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Project Memorandum

To:	**Fraser Basin Council (FBC)**		
Attention	**Mike Simpson**	**Project No.:**	**0511-002**
From:	**Kris Holm**	**Date:**	**August 8, 2018**
Subject:	**NDMP 2019 Stream 2 Project Site Long List**		

1.0 INTRODUCTION

BGC Engineering Inc. (BGC) is currently working with Fraser Basin Council (FBC) to complete a flood and landslide geohazard risk prioritization study for the Thompson River watershed (TRW) under National Disaster Mitigation Program (NDMP) Stream 1 funding (the regional study). An outcome of the regional study will be an assessment and prioritization of geohazard areas across the TRW.

BGC understands that NDMP Stream 2 funding applications must be submitted by August 31, 2018. This deadline precedes the expected March 2019 completion of the regional study. In support of that application, BGC has prepared a preliminary list of sites to consider for NDMP Stream 2 funding applications for hazard mapping. A total of 31 areas are included in the list, including 18 areas subject to clear-water flood hazards, 10 areas subject to steep creek hazards, and 3 areas subject to landslide-dam flood hazards.

This memorandum describes how areas identified for further hazard mapping were identified based on the information collected to date (Section 2.0), discusses the preliminary ranking and assessment limitations (Section 3.0), and provides recommendations for next steps (Section 4.0). The areas identified for further mapping should not be considered exhaustive nor exclusive. However, based on the information currently available, we believe that they will rank relatively highly in the risk prioritization being completed for the regional study. This memorandum will be superseded by the systematic analyses and results of the regional study once completed.

2.0 METHODS

Table 2-1 summarizes the methods used to identify and rank areas for each of the following in-scope geohazards including:

- **Clear-water floods:** riverine and lake flooding resulting from inundation due to an excess of clear-water discharge in a watercourse or body of water such that land outside the natural or artificial banks which is not normally under water is submerged.
- **Steep creek debris floods/flows:** creeks with processes characterized by the rapid flow of water and debris in a steep channel such as debris flow or debris flood hazards on alluvial fans. These evens are also often associated with extreme bank erosion.
- **Landslide-dam flooding:** floods caused when landslides impact and temporarily dam major watercourses. Flooding due to landslide dams can occur both upstream from water impoundment, and downstream when dam failure results in the sudden release of

impounded water. BGC applied different assessment methods for landslide-dam flooding compared to clear-water floods, given the different source of hazard. Note that it is the up- and downstream flood hazard area, not the impact from the landslide itself, that is ultimately prioritized in this study.

Table 2-1. Summary of methods used for the preliminary geohazard area prioritization.

Hazard-type	Assessment Approach
Clear-water flooding	• Historical floodplain extents were obtained from iMapBC (Government of BC, 2016). • Predicted floodplain extents representing low-lying areas adjacent to mapped watercourses were identified using a GIS-based modelling approach and prioritized as areas containing development based on the NRCan exposure model data and visual assessment of the developed areas in Google Earth. Clear-water flood hazards for areas without existing historical floodplain mapping are based on predicted floodplain extents. • Historical flood events were used to confirm flood-prone low-lying terrain outside of areas covered by historical floodplain maps. • Flood hazard areas were intersected with the NRCan exposure model to estimate the total affected population and number of buildings.
Steep creeks	• Alluvial fans within in-scope areas subject to steep-creek geohazards and containing development were considered[1]. • Historical steep-creek events were used to confirm areas prone to debris flows and debris floods. • Steep-creek flood hazard areas were intersected with the NRCan exposure model to estimate the total affected population and number of buildings.
Landslide-dam flooding	• Historical landslide events were used to identify areas where residual hazard or risk is present due to potential reactivation or landslide susceptibility. • Subjective screening for potential landslide dam flooding of "gateway"[2] communities located downstream of relatively large undeveloped upstream catchments with landslide dam potential. This screening was watershed-wide but is being undertaken part way through our larger study. As such, the final list of 'gateway' communities may differ from those listed in Table 3-3.

As part of the regional study, BGC is currently identifying hazard areas and compiling a digital inventory of the built environment across the TRW (elements at risk). Cadastral parcels and BC Assessment (BCA) data were not yet available to BGC at the time of writing. As a result, an estimation of the value of improvements in candidate areas could not be included in the preliminary ranking of sites. In lieu of these data, BGC used the Natural Resources Canada (NRCan) Draft Risk Exposure Model, which defines total population and number of buildings on a census-block level.

[1] BGC's inventory of steep-creek fans within the TRW is partially complete. As such, the final list of prioritized sites may differ from the steep creeks identified in Table 3-2.

[2] The term "gateway" is used to describe an area or community located at the upstream extent of development. Upstream from the "gateway" area or community is a relatively undeveloped and unpopulated region with a relatively larger watershed area, many tributary valleys and steep slopes with landslide dam potential.

BGC compiled a historical flood, steep creek, and landslide dam inventory across the TRW and digitized the locations of historical events from Septer (2007), DriveBC (MOTI, n.d.), and 2018 freshet-related floods and landslides sources (e.g., media reports). Historical events compiled as part of this inventory were considered in the preliminary prioritization. BGC also considered the priority sites identified in the Community to Community Forum between FBC and the TRW stakeholders (Fraser Basin Council, 2018). Candidate sites were developed based on information compiled to date, records of historical events, and professional judgement.

The regional study focuses on both urban and rural areas within the TRW, but not areas that are entirely undeveloped. The boundary between settled areas and wilderness is not always sharp, so defining the areas to be assessed can be challenging. Prioritized geohazard areas typically include buildings improvements and adjacent development (i.e., transportation infrastructure, utilities, and agriculture). Although infrastructure in otherwise undeveloped areas (e.g., roads pipelines, transmission lines, and highways) could be impacted by geohazards, these were outside the focus of the study and therefore not included.

3.0 PRELIMINARY RANKING

Prioritized hazard areas for each geohazard type based on BGC's preliminary assessment are shown in Figure 3-1 for 18 clear-water flood hazards, and Figure 3-2 for 10 steep creek and 3 landslide hazards.

3.1. Clear-water Floods

Table 3-1 summarizes the preliminary ranking for 18 clear-water flood hazards within the TRW. The list includes 11 areas with and 7 areas without existing historical floodplain mapping or flood protection measures. Areas with historical floodplain mapping were included in the preliminary ranking because mapping within the TRW is on average 30 years old and as a result does not:

- Reflect only a portion of the full data record available for hydrometric stations within the watershed
- Reflect potential changes in channel planform and bathymetry (e.g., aggradation and bank erosion as well as channel changes and avulsion paths formation)
- Consider climate change impacts on flooding (directly by predicted changes in rainfall and/or snowmelt and indirectly by changes in vegetation cover through wildfires and/or beetle infestations).

The quality and accuracy of the historical floodplain mapping was not evaluated as part of the prioritization. The ranking shown in Table 3-1 is based on the results from the NRCan exposure model. Many of the census block boundaries from the NRCan exposure model extend beyond the extents of the historical and predicted floodplains. Thus, the values reported may over-estimate the total population and buildings that may be affected by clear-water flood hazards. BGC notes that some uncertainties result from the lack of BC Assessment data at the time of preparation of this memorandum, which is an interim deliverable of the main study. Hazard

exposure characterized as part of the main assessment will consider BC Assessment data and will supersede the results of this memorandum once completed.

FBC may want to consider additional stakeholder input described in FBC (2018) to further refine this list. Also, some identified areas have relatively recent floodplain mapping (e.g., the Thompson River in 2004) that could be prioritized lower. Five areas were included in Table 3-1 that were not identified as a priority area in FBC (2018) based on a review of historical flood events or the presence of historical floodplain mapping.

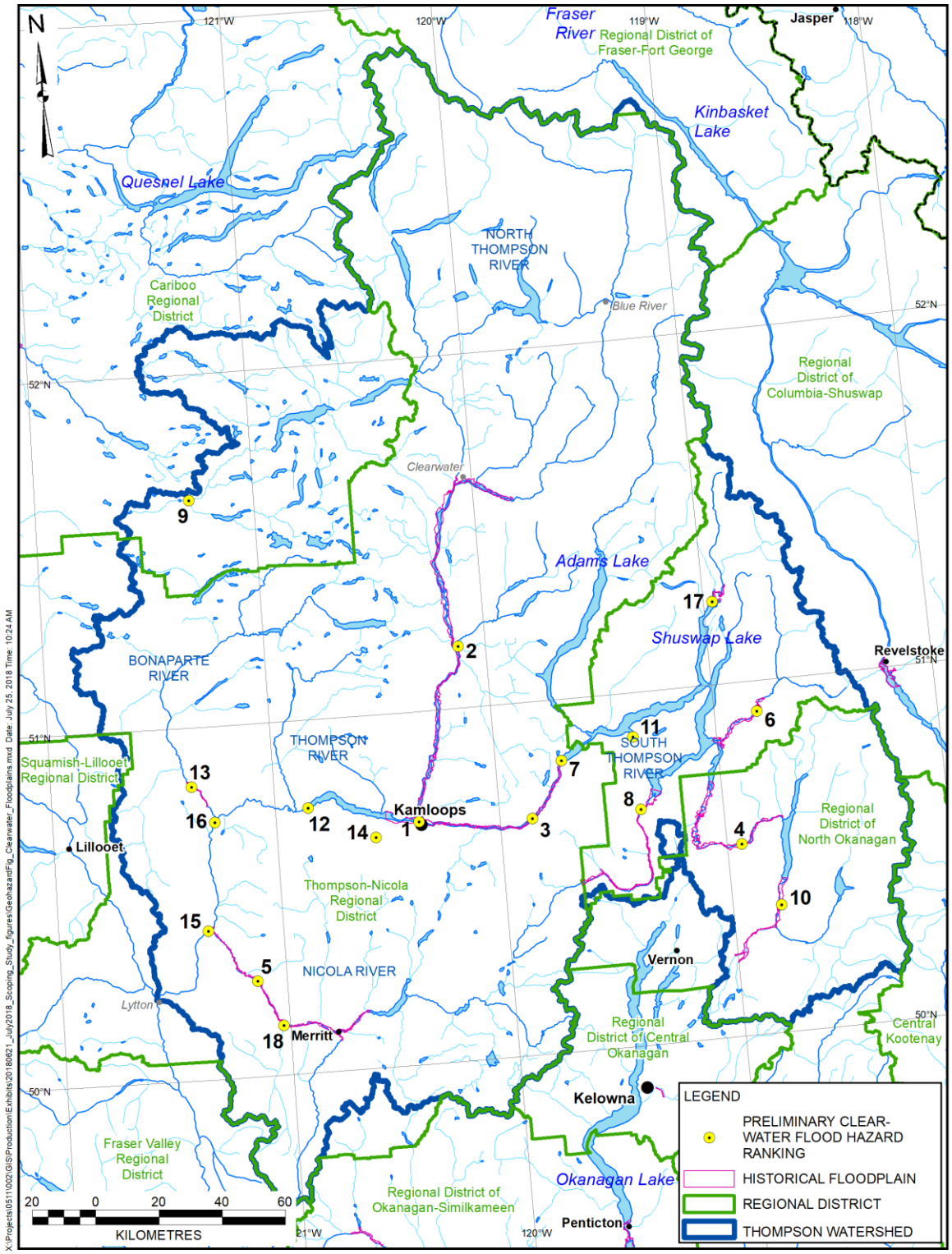

Figure 3-1. Prioritized geohazard locations for clear-water flood areas.

Table 3-1. Preliminary ranking of clear-water flood hazard areas.

Site No.	Watercourse (Area)	District	Approx. Floodplain Area (km^2)	Census Block Total Population	Census Block Total Building Count	Historical Floodplain Mapping? (Map Year)	Flood Protection Measures?	2018 Identified Priority?	Recorded Historical Flooding Events	Comments/Recommendations
1	Thompson River (Kamloops Area)	TNRD	27.8	17,327	4,978	Yes (1976, 2004 update)	Yes	Yes	1894, 1928, 1948, 1972, 1990, 1997, 1999, 2012	City of Kamloops updated floodplain maps in 2004. Portion of Tk'emlups te Secwepemc reserve land had floodplain mapped as part of City of Kamloops in 2004.
2	North Thompson (Vavenby to Kamloops)	TNRD	126.8	9,290	3,502	Yes (1982)	Yes	Yes	1894, 1928, 1948, 1972, 1990, 1997, 1999, 2012	TNRD currently undertaking official community plan in North Thompson. River is prone to ice jams. Areas with existing floodplain mapping could be considered (e.g., Lower Barriere River has existing floodplain mapping but could be extended to the upper reaches of Barriere River). Additional areas that could be considered for floodplain mapping include Clearwater, Little Fort and 100 Mile House.
3	South Thompson River (Kamloops to Chase)	TNRD	30.2	6,445	2,594	Yes (1976, 2004 update)	Yes	Yes	1894, 1928, 1948, 1972, 1990, 1997, 1999, 2012	City of Kamloops updated floodplain maps in 2004. Portion of Tk'emlups te Secwepemc reserve land had floodplain mapped as part of City of Kamloops in 2004. Area could be prioritized lower due to more recent floodplain mapping.
4	Shuswap River (Mara Lake to Mabel Lake)	RDNO	45.1	3,352	1,504	Yes (1980)	Yes	Yes	1983, 1990, 1997, 1999, 2012, 2018	Flooding at the northern extent of Shuswap River is influenced by Mara Lake levels. In 1990 and 1997 some of the flood events were debris flows and debris floods in tributaries adjacent to floodplain triggered by intense rainfall. Frequent flooding of Highway 97A near Grindrod.
5	Nicola/Coldwater Rivers (Nicola Lake to Spences Bridge)	TNRD	24.8	3,230	1,284	Yes (1989)	Yes	Yes	1894, 1922, 1954, 1974, 1980, 1984, 1991, 1997, 2002, 2017, 2018	Debris and sediment pile up at mouth of Nicola River at Spences Bridge. LiDAR was collected in 2016 for City of Merritt area. Stump Lake previously flooded in 2017 and TNRD is assessing options to manage Stump Lake water levels. Many of the areas in Nicola/Merritt Valley were impacted by 2017 and 2018 flooding. First Nations completed hydrological study in 2015 and has funds for flood mitigation planning.
6	Eagle River (Malakwa to Sicamous)	CSRD	20.4	2,487	1,048	Yes (1979)	Yes	No	1967, 1972, 1982, 2012	Flooding at the western extent of Eagle River is influenced by lake levels on Shuswap and Mara Lakes. Costs for flooding damage in Sicamous area (including steep creeks on Sicamous and Hummingbird Creeks) totalled approximately $3.8M (Public Safety Canada, n.d.). Sicamous completed a hydrological connectivity study and applied for flood mitigation funding for Sicamous Creek.
7	Chase Creek (Chase)	TNRD	4.8	2,297	1,148	No	No	Yes	1935, 1948, 1960, 1972, 1996	Past flood events from rise of Little Shuswap Lake.
8	Salmon River (Falkland to Salmon Arm)	CSRD	24.9	2,267	994	Yes (1991/1992, 2011 update)	No	Yes	1894, 1972, 1999, 2018	Flooding at the northern extent of Salmon River is influenced by lake levels on Shuswap Lake. Adams Lake Indian Band is currently conducting climate modelling for Chase Creek, Salmon River, and others. Lower reaches around Salmon Arm have updated floodplain mapping (2011).
9	Bridge Creek (Camin Lake to 100 Mile House)	CRD	14.8	2,109	1,132	No	No	Yes	1997,1999	Flooding in 1999 caused approximately $400,000 in damage including bridge replacement. An ice jam on Bridge Creek near 100 Mile House created localized flooding in 1997. Wildfires near Camin Lake in 2017, mitigation planning underway.

Site No.	Watercourse (Area)	District	Approx. Floodplain Area (km^2)	Census Block Total Population	Census Block Total Building Count	Historical Floodplain Mapping? (Map Year)	Flood Protection Measures?	2018 Identified Priority?	Recorded Historical Flooding Events	Comments/Recommendations
10	Shuswap River, Bessette & Duteau Creeks	RDNO	24.4	1,548	674	Yes (1998)	Yes	No	1983, 1997, 1999, 2012, 2018	Flooding at the northern extent of Shuswap River is influenced by Mabel Lake levels and the Shuswap Falls dam. Regional District of North Okanagan applied for structural mitigation upgrade funding. Village of Lumby secured funding for floodplain mapping in 2017.
11	Shuswap Lake (Southern Shuswap, Blind Bay, Sorrento)	RDNO	5.8	1,460	690	No	No	No	1935, 1948, 1960, 1972, 1996	Several past flood events from rise of Shuswap Lake
12	Thompson River / Kamloops Lake (Savona to Ashcroft)	TNRD	8.3	1,255	555	No	No	Yes	1894, 1948, 1972, 1990	Past flood events from rise of Kamloops Lake and flooding on Deadman Creek. Flooding has caused damage to property within Savona and infrastructure (bridges and railway lines) along Thompson River. Flooding in 1990 caused approximately $50,000 in damage (Septer, 2007).
13	Bonaparte River (Cache Creek)	TNRD	2.1	616	281	Yes (1996)	Yes	Yes	1866, 1875, 1880, 1990, 1997, 1999, 2015, 2017, 2018	Flooding in 1990 caused approximately $100,000 in damage (Septer, 2007). 40% of Bonaparte River catchment was burned in 2017 Elephant Hill wildfire. Existing floodplain mapping limited to Cache Creek and could be extended to Ashcroft. Cache Creek has secured funding for flood mapping studies (FBC 2018); and could be removed from the list.
14	Cherry Creek	TNRD	3.9	186	63	No	No	Yes	1997, 2018	Impacts to homes and road washouts during previous flood events.
15	Thompson River (Spences Bridge to Lytton)	TNRD	2.4	173	65	No	No	Yes	1894, 1900, 1958, 1972, 1974, 1990, 1999	History of past flood and landslide events along the Thompson River corridor between Spences Bridge to Lytton. In 1899 a landslide event dammed the Thompson River at Spences Bridge.
16	Thompson River (Ashcroft to Spences Bridge)	TNRD	3.3	161	60	No	No	Yes	1881, 1894, 1900, 1903, 1960, 1982	History of past flood and landslide events along the Thompson River corridor between Ashcroft to Spences Bridge. Potential for landslide dam induced flooding.
17	Seymour River at Seymour Arm	CSRD	6.0	67	34	Yes (1989)	No	No	Unknown – no historical accounts	Provincial floodplain designation has been withdrawn and mapping information is not accessible on iMapBC (Government of BC, 2016). No additional information was available on the reason why the map was withdrawn.
18	Spius Creek	TNRD	0.8	35	15	Yes (1989)	No	No	1997	Developed as part of Nicola/Coldwater Rivers floodplain maps, but identified as unique floodplain in digital floodplain dataset. Fire-related disturbance/aggradation event prior to 1960. Flood event in 1997.

3.2. Steep Creeks

Table 3-2 summarizes the preliminary ranking for steep-creek hazards within the TRW. The creeks are grouped into two general geographical areas: Shuswap and Thompson River (including the North Thompson River).

Some of the areas proposed for further assessment are fan deltas (fans that form in standing water bodies, such as large lakes), which may be characterized by a higher avulsion potential than terrestrial (land-based) alluvial fans due to channel back-filling from the delta mouth particularly when high lake levels coincide with high runoff events. Site selection was subjective and judgement-based. It is should not be considered exhaustive nor exclusive; however, we believe that the sites included in the long list are likely to be prioritized in the final results of the Stream 1 assessment.

Existing infrastructure data were compiled from available provincial government information sources. The available information did not include the design basis. Such information would need to be gathered from the approving authority.

As for clear-water flood hazard areas, the ranking shown in Table 3-2 is based on the results from the NRCan exposure model. Some census block boundaries from the NRCan exposure model extend beyond the extents of the alluvial fans and may over-estimate the total population and buildings that may be affected by steep-creek hazards.

Table 3-2 also outlines BGC's understanding of the availability of LiDAR data for the alluvial fan and watershed. These data could be used to more accurately map the alluvial fan boundaries, to identify potential sources of sediment or landslides in the watershed, and to characterize the steep creek hazard characteristics on the alluvial fan. High-resolution digital elevation data, such as LiDAR, would be required to model flow and sediment transport during detailed hazard assessments of these sites.

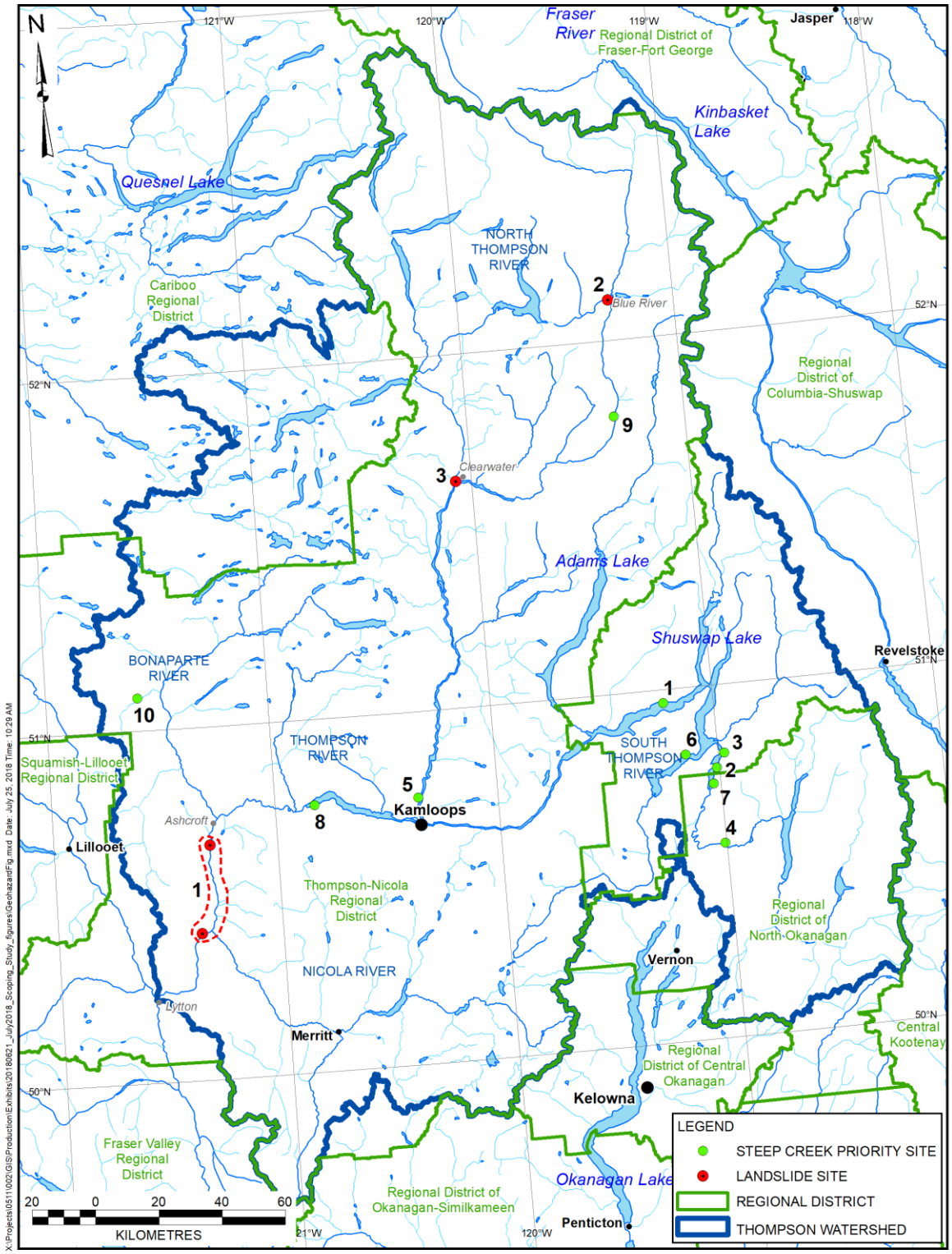

Figure 3-2. Prioritized geohazard locations for steep creek and landslide areas.

Table 3-2. Preliminary ranking of steep-creek hazard areas.

Site No.	Watercourse	District	Census Block Total Population*	Census Block Building Count*	Hydrogeomorphic Process	Group Area	2018 Identified Priority?	Comments	Existing Infrastructure	LiDAR availability
1	Ross Creek	CSRD	117	58	Debris flood	Shuswap	Yes	Fan-delta into Shuswap Lake, high aggradation and avulsion potential, events in 1948, 1971, 1997, and 1999. 65% of watershed burned by fire in 1994. Event in 1999 required $650,000 to mitigate stream.	Partial dike on left and right banks	BCTS (partial watershed)
2	Hummingbird Creek	CSRD	145	72	Debris flow	Shuswap	Yes	Fan-delta into Mara Lake, high aggradation and avulsion potential, events in 1997, 2012, and possibly in 1930s. Event in 1997 caused extensive damage to homes and cabins.	Rip rap, partial dike on right bank	MOTI (partial fan)
3	Sicamous Creek	Sicamous	163	62	Debris flood	Shuswap	No	Fan-delta into Mara Lake, high aggradation and avulsion potential, events in mid-1920s, 1935, 1950s, 1997, and 2012. Event in 2012 avulsed and damaged several homes. Creek is subject of ongoing litigation from 2012 event.	Rip rap	MOTI/BCTS
4	Ashton Creek	RDNO	334	160	Debris flood	Shuswap	Yes	High channel erosion and aggradation potential, events in 1990, 1997, 1999, 2012, 2013. Event in 1997 caused aggradation and cost approximately $150,000 to repair.	Unknown	None
5	Westsyde Gullies	Kamloops	7037[3]	2357[3]	Debris flow	Thompson	No	Several small gullies on steep slope above development, houses built adjacent to gullies at toe of slope, “flash flood” events in 1997 and 2015. Emergency works in 2015 estimated at $740,000.	Unknown	McElhanney, City of Kamloops
6	Unnamed/Hart/ Robinson/McIntyre Creeks	CSRD	13	6	Debris flow	Shuswap	No	Fan-deltas into Shuswap Lake, events in 1928 (Hart), between 1987 and 1994 (Hart), 2014 (McIntyre), 2017 (Robinson). Fatality in 2017 (Robinson) and two homes destroyed.	Emergency mitigation berm (McIntyre)	MOTI (McIntyre)
7	Rogers Creek	RDNO	155	69	Debris flood	Thompson	No	Fan-delta into Mara Lake, high avulsion potential, similar lithology and process mechanism to Hummingbird Creek.	Unknown	MOTI (fan)
8	Savona	TNRD	477	217	Debris flow	Thompson	No	Fan-deltas into Kamloops Lake, thick erodible sediments upstream.	Unknown	MOTI (fan)
9	Avola	TNRD	11	6	Debris flow	Thompson	No	Most of the community is built on the fan. Recent debris flows in adjacent watershed.	Unknown	McElhanney/BCTS
10	Soues Creek	TNRD	566	272	Debris flood	Thompson	No	Anecdotal reports of a debris flow in Clinton in 1873 caused by dam or logjam breach in “Mill Creek” (unknown drainage). Community of Clinton built on fans with infrequent steep creek and clearwater processes.	Unknown	MOTI (partial fan)

Note: *Many of the census block boundaries extend beyond the extents of the alluvial fans. Thus, the values reported are an overestimation of the total population and buildings that may be affected by these hazards.

[3] Only a small portion of populous census blocks intersect alluvial fans in this area. The actual exposure to steep creek hazards is lower than this estimate derived from the NRCan exposure model.

3.3. Landslide-Dam Floods

Table 3-3 summarizes the preliminary ranking for landslide hazards within the TRW. Landslides are common within the TRW and some have potential to dam waterways and cause flooding. BGC has selected historical landslide dam flood event areas and "gateway" areas as sites for prioritized study. Information on relevant recorded landslides will be included with the main report. BGC's list of candidate sites to be considered for detailed analysis include the stretch of Thompson River between the communities of Ashcroft and Lytton, the Clearwater area, and the Blue River area.

Table 3-3. Preliminary ranking of landslide-dam flood areas.

Site No.	Geographical Area	Watercourse Name	Communities Potentially Exposed to Hazard	Comments	LiDAR Availability comment
1	Ashcroft to Lytton	Thompson River	Ashcroft, Spences Bridge, Lytton	Multiple historical accounts of landslide dams and flooding that impacted communities	Yes
2	Community of Blue River	North Thompson River	Blue River	Gateway community with large upstream catchment	No
3	Community of Clearwater	Clearwater River	Clearwater	Gateway community with large upstream catchment	No

The Ashcroft to Lytton area contains several large historical landslides, susceptible communities (e.g., Ashcroft, Spences Bridge, Lytton), and the only historical accounts of landslide dam flooding events and community impact within the TRW. Major landslides within this area include:

- Landslides immediately south of Ashcroft (Journault et al., 2018; Tappenden and Martin, 2015; Quinn et al., 2012, Eshraghian et al., 2008, Clague and Evans, 1994)
- Spences Bridge (Walkem, 2015; Clague and Evans, 1994)
- The Drynoch earthflow approximately 8 km south of Spences Bridge (VanDine, 1982; Bovis and Jones, 1992; Bovis, 1985).

Multiple damming events in this area have occurred in the Ashcroft area and at Spences Bridge (Clague and Evans, 1994). Most notable are the 1880 Black Canyon landslide in the Ashcroft area and the 1905 landslide at Spences Bridge which flooded the nearby towns of Ashcroft and Spences bridge, respectively.

The North Thompson watershed "gateway" communities of Clearwater and Blue River were selected because upstream of both are large mountainous catchments with multiple locations that may be susceptible to landslide dam formation. In the North Thompson River valley above Blue River, large bedrock landslides have been mapped (Moretti et al., 2013), and concerns about blockage of the Clearwater River were raised at the Community to Community Forum (FBC,

2018). It is not yet known whether flooding from any such dam can produce an outburst flood large enough to impact these communities or other downstream settled areas. Further analysis could help determine if landslide dam outburst flooding in the far upstream reaches are of consequence to these gateway and downstream communities, and if additional detailed hazard and risk assessments are needed and other communities further downstream.

4.0 SUMMARY

Although the preliminary geohazard areas are presented separately as clear-water, steep creek and landslide-dam flooding areas, some areas may be subject to more than one geohazard type (i.e., hazard area may overlap). Multi-hazard areas were not explicitly identified as high priority in the tables, as the level of detail does not allow summation of total risk. Table 4-1 presents grouped areas of potential overlap. The groupings can help direct NDMP Stream 2 funding applications that consider a larger geographical scope.

Table 4-1. Potential grouping of ranked areas by geographical area.

Watercourse (General Area)	District	Site Numbers by Hazard Type			Consideration
		Clear-water flood	Steep creeks	Landslide-dam flood	
North and South Thompson (Kamloops)	TNRD	1,2,3, 7	5,9	2,3	Flooding on North and South Thompson Rivers and major tributaries (Barriere, Louis Creek, Clearwater), steep creek hazards adjacent to the floodplain, and landslide dam “gateway” flooding hazard at Clearwater and Blue River.
Thompson River / Kamloops Lake (Savona to Lytton)	TNRD	12, 13, 14, 15, 16	8, 10	1	Kamloops Lake levels, steep creek and landslide dam flooding
Shuswap / Mara Lakes	CSRD	6, 8,11, 17	1,2,3,6	-	Shuswap and Mara Lakes levels, steep creek hazards on fan deltas.
Shuswap River (Lumby)	RDNO	4, 10	4, 7	-	Flooding and steep creek hazards on alluvial fans adjacent to the floodplain
Nicola River (Merritt)	TNRD	5,15, 18	-	-	Flooding hazard, dam hazard, and steep creek hazards (not prioritized) adjacent to Nicola River floodplain
Camin Lake (100 Mile House)	TNRD	9	-	-	Flooding hazard from Camin Lake to 100 Mile House and Horse Lake

5.0 NEXT STEPS

The following schedule is proposed:

July 30 – 31: BGC/FBC discuss and finalize list of areas to prepare funding applications, with consideration of the required schedule.

August 1 – 24: BGC prepares supporting material for funding application submission.

August 25 – 31: Final FBC/BGC review and application submission by August 31, 2018.

6.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of Fraser Basin Council (FBC). The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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