide a proposal to provide services in support of recommendations in Table 1 prior to freeze-up.

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Table 1: Recommended Initiatives, Studies, or Actions Prior to Freeze-Up

Item	What We Have Observed and/or Anticipate	What We Recommend	How This Recommendation Helps YG
1	<ul style="list-style-type: none"> The existing berms consist of several different installation types, with a given section of berm often consisting of multiple installation types/materials (e.g., sandbags surrounding a superbag berm, or sandbags over an earth poly berm core). Characterization and quantities of berms/berm materials will be important for recovery and demobilization planning. Property owner requests and communication in the coming months will likely require an understanding of berm characteristics on a lot-by-lot basis. 	<p><u>Detailed Berm Inventory.</u> Complete a detailed berm inventory on a lot-by-lot (or finer) basis. Data includes berm dimensions, crest elevations, material types and quantities (totals and by lot), and photographs.</p>	<ul style="list-style-type: none"> The detailed inventory will provide the berm characteristics and quantities necessary for YG to move forward with recovery and demobilization planning. The information is provided at a scale which facilitates property-specific management and discussions. <p><i>Note: At the request of YG, Stantec is currently completing this inventory. Projected submission is mid-September</i></p>
2	<ul style="list-style-type: none"> The existing berms were not formally designed. Rather, they were constructed in an emergency state and as identified in item 1, often consist of several different materials in a given berm section. The existing berms were not designed to resist the wave action on these large lakes, which functionally behave as coastal erosion processes. The existing berms are to remain in place for a much longer period than originally anticipated during construction. All of the above means the berms may be prone to degradation over time. 	<p><u>Regular Monitoring</u> Until freeze up, continue regular monitoring of berms by a consistent group of individuals who are trained in berm assessment and maintenance.</p>	<ul style="list-style-type: none"> Identifies problem areas before they become larger issues and threaten the overall defense structure.
3	<ul style="list-style-type: none"> Due to wave erosion processes occurring at high water levels, significant shoreline erosion and loss has occurred in several locations in the Southern Lakes. Landowners may look to reclaim this lost land or perform shoreline stabilization. Their desired work may extend cross over the Ordinary High Water Mark (OHWM). Regulations from Fisheries and Oceans Canada (DFO) are applicable below the OHWM. Property setbacks and easements (important for maintenance, recovery, and demobilization post-emergency) are often based on the OHWM line. Stantec is not aware of a mapped OHWM on the Southern Lakes, nor are we aware of a consistent method which has been adopted to delineate OHWM in the Yukon. There are published definitions and delineation methods for determining OHWM in Canada which may be applied. 	<p><u>Identify OHWM and Applicable Regulations</u>¹ In consultation with applicable regulatory agencies, identify a consistent method (if required) for delineating the OHWM, and map the OHWM in the Southern Lakes. Identify what can and can't be done by a) private property owners and b) YG above and below the OHWM.</p>	<ul style="list-style-type: none"> Provides clarity for YG and for private property owners what regulations apply to which areas, informing what can or cannot be done in certain areas. Identifying and communicating this information to property owners will reduce regulatory issues during maintenance, demobilization, recovery, and beyond.

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4	<ul style="list-style-type: none"> In declaring a State of Emergency, YG may be eligible for certain disaster funding from the federal government (e.g., Disaster Mitigation and Adaptation Fund, or DMAF). 	<p><u>Investigate Disaster Relief Funding</u>²</p> <p>Investigate potential disaster relief and climate resiliency funding through the DMAF.</p>	<ul style="list-style-type: none"> Provides potential funding for emergency response work already completed (recoup costs) and future repairs.
5	<ul style="list-style-type: none"> The 2021 federal budget contains significant funding for climate resiliency, of which flood mitigation and planning would qualify. Actively following funding opportunities and applying during open windows is required for these opportunities. 	<p><u>Investigate Flood Mitigation Funding</u>²</p> <p>Investigate multiple sources of potential flood mitigation and climate resiliency funding, including limited-time grants offered under the 2021 federal budget</p>	<ul style="list-style-type: none"> Provides potential funding for improvements to infrastructure and overall flood management, including climate change adaptation.
6	<ul style="list-style-type: none"> The existing berm was built under a State of Emergency, and appears to cross over private property, easements from the OHWM, and below the OHWM From conversations to date, there appears to be some confusion over land ownership and jurisdiction, as property owners have encroached onto the public land with their belongings, fencelines, and outbuildings. Landowners may be of the impression that they own what may be considered public/easement land, where the berms are built Clarity should be provided regarding YG’s liability for impacts to private property resulting from the installation of the berm on or adjacent to private property under a State of Emergency 	<p><u>Legal Counsel</u></p> <p>Engage legal counsel specializing in emergency protection measures and public entity responsibilities and/or jurisdiction in a state of emergency. Through this initiative, identify legal land title and jurisdiction boundaries.</p>	<ul style="list-style-type: none"> Helps YG to understand what the government is responsible or liable for following the installation of the existing berms. Informs the legal jurisdiction and ramifications of future actions both during and after the State of Emergency is lifted. Allows for consistent messaging and approach for public. This can be included in the enhanced communication strategy (see item 15)
7	<ul style="list-style-type: none"> To our knowledge, detailed bathymetry of near-shore areas is not currently available Bathymetry of near-shore areas will likely assist in future analysis and planning, including coastal erosion study (see item 8) and potential shoreline reclamation works Bathymetric survey is most efficiently completed by boat during an open water (non-frozen) conditions. 	<p><u>Bathymetric Survey</u>³</p> <p>Complete a near-shore bathymetric survey at locations where coastal erosion processes are of concern (e.g., Swan Haven, River Road/Bayview, South M’Clintock, Army Beach, California Beach). Consult with coastal engineering specialists to determine required survey extents.</p>	<ul style="list-style-type: none"> Provides the data needed for multiple analyses and planning works which may occur over the winter of 2021/2022. If bathymetric survey is not completed prior to freeze-up, it will mean a delay in analysis and planning (pushed to open water season in 2022).

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<p>8</p>	<ul style="list-style-type: none"> Berm integrity on the Southern Lakes is ultimately a function of three disciplines: structural stability (geotechnical), water levels (hydrology/hyrotechnical), and stability under wave action on large lakes (analogous to coastal engineering). Many of the berm failures and repairs observed to date are due to wave action (coastal process) Wave action impacts certain areas of the berm structure more than others. 	<p><u>Coastal Erosion Study</u>^{3,4} Formal coastal process assessment to determine wave severity, wave action impacts to berms, and vulnerable areas in the flood defense berm considering the coastal environment.</p>	<ul style="list-style-type: none"> Identifies areas which are vulnerable to coastal erosion, and evaluates the degree to which they are vulnerable. Identifies/prioritizes berms which may need to be fortified/reinforced given vulnerability to wave action.
<p>9</p>	<ul style="list-style-type: none"> According to YG Water Resources Branch hydrologists, the Southern Lakes will be higher, later into the year (through Period 1; full supply level = FSL reached in November). Therefore, in Period 2 (winter), water will freeze at a higher elevation than normal in areas and adjacent to the lakes. As of August 2021, many properties were still actively pumping from basements and sumps on their property. Given the FSL will be reached later, and very close to the December 1 date when discharges are restricted (see item 10), how low will the Southern Lakes be drawn down to? 	<p><u>Specific Water Level Projections</u>³ Obtain Southern Lakes water level projections from YG Water Resources Branch for: i) 2021 and a typical year at freeze-up ii) 2021 and a typical year at winter low</p>	<ul style="list-style-type: none"> The water level at freeze up informs whether lake ice is a threat to berm integrity. Water level at freeze up informs the degree to which property infrastructure may be at risk of freeze/thaw damage. The water level at winter low informs the starting point for the 2022 flooding phases (Period 3 and Period 4), a. Can be included in enhanced communication strategy to calibrate public expectations for 2022 flooding, requirement for berms.
<p>10</p>	<ul style="list-style-type: none"> Through the winter, the Southern Lakes are drawn down by discharges through the Yukon River by Yukon Energy Corporation (YEC), by way of their Whitehorse Dam discharges. Per YG Water Resources Branch hydrologists, YEC is to keep Whitehorse Dam discharge relatively consistent (~150 m3/s) after December 1 (approximately when the Yukon River is frozen over). The reason for this requirement is related to potential ice jamming and flooding at Marwell, in the City of Whitehorse downstream of the Whitehorse Dam. In the summer of 2021, the City of Whitehorse installed berms at Marwell. These berms and/or any additional flood mitigation works at Marwell may change the calculation of allowable flows. 	<p><u>Winter Discharge Restrictions</u>³ Investigate the details of the 150 m³/s winter discharge prescription, and whether a higher “emergency” winter discharge prescription in 2021/2022 is possible without a) flooding Marwell and b) causing unsafe ice conditions in the Yukon River and Southern Lakes. Evaluate whether increased winter flow would result in a meaningful decrease to the Southern Lakes water level heading into spring freshet 2022. Potentially pursue water license amendment.</p>	<ul style="list-style-type: none"> If increased discharge is permitted through the winter, the Southern Lakes water level can be lowered more rapidly through the winter which may improve the “starting point” for the 2022 flooding season (Period 3 and Period 4).

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<p>11</p>	<ul style="list-style-type: none"> At the end of Period 1 and through Period 2, the elevated freezing in near-lake areas may pose risks to building or other infrastructure (pipes, foundations, septic, pumps, etc.) Property owners are going to take action. In June/July, we observed property owners taking action on the berm building prior appropriate guidance being communicated to them. Many of these installations were not effective, and sometimes were even counterproductive resulting in hazards to adjacent property and life should they breach. Property owner action is effective if proper technical information and Best Management Practices are communicated. 	<p><u>Freeze/Thaw Implications for Buildings</u>³</p> <p>Investigate the potential impacts to building infrastructure with elevated freezing level in areas adjacent to lakes, and develop some BMP's for property owners.</p>	<ul style="list-style-type: none"> Provides YG with technically sound Best Management Practices to communicate to homeowners and facilitate their positive action Findings can be included in enhanced communication strategy (item 15)
<p>12</p>	<ul style="list-style-type: none"> Through Period 2, snow will accumulate on properties, behind the berms. The accumulation of snow on top of the saturated and frozen soil ("frozen wet sponge") sets conditions in place for local flooding during site snowmelt (Period 3, first phase of flooding). Many property owners have their own heavy equipment and have expressed concern about the snow accumulation now that their drainage to the lake has been blocked by berms. Without this infrastructure, property owners will likely do something about the snow but their actions might not be consistent or advisable. 	<p><u>Snow Management Plan</u>³</p> <p>Develop a snow management plan whereby snow could be cleared by property owners and moved to a location offsite where snowmelt (during Period 3) will cause fewer issues for individual properties.</p>	<ul style="list-style-type: none"> Reduces the severity of "Phase 1" of flooding (site drainage) for landowners in 2022. Keeps landowners engaged in helping protect their own property. This can also be included in the enhanced communication strategy (item 15)
<p>13</p>	<ul style="list-style-type: none"> The current target protection level (659.200 m in CGVD 2013 at Marsh Lake) is not tied to a protection level formally defined by any policy or technical study (e.g., XX-year flood event, XX-year wind event). This elevation was selected by YG as an "initial target" after considering the time and resource constraints present when the berms were being constructed, the 2021 water level projections, and some cursory wind/wave estimates. To Stantec's knowledge, the 659.200 m was not intended as a final berm height, nor was it to be considered protection to any formally defined design criteria (including wave action). 	<p><u>Clarify and Update Hydrology</u>³</p> <p>Two parts:</p> <p>i) Clarify (internally and externally) the origin of the current berm target elevations.</p> <p>ii) Refresh return period estimates of 2021 event by including 2021 in the source period of record, and also accounting for river regulation impacts to flow peaks.</p> <p>Yukon University's hydrology research lab has been performing some preliminary analysis and may have valuable insights.</p>	<ul style="list-style-type: none"> Provides proper context for i) the current berm target and construction level, and ii) for the severity of the 2021 event. This frame of reference ("how bad is it?") is crucial for decision makers to have when determining next steps. Informs "level of protection" discussions. Findings can be included in the enhanced communication strategy, as a way to calibrate public expectations and encourage accurate public discourse (see item 15).

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14	<ul style="list-style-type: none"> The existing berms consist of several different installation types, with a given section of berm often consisting of multiple installation types/materials (e.g., sandbags surrounding a superbag berm, or sandbags over an earth poly berm core). These berms were not formally designed (emergency installation), nor was it anticipated (during construction) that they would need to withstand a Yukon winter. If these berms are to be relied upon for the 2022 flooding season, an understanding of necessary upgrades would be advantageous. 	<p><u>Evaluate Berm Overwintering Integrity</u></p> <p>Using the detailed berm inventory as a base dataset, review which berm types may be at risk to degradation from overwintering and freeze/thaw and identify any overwintering monitoring requirements.</p>	<ul style="list-style-type: none"> The results of this evaluation would identify areas requiring fortification or upgrades prior to the 2022 flood season. As needed and depending on weather, completing this evaluation in Period 1 may allow for the necessary upgrades to be implemented in the fall of 2021.
15	<ul style="list-style-type: none"> Projected wet winter means that the Southern Lakes are currently anticipated to experience high-water again in 2022 (Period 4, second phase of flooding). Property owners will want information about the plans for the current berms and the plans for next year. Yukoners expect clear, transparent and open communication from YG. Any communication or engagement should be done in close collaboration with the YG communications staff. 	<p><u>Communication & Engagement</u>^{3, 5}</p> <p>Develop an enhanced communication and engagement plan to guide activities over the next year. This will include identifying objectives and goals, developing communication materials and outlining specific engagement approaches/events to be used.</p> <p>In the short-term, the priorities will likely be developing an information package about the berm and plans for the fall/winter planning public meetings or open houses to present information and answer questions, in collaboration with YG communications staff.</p>	<ul style="list-style-type: none"> Improves accurate dispersal of information. Allows two-way communication between government and property owners. Sets the stage for proactive problems solving and adaptive management.

Notes:

¹ Recommended to the IMT in email correspondence on August 27, 2021

² Recommended to the YG Emergency Measures Organization (EMO) in email correspondence on June 30, 2021

³ Recommended to the IMT in email correspondence on August 14, 2021

⁴ Recommended to the IMT in email correspondence on July 27, 2021

⁵ Recommended to the IMT in email correspondence on July 29, 2021

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Stantec remains committed to supporting YG and our fellow Yukoners with the ongoing flooding challenge. As a multidisciplinary consulting firm with significant local presence (26 full time employees spanning multiple disciplines in our Whitehorse office) and extensive experience in flood management planning and implementation across Canada, Stantec is capable of assisting the Yukon Government with the full scope of technical and planning components of the emergency and future flood work. At your request, we can prepare a proposal to provide comprehensive flood management and technical/planning services (or components thereof) for your consideration, whether that be as an addition to our current contract with YG or in response to an invitational or public procurement process.

Please do not hesitate to contact the undersigned with any questions you may have.

Regards,

Stantec Consulting Ltd.

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