

To: Columbia Shuswap Regional District  
555 Harbourfront Drive NE  
Salmon Arm, B.C.

August 14, 2018

Re: Submission regarding No. 725-133 at # 4990 Sunnybrae-Canoe-Point Road, Tappen

Dear Manager of Development Services and Directors of the Board:

We are the owners of the six properties [REDACTED] of the this planned development and subdivision at #4990 Sunnybrae-Canoe-Point Road. The first attachment depicts a neighborhood plan showing the locations of [REDACTED] which are owned by myself and my husband [REDACTED] and [REDACTED] owned by [REDACTED]. The second attachment shows a higher resolution of the location of the proposed park in relation to [REDACTED] Sunnybrae Road.

In general, we are not opposed to the sub-division of this piece of property into several residential lots even though we prefer a lesser density than proposed, i.e. less than fourteen. We are also not opposed to the relocation of the road. A positive side effect would be better visibility when exiting our driveways westbound (a true hazard at [REDACTED]). In fact we believe that the proposed plan is the best of all of the development ideas we have encountered during the time potential purchasers were investigating this piece of land, e.g. water slide, campground (similar to Sandy Point).

However, we are writing this submission to object in the strongest way the dedication of a public park pursuant to 75 (1) (c) LTA which is adjacent to our properties and directly below in the case of [REDACTED]

Our reasons:

1) Noise, including during the night, and disturbance of the occupants of the three nearest houses. The beach of the proposed dedication pursuant to 75 (1) (c) LTA is only approximately 10 meters below from the house at [REDACTED] (a rental house), 17 meters away from [REDACTED] (which is the writer's main residence), and 50 meters from [REDACTED]. Noise carries very well along the water and the unobstructed beach front area. During the last two years houseboats had tied up at #4990 Sunnybrae and despite being more than 300 meters away from us there were many nights that we could not sleep due to the noise created by the boaters.

2) Invasion of privacy and safety.

We understand and do respect the right of the public to be anywhere along the waterfront. However, there will doubtlessly be foot traffic right at the edge of our gardens and patios not only during the day but also during the night [REDACTED]. Latter is quite disconcerting as we have already had burglaries and break-ins by people entering our properties and our neighbor's (= [REDACTED]) via the beach. As recent as May of this year we confronted a shady looking individual who was loitering on our dock where a boat was parked. He then proceeded to a dock of one of our neighbors to the East.

3) The house nearest to the proposed park [REDACTED]. For much of the year it is a vacation rental frequented by mostly out of province visitors, some of who are repeat customers. It is promoted as a quiet and peaceful retreat and is contributing to the commerce and income of the Shuswap. [REDACTED] is a long term rental house also promoted as being in a quiet and rural neighborhood. If a park were

developed at the proposed location it is my opinion that we would lose business due to the loss of privacy and the level of noise created (at least in the case of [REDACTED]).

4) Disturbance of wildlife.

There are deer, birds, bears, otters, fishers, mink, eagles, ospreys, etc. using this piece of land to access the foreshore and the lake.

5) Pollution of water and land.

Nearby "Beer Bottle Bay" is a perfect example of what happens to a small area of beach where houseboats dock for the night or people use a beach that has no proper management. Local residents complain about noise and have called police for help on many occasions. There is garbage, including broken glass, on land and in the water. Bags full of garbage, weighted down with rocks and submersed into the water along the beach line have been found.

6) Traffic and servicing issues.

Not only would a day park increase the traffic volume on Sunnybrae Road, which is often congested during the summer months, there is also no parking anywhere for this proposed park. The land's configuration is too steep, small and narrow to build a road and parking lot. People would likely try to park along the road side which would become a hazard especially due to limited visibility of oncoming traffic at that particular place in the road. Without a road leading into this proposed park how could bathroom facilities or outhouses be established and serviced? It is obvious where people would go to the bathroom when there are no facilities.

7) We do not see the need for another park given that Herald's Provincial Park is less than two kilometers away and whose day area allows plenty of space for people to enjoy the beach and playground for most of the year. A second park nearby would unnecessarily increase the overhead costs incurred by the CSRD due to its establishment and maintenance and would add to the tax burden on local residents.

Sincerely,

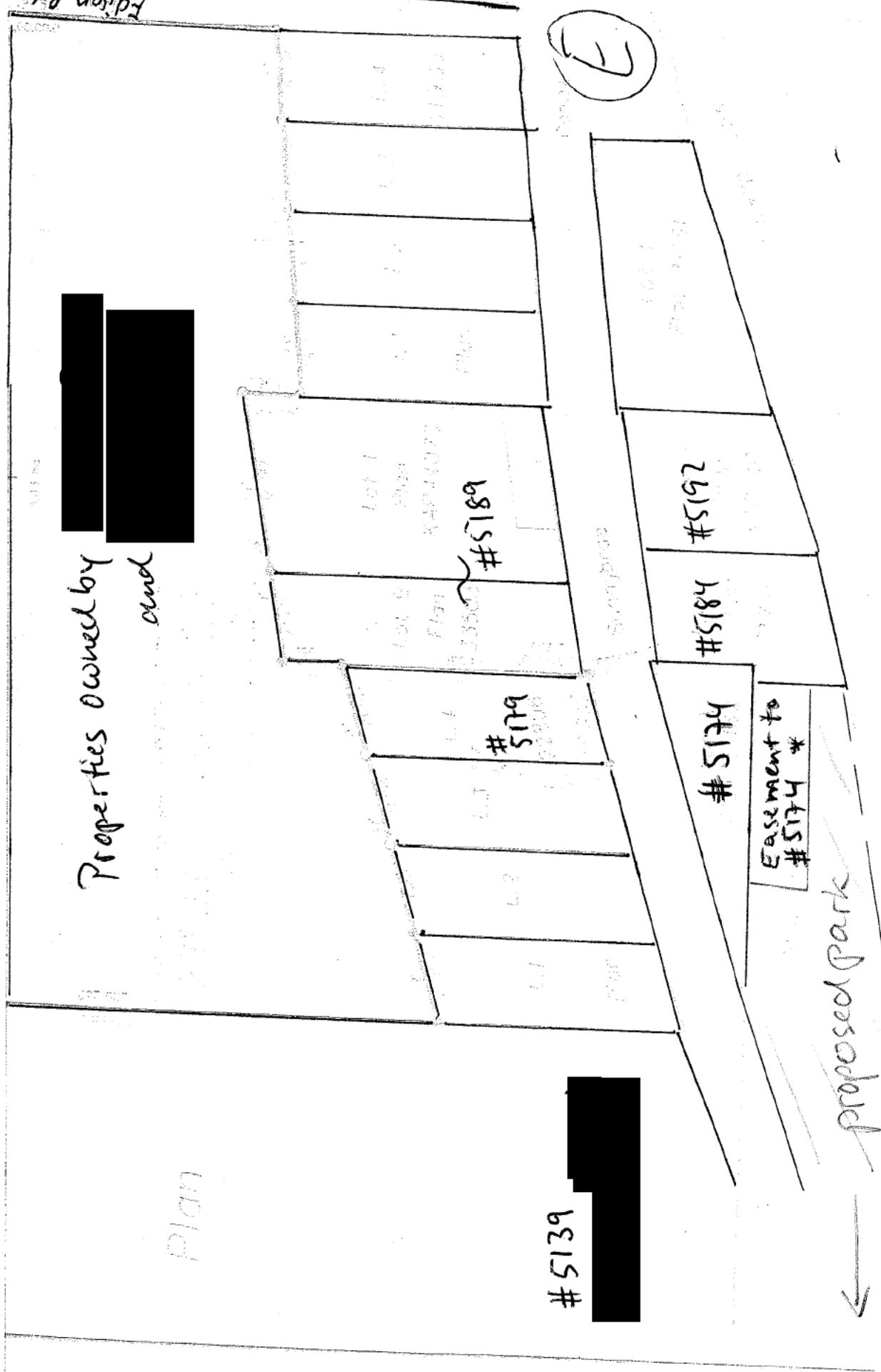
[REDACTED]

[REDACTED] (copied)

[REDACTED] (copied)

(B)

(N)



Properties owned by [redacted] and [redacted]

#5139 [redacted]

Easement to #5174 \*

proposed park

\* see second attachment

(S)

(E)



AUGUST 10-2018

Pg 1 of 2

To: CSRD

555 HARBOURFRONT DRIVE N.E.  
SALMON ARM BC

FROM:

RE: DP SUBMISSION NO. 725-133

CHANGE IS INEVITABLE - I UNDERSTAND THE NEW OWNER WANTING TO DEVELOPE - HOWEVER, AS A LAKE FRONT PROPERTY OWNER (SINCE 1991) IN CLOSE PROXIMITY TO THIS PARCEL, I DO HAVE A LOT OF CONCERNS.

- 1) CURRENTLY ZONED "INDUSTRIAL" - GOING TO 14 HOMES - TO ME THAT WOULD THEN BE "MULTI-RESIDENTIAL" PROPERTY. WHATS TO STOP FUTURE EXPANSIONS - I.E. MORE HOMES? & PEOPLE ADDING GUEST HOMES TO THEIR ONE ACRE PARCELS?
  - 2) MY UNDERSTANDING IS THAT CURRENTLY 5 ACRES IS REQUIRED FOR SUBDIVIDING FOR ONE RESIDENCE. THIS REGULATION MUST BE IN PLACE FOR SEVERAL REASONS. WHY SHOULD THIS PROPERTY BE ANY DIFFERENT OR EXEMPT?
  - 3) GIVEN THAT THE LAND WAS USED IN THE LOGGING INDUSTRY FOR SEVERAL YEARS - THE LAND IS MOST LIKELY TOXIC. 14 SEPTIL SYSTEMS & 14 IRRIGATION SYSTEMS CAN ONLY MEAN TOXIC LEACHING INTO THE LAKE.
- A) MANY HOMES USE LAKE WATER FOR DRINKING WATER. THIS COULD MEAN MORE CONTAMINATION - & WHERE OF THE CREEK / STREAM THAT COMES INTO THE LAKE RIGHT BESIDE THE PROPERTY? & THE FISH? HAVE GROUND SOIL TESTS BEEN DONE? HAS D.F.O. HAD ANY INPUT?

CONTINUED.

FROM: [REDACTED]

RE: DP SUBMISSION NO. 725-133

Pg 2.

CONTINUED - CONCERNS:

- 5) THERE IS NO NATURAL GAS AVAILABLE TO THIS AREA. POTENTIALLY 14 WOOD BURNING UNITS - OR MORE. WINTER AIR QUALITY WILL BE LIKE LIVING BESIDE AN ACTIVE BEEHIVE BURNER - FOR THOSE OF US WHO LIVE HERE YEAR ROUND.
- 6) WILL THIS MEAN THE IMPACT OF 14 NEW WHARFS? MORE POLLUTANTS
- 7) AS SUNNYBRAE IS STILL A NARROW COUNTRY ROAD, TRAFFIC VOLUME WILL SUBSTANTIALLY INCREASE FOR THOSE OF US WHO LIVE HERE YEAR ROUND - FURTHER THAN HEROLD'S PARK FACILITIES
- 8) DRAWINGS I HAVE BEEN SHOWN ARE FAR TOO HARD TO DISTINGUISH ANY DETAIL. HOME OWNERS NEED BETTER TO MAKE ADEQUATE DECISIONS

IN SUMMARY - LOTS OF CONCERNS - DENSITY NOW & FUTURE; SEPTIC SYSTEMS; WATER CONTAMINATION ISSUES; AIR QUALITY ETC.

PLEASE CONSIDER THESE ITEMS & NOT INCREASE PERMIT TO 14 RESIDENCES I DO PLAN TO ATTEND CSRD MEETING AUG 16<sup>th</sup>

THANK YOU.

[REDACTED]

**Re: Opposition to development at 4990 Sunnybrae-Canoe Point Road, DP No. 725-133**

Dear CSRD Manager of Development Services & CSRD Board of Directors:

Please find below our rationale for opposing Development Permit application No. 725-133:

- (1) Multiple recent catastrophic debris flow events along Sunnybrae-Canoe Point Rd have caused a death and damage/destruction of private properties, and are therefore of particular concern to the safety of current and future residents. Geotechnical reports produced following these events have explicitly recommended that the CSRD conduct a landslide risk analysis and require geotechnical assessments for future developments in steep slope areas from Sunnybrae to Bastion Creek (*Westrek 2015 & 2017* - attached), such as those upslope of the proposed development. These recommendations have been echoed by the Forest Practices Board. As these debris flow events have initiated upslope of impacted private lands, geotechnical assessments should extend to areas upslope of any proposed development. The CSRD committed to moving toward establishing a Hazardous Lands Development Permit Area for Sunnybrae by fall 2017, but we are not aware of this being achieved. Due diligence as well as geotechnical event liabilities related to public safety and private property damages falls on the CSRD, as it occupies a regulatory field and has ample reasonable basis for concern;
- (2) With respect to the parcel in question, s.3.6.2. of the Electoral Area C Official Community Plan Bylaw No. 725 ('OCP' herein) states that "New waterfront development will only be supported if it... Has maximum densities of... 1 unit/2 ha(1 unit/4.94 ac)..." Adjacent lots are currently primarily designated RR2 or SH, for which the OCP specifies a maximum density of 1 unit per 5 acres (2 ha) and 1 unit per 10 acres (4 ha), respectively (s.3.4.1.2). The CSRD previously communicated that the above would be mandated in zoning well-before this point in time;
- (3) Traffic density on Sunnybrae-Canoe Point Rd is already excessive, and the addition of 14 lots would negatively impact public safety on the road (see '*Concept Plan: Shuswap Park & Boat Launch*' attached for details);
- (4) A development of the proposed density could have several negative impacts to the environment, including those on water quality, wildlife corridors, foreshore and riparian integrity, tranquility, and visual appeal (see '*Concept Plan: Shuswap Park & Boat Launch*' attached for details);
- (5) The 100 m Development Permit notification radius is an urban standard not appropriate for the rural area in question due to the far wider-reaching impacts associated with the large adjacent public use shared resource area (Shuswap Lake), the single access road, and the size of adjacent lots. Therefore, submissions from residents of Sunnybrae-Canoe Point Rd outside this arbitrary radius should be given equal consideration to those within.

In closing, we do not support the Development Permit application No. 725-133 due to the potential inherent risk and negative impacts on public safety, on the community, and on the environment, and to maintain the sustainable development of our community as outlined in the OCP.

Sincerely,

A large black rectangular redaction box covering the signature and name of the sender.



## **2014 McIntyre Creek Debris Flow Emergency Response and Investigation Findings**

*Prepared for:*

**Columbia Shuswap Regional District**

781 Marine Park Drive NE  
Salmon Arm, BC V1E 4P1

and

**Emergency Management BC**

1255D Dalhousie Drive  
Kamloops, BC V2C 5Z5

*Prepared by:*

**Westrek Geotechnical Services Ltd.**

101 – 1285 Dalhousie Drive  
Kamloops, BC V2C 5Z5  
Phone: 778-471-7107  
[www.westrekgeotech.com](http://www.westrekgeotech.com)

January 2, 2015  
File No. 014-024

## Table of Contents

<b>1</b>	<b>Introduction, Scope and Limitations</b> .....	<b>1</b>
<b>2</b>	<b>Methods and Information Used</b> .....	<b>1</b>
<b>3</b>	<b>General Setting</b> .....	<b>3</b>
3.1	Geology.....	3
3.2	Development and Landslide History.....	4
<b>4</b>	<b>April 23 2014 Debris Flow</b> .....	<b>4</b>
4.1	Landslide Characterization.....	4
4.2	Detached Earth Mass.....	6
4.3	321 Road Condition .....	6
4.4	Weather Conditions.....	7
<b>5</b>	<b>Summary of Activities During the Emergency Evacuation</b> .....	<b>7</b>
5.1	Elimination of Cross-ditch 090 on the 321 Road.....	7
5.2	Detached Earth Mass.....	8
5.3	Adjustment of Evacuation Order Boundaries .....	8
5.4	320.080 Road .....	8
5.5	Temporary Works On the Fan .....	8
5.6	Debris Flow Hazard Bulletin.....	9
5.7	Further Investigation of Debris Flow Hazard.....	9
<b>6</b>	<b>Analysis and Assessment</b> .....	<b>10</b>
<b>7</b>	<b>Risk Mitigation Options</b> .....	<b>11</b>
7.1	Permanent Risk Mitigation Measures.....	11
7.2	Interim Risk Mitigation Measures.....	13
<b>8</b>	<b>Closure</b> .....	<b>13</b>

## 1 Introduction, Scope and Limitations

On April 23 2014, a debris flow event occurred in McIntyre Creek, which is situated about 12 km northwest of Sunnybrae, BC [see attached Figure 1]. The debris flow blocked the Sunnybrae - Canoe Point Road and affected several private lots. The Columbia Shuswap Regional District (CSRD) activated an Emergency Operations Centre (EOC) that worked with provincial government agencies at the scene under the support of Emergency Management BC (EMBC). After an initial review by provincial agencies, the CSRD issued an Evacuation Order to the affected private lots. Westrek Geotechnical Services (Westrek) was retained to provide geoscience and engineering services during the emergency response. This report provides a summary of Westrek's activities and input during that period. Several photographs of the landslide and adjacent area are attached to this report.

During emergency response, readily available information is gathered and analyzed to facilitate rapid decision-making, often with little opportunity available for data verification or the full consideration of all implications or stakeholders. This is the nature of emergency management. As such, it is expected that some information may have to be confirmed or in some cases discounted if the project advances into engineering design and works implementation; therefore, any users of the information in this report should take their own opportunity to verify its appropriateness for their own use and tasks.

The services provided by Westrek are subject to the terms and conditions set out the *Interpretation and Use of Study and Report and Limitations of Liability*, which is attached in Appendix A and incorporated herein by reference.

## 2 Methods and Information Used

The following was used for background information during this project:

- Air photographs:
  - 15BCC07010, #091-093 and 15BCC07016, #172-173 (digital thumbnail only, 2007);
  - 15BCC04022, #025-027 (2004);
  - 15BCC01024, #044-045 (2001);
  - 15BCB97025, #135 (1997);
  - 30BCC94042, #016-019 and 083-085 (1994);
  - 30BCC1047, #88-90 and 180-181 (1989);
  - 30BC84064, #077-079 (1984);
  - 30BC78061, #045-047 (1978);
  - BC5717, #237 (1976);
  - BC7647, #157-159 and BC7648, #082-083 (1974);
  - BC2615, #2-4 and BC2627, #19-21(1959); and
  - A368, #106-107 and A379, #26-27 (1928).
- Google Earth™ imagery (2004).
- Aerial imagery after the debris flow event provided to the CSRD by Terrasaurus (2014).
- Base Mapping: 1:20 000 Terrain Resource Information Management (TRIM), retrieved from the BC Web Mapping Service [<http://openmaps.gov.bc.ca/mapserver/base2>] on May 25, 2014.
- Geology: Thompson, R.I. (compiler). *Geology – Sorrento, British Columbia*. Geological Survey of Canada. Open File 4383. NTS map sheet 82L/14. Scale 1:50,000.

- Geology: Geology map on-line database, BC Ministry of Energy and Mines, [<http://webmap.em.gov.bc.ca/mapplace/minpot/bcgs.cfm>], retrieved May 23, 2014.
- Terrain stability mapping: *Terrain Stability Mapping for the Salmon Arm Forest District - Bastion & Mount Ida / Canoe*, by EBA Engineering Consultants Ltd. and JM Ryder and Associates Terrain Analysis Inc. March 1998. Scale 1:20,000.
- Weather data for Salmon Arm, Salmon Arm Fire Station, and Turtle Valley Fire Station, provided by Environment Canada on April 27 and July 30, 2014.
- Snow survey data, Anglemont Snow Survey (F102), retrieved from obtained from the BC Web Mapping Service [<http://openmaps.gov.bc.ca/mapserver/base2>] on April 25, 2014.
- Ground photos taken on April 23, 2014, supplied by Terry Harbicht PEng, Ministry of Transportation and Infrastructure (MoTI).

Westrek personnel undertook field visits on numerous occasions between April 24 and July 31, 2014. Site observations were referenced to waypoints (Wpt) using a handheld GPS receiver. The horizontal accuracy of waypoints is typically 5 to 10 m, but it depends on the GPS satellite constellation when readings were taken and it can be significantly less in steep terrain. Unless otherwise noted, elevations referenced in this report are based on TRIM information. Information on surficial materials, bedrock types and drainage was collected from visual observations at surface exposures. No topographic surveying or investigation of the subsurface conditions by mechanical methods has been undertaken to date, and no laboratory testing to establish strengths parameters for the surficial deposits and bedrock has been completed.

Westrek participated in several conference calls over the course of the evacuation and attended public meetings in Salmon Arm on May 20 and June 11, 2014. After local residents reported inconsistent flow in Hart Creek during the latter public meeting, Westrek participated in a helicopter flight over McIntyre, Robinson and Hart Creeks with Andy Oetter RFT of the Ministry of Forests, Lands and Natural Resource Operations (MoFLNRO), at the request of the CSRD.

Westrek submitted written correspondence to both the CSRD and EMBC over the course of the emergency response. These documents included:

- Technical Memorandum No. 1, *McIntyre Creek Debris Flow, Interim Report on Observations and Recommendations to May 1, 2014*, dated May 9, 2014.
- Technical Memorandum No. 2, *Proposed Work Plan and Budget Estimate, McIntyre Creek Assessment*, dated May 15, 2014.
- Technical Memorandum No. 3, *Rationale for Adjusting the Evacuation Order, Civic No. 6098 and Access Driveway for Civic No. 6046, McIntyre Creek*, dated June 10, 2014.
- Technical Memorandum No. 4, *McIntyre Creek Fan – Access Road Works*, dated June 18, 2014.

Westrek collaborated with Kerr Wood Leidal (KWL) to produce an information bulletin that summarized the general hazards associated with living on an alluvial fan. The bulletin was entitled *Columbia Shuswap Regional District – Shuswap Emergency Program, McIntyre Creek Debris Flow Hazard Information*, dated July 30, 2014, and was co-presented with KWL to the residents on the McIntyre Creek fan on July 31, 2014.

Additional field reconnaissance, monitoring and analysis have occurred subsequent to the issue of the Technical Memorandum No. 1, which contained some basic technical characterization of the debris flow. Where there is an inconsistency between that document and this report, the values in this report should be considered more accurate.

### 3 General Setting

McIntyre Creek drains a steep, narrow catchment on the north shore of the Salmon Arm of Shuswap Lake [see attached Figure 1]. The watershed has an area of about 2.2 km<sup>2</sup>. The upper part of the watershed is a moderately sloped, rolling plateau that extends to elevation ±1580 m and generally drains to the southeast. The edge of the plateau generally lies at elevation ±1200 m but is somewhat irregular, and is characterized both by an increasingly steep slope off the plateau to abrupt transitions defined by discontinuous near-vertical cliffs.

TRIM maps indicate that a number of streams drain the plateau, but most are minor and have poorly defined draws. They converge into two main streams that become deeply incised on the steep slopes immediately below the edge of the plateau. The streams are controlled by the bedrock structure, and waterfalls with vertical drops of 5 to 20 m and cascades that range up to 175 m in length are present. The two streams converge halfway down the steep slope at elevation ±775 m. The creek exits the watershed through a 15 m deep box canyon onto an alluvial fan at elevation 400 m. McIntyre Creek has an average channel gradient of 50% below the edge of the plateau.

The Sunnybrae - Canoe Point Road (a public road) crosses the fan just below its apex about 150 m upstream from the lake, and it forms the upper (north) boundary of the seven private properties. The fan gradient is steep, varying from 35% near the public road to about 25% at the lake, and it has several abandoned channels and what appear to be old levees from previous debris flow events [Figure 1]. These deposits have not yet been thoroughly investigated; however, one large cedar tree recently felled from the stream channel in the lower part of the fan was about 145-150 years old.

Two similar watersheds drain the plateau to west of McIntyre Creek. Robinson Creek lies immediately west and it is slightly smaller than McIntyre Creek. It has no defined crossing on the public road, reportedly because it was diverted on the slope above. Hart Creek lies west of Robinson Creek and it is slightly larger than McIntyre Creek. Both Robinson and Hart Creeks have much more prominent bedrock cliffs along the plateau edge.

#### 3.1 Geology

Thompson (2004) indicates there are two bedrock formations in the area. Bedrock on the plateau is mapped as the Sicamous Formation, which is generally grey re-crystallized limestone with black argillaceous partings. The steep slopes below the plateau are mapped as biotite-muscovite-garnet schist, carbonaceous schist, micaceous quartzite, quartzite and minor marble of the Silver Creek Formation. The contact between the two formations lies along the edge of the plateau. The provincial mapping indicates that the two formations are separated near the plateau edge by mudstone, siltstone, shale and fine-clastic sedimentary rocks of the Mount Ida Assemblage.

Available terrain mapping indicates that the two creek draws of the steep slope are rated as “unstable”. The draws are mapped primarily as bedrock with minor colluvium<sup>1</sup> and thin till<sup>1</sup>, which are a potential source material for debris flows. The steep areas adjacent to the creek draw are rated either as “potentially unstable” or as having a “moderate likelihood of landslide initiation following forestry development”. The mapping indicates these slopes are moderately steep bedrock, thin colluvium or variable till. Although these ratings are specifically defined for forestry operations, they provide an indication of the potential natural landslide hazard in the area.

---

<sup>1</sup> Colluvium is a surficial deposit emplaced primarily by gravity (erosion) processes, such as slope wash, creep, landslides, or rockfall. Till is a non-stratified deposit emplaced by glacial activity.

## 3.2 Development and Landslide History

The McIntyre Creek alluvial fan has been occupied for almost a century. The 1928 image resolution is poor, but it appears that a dock was present at that time. The public road was in place by 1959, along with a building and a dock along the lakeshore. Three buildings and associated docks are present on the 1970 photos. Building progressed through to the mid 1990s when the remainder of the fan was developed.

Forestry development in the area is absent on the 1928 air photos but an extensive road and trail network was built prior to 1959 to facilitate selective logging on the slopes to the east of McIntyre Creek. The first phase of modern forestry operations occurred between 1980 and 1984 when three blocks were clear-cut logged in the upper part of the plateau. These blocks were accessed via the Blackwood FSR, which is part of the Bastion road system to the north. Three other blocks were logged on the plateau between 2000 and 2004, as summarized below:

- Openings 80 and 81 were logged on the plateau and in 2000 and 2001. The 320-080 Road, which accesses Opening 81 along the edge of the plateau, was probably built at that time.
- Opening 86, which straddles the eastern watershed boundary about halfway up the steep slope, was logged between 2002 and 2004. It was accessed via old roads built prior to 1959, and by constructing the 321 Road and a short spur. The western switchback of 321 Road and the western tip of the Opening 86 Spur lie within the McIntyre Creek watershed. These roads were seasonally deactivated, probably shortly after the logging program.

No landslides were noted in McIntyre Creek on the historical air photos. One small landslide, too small to be visible on air photos, was observed during fieldwork on May 28, 2014, along the east side of the main creek draw just below the edge of the plateau (Figure 1). A significant debris flow is visible on the 1928 air photo in Hart Creek. It initiated within a tributary channel in the upper watershed, near elevation 1100 m, and travelled about 2 km down the gully into Shuswap Lake [Figure 1]. A second debris flow occurred in the same gully sometime between 1987 and 1994. The track of the second event was readily evident during the helicopter flight on June 11, 2014.

The only other significant landslide near the site occurred below the junction of the 321 Road and the 86 Spur, about 800 m east of McIntyre Creek (Figure 1). According to the Ministry of Forests, Lands and Natural Resource Operations, this landslide occurred about a week before the debris flow in McIntyre Creek. Westrek is not aware of any report on that landslide.

## 4 April 23 2014 Debris Flow

### 4.1 Landslide Characterization

The debris flow in McIntyre Creek occurred between 10:00 and 11:00 PDT on April 23, 2014. It was triggered by a debris slide at elevation  $\pm 740$  m, near the eastern boundary of the watershed (Figure 1). The debris slide initiated on a 65-70% slope about 25 m downhill from a 2.5 m high bedrock outcrop, likely associated with the Silver Creek Formation. The initiation zone was about 9 m wide and 12 m long. The scarp exposed a loose colluvium layer that varied from silty sand with some angular fragments to small-sized angular fragments with a silt and sand matrix. This layer varied from 0.4 to 1.1 m in thickness. The initiation volume was estimated at  $100 \pm 25$  m<sup>3</sup>. The colluvium was underlain by a dense till comprised of silty sand with abundant mixed fragments (sub-angular to sub-rounded). Shallow subsurface runoff eroded rivulets into the exposed till subsequent to the landslide event. Several photos of the initiation zone and the debris flow are attached.

The debris slide became confined in a broad, 1.5 to 2 m deep draw below the initiation zone, where it transformed into a debris flow. It then entrained additional material from the sidewalls and channel of the draw. At about 350 m from the initiation point (elevation  $\pm 620$  m), the debris flow entered a larger, but broader, draw that drains the area below the 321 Road switchback [Figure 1]. This draw contained a small stream. There was less debris entrainment below this point as the channel bottom was mostly bedrock. At about 650 m from the initiation point (elevation 470 m), the debris flow spilled over a 20 m high cliff into the McIntyre Creek canyon. It then travelled 200 m along the creek channel, where it entrained additional sediment and several large trees. The profile of the landslide track is shown on Figure 2.

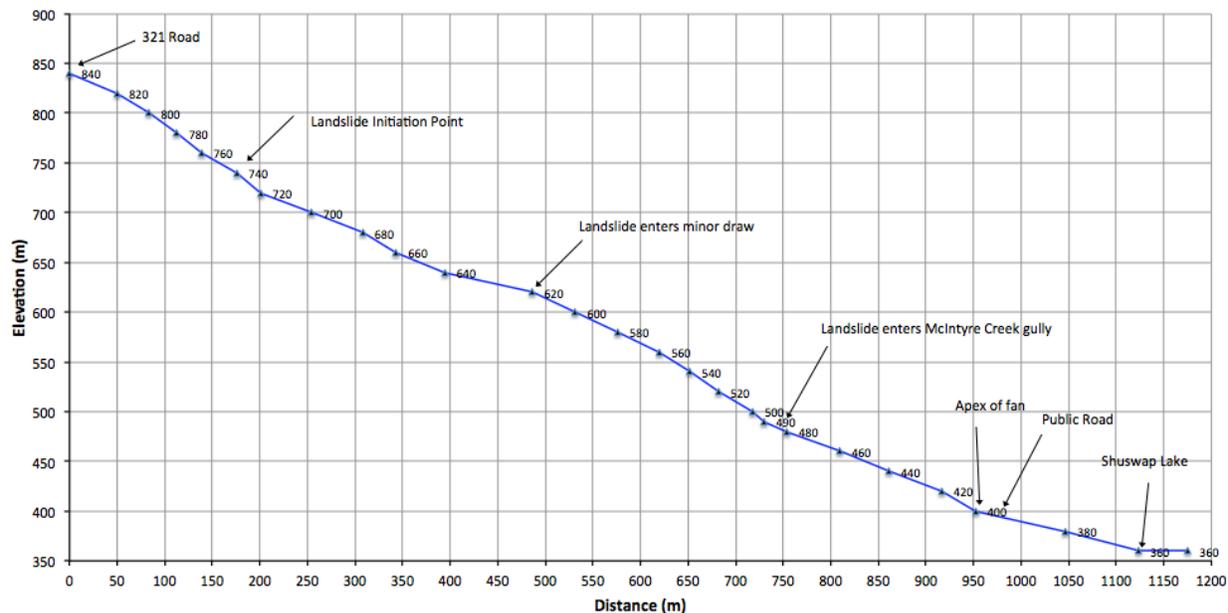


Figure 2 – Profile of McIntyre Creek debris flow path, based on TRIM map contours.

The debris flow immediately began deposition when it exited the box canyon at the apex of the alluvial fan. A large fraction of the debris arrested on the public road, where it accumulated to a maximum thickness of about 2 m and plugged a small stream culvert in the crossing. Most of the entrained logs were deposited at this point. The remainder of the debris was relatively muddy, and it travelled down the existing creek channel within the alluvial fan. Some deposition occurred in narrow levees along the draw, but the majority deposited in the lower section of the fan where two driveways obstructed the draw. The culverts in these driveways plugged and most of the remaining debris was deflected into a multi-fingered plume, including one that caused some damage to the residence at Civic 6084 [Figure 1]. A small amount of material continued down the main channel below the driveways and entered Shuswap Lake. Photographs are attached.

MoTI staff estimated about 650 to 950 m<sup>3</sup> of debris arrested on the public road, of which 400 to 600 m<sup>3</sup> was hauled away<sup>2</sup>. About 250 m<sup>3</sup> was placed in a clearing on the west side of the fan apex and sloped to a stable angle, and some was left in place within the channel. An additional 700 to 900 m<sup>3</sup> of debris was deposited on the fan below the public road. In total, an estimated 2000 +/- 400 m<sup>3</sup> of debris was deposited during the event.

<sup>2</sup> Electronic mail message from Peter Gooch (MoTI) to Kevin Turner, September 15, 2014.

## 4.2 Detached Earth Mass

Concurrent with the landslide on April 23, 2014, a 20 to 30 m long tension crack developed about 20 m uphill and slightly to the east of the initiation point. The crack lies within a thicker and rockier layer of colluvium present near the base of the bedrock cliff [Figure 1]. The slope at the tension crack is 70 to 75%. Tree cover is noticeably less dense in this area, with more broad leaf trees present. The earth mass displaced about 20 cm at its crown. Its total volume was initially estimated to be as high as 300 to 400 m<sup>3</sup>, but more detailed follow-up measurements suggest that the detached volume is probably about 100 m<sup>3</sup>. When initially investigated by provincial government agencies, there was substantial concern that the detached earth mass would release and cause another debris flow. To better assess the hazard, Westrek recommended that a monitoring system be established on the soil mass (Technical Memorandum 2) and this was authorized by the CSRD on May 15, 2014. The monitoring system was established on May 16, 2014, and the results are discussed in Section 5.2.

## 4.3 321 Road Condition

The debris flow initiated about 220 m down the slope from the 321 Road, which is under road permit to Canoe Forest Products (Canoe). The 321 Road crosses the slope above the landslide at elevation 850 m. Photos of the road and area are attached. The average slope between the road and the landslide initiation point is 60%. The terrain in this zone is largely bedrock controlled with thin surficial deposits present. The foliation of exposed bedrock dips steeply into the steep slope.

The landslide initiated directly below a cross-ditch<sup>3</sup> in the 321 Road, located at Wpt 090 [Figure 1]. This feature was likely constructed when the road was seasonally deactivated. The cross-ditch is located about 40 m down the grade from a switchback, and just inside the eastern edge of the McIntyre Creek drainage<sup>4</sup>. Photos of the road drainage configuration are attached.

Provincial government personnel observed that runoff was flowing down the wheel paths in the 321 Road on the day of the landslide (April 23). A small cut slope failure just above the switchback had blocked the ditch and this diverted some runoff onto the 321 Road surface<sup>5</sup>, which subsequently flowed down to a cross-ditch in the road at Wpt 090. Westrek determined that about 65 m of road and ditch was contributing runoff to this cross-ditch.

On April 26, 2014, Westrek estimated the discharge from the cross-ditch to be approximately 35-40 L/min ( $\pm 8$  Igpm). Westrek also observed that the discharge infiltrated into the ground 10 to 15 m below the 321 Road, and there is no direct surface flow path to the landslide initiation point. In comparison to photos by provincial government personnel on April 23, the discharge observed by Westrek on April 26 had abated noticeably. Provincial government personnel noted that the runoff tended to alternatively infiltrate and re-emerge farther down the slope than was observed by Westrek. The discharge from the cross-ditch was noticeably lower three days after the event, but neither provincial government personnel nor Westrek observed evidence of direct surface flow from the cross-ditch to the landslide initiation point at any time.

---

<sup>3</sup> A cross-ditch is a drainage structure excavated through a road to convey ditch water across. It is usually installed as a measure to reduce the likelihood of drainage diversion when the use of a road is suspended, as it is considered less prone to malfunction than a culvert.

<sup>4</sup> The BC government's on-line data shows the switchback outside the eastern border of the McIntyre Creek drainage; however, this boundary is based on TRIM contours, which are relatively unreliable. The watershed boundary shown on the attached Figure 1 has been adjusted to include the area around the April 23, 2014 debris flow event.

<sup>5</sup> The greater portion of the flow from the ditch was flowing off the switchback.

## 4.4 Weather Conditions

Landslides usually have an associated hydrological factor that affects antecedent soil moisture conditions. Reconnaissance immediately following the debris flow indicated that the snowpack had recently melted from the surrounding area, as patchy snow remained in shadowed areas. Snow and weather data were gathered and analyzed to determine the significance of the weather.

Snow pack data was obtained from the nearest snow survey station at Anglemont, which is located about 17 km to the north and lies at elevation 1190 m). This site has been monitored almost continuously since 1956. The data are included in Appendix B. The data indicate that the snow pack was consistently above normal in 2014, but it was not extreme, e.g. the snow pack regularly varies from 85 to 125% of normal. On April 1, the snow pack was 126% of normal<sup>6</sup>, or 117% of average. Technical issues prevented the snow pack from being measured on May 1, but by May 16 it had reduced to 114% of normal or 79% of average<sup>7</sup>. Although not conclusive, snow pack depletion appeared to accelerate between April and mid-May, which would likely have resulted in elevated antecedent soil moisture levels, general surface runoff and/or stream flow at that time.

Weather data were obtained from three stations in the area: Environment Canada's *Salmon Arm CS* (elevation 351 m); *Salmon Arm Forestry Station* (elevation 527 m); and *Turtle Valley Forestry Station* (elevation 640 m). Climate normal data is not available at these stations, so normal data was obtained from Environment Canada's *Salmon Arm A* station. The data set is included in Appendix B.

The data indicates that the monthly precipitation (snow and rain) received at the *Salmon Arm CS* station was below the *Salmon A* normal for the 7 months preceding the debris flow, with the exception of March 2014 when it was slightly above normal. Unsettled weather during the week preceding the debris flow brought intermittent moderate-intensity rainfall to the area [Appendix B]. Five to six days before the debris flow, 16.6 to 17.8 mm of rain was recorded in the stations during a period with rising average temperatures. Recorded rainfall intensities were 1.4 to 4.3 mm/hr. Between 8.4 to 15.3 mm of rain with highly variable intensities (0.6 to 4.0 mm/hr) was recorded on the day prior to the event, and average temperatures had declined somewhat. Only about 1.3 to 2.4 mm of rainfall was recorded at the three stations on the day of the debris flow. This suggests that a specific rain event was likely not the cause of the debris flow, but the rapid snow pack ablation that was influenced by the preceding moderately heavy rainfall was likely a factor.

## 5 Summary of Activities During the Emergency Evacuation

### 5.1 Elimination of Cross-ditch 090 on the 321 Road

On April 26, 2014, Westrek recommended elimination of the cross-ditch (Wpt 090) above the landslide site and the restoration of the drainage at the 321 Road switchback as a precaution to reduce the volume of water that was being concentrated on the slope above the landslide. The forest licensee (Canoe) completed this work on April 29, 2014, which was reviewed by Westrek. As we understand it, Canoe evaluated the drainage conditions along the remainder of the 321 Road at that time but Westrek has not received any report on this work.

---

<sup>6</sup> The "normal" value is the average value of a parameter over a fixed, usually 30-year, period. At present the normal period is 1981-2010. Average is the mean value over the entire record.

<sup>7</sup> The large variation between the "normal" and the "average" is related to the limited number of May 15 readings. Readings that are missing do not mean the snow pack was depleted, and this affects the average value calculation.

## 5.2 Detached Earth Mass

Westrek established a monitoring program on the detached earth mass immediately uphill from the landslide scarp on May 16, 2014. The system consisted of fourteen monitoring points as illustrated on the attached Figure 1 [Inset 2] and as summarized below (see attached photographs):

- **Eight reference points** were established on or adjacent to the detached earth mass: four on the detached mass below the tension crack; one below the projected tension crack extension on the east side; and three were positioned along the projected extension of the tension crack on the west side. The reference points consisted of 0.6-0.9 m long steel bars driven into the colluvial deposits and reinforced at the surface with rocks. All points were flagged and labelled.
- **Six target points** were established immediately above the detached mass for monitoring. Five target points were painted on the near-vertical bedrock outcrop(s) directly uphill, and the easternmost point was painted on the lower part of the trunk of a large Douglas fir tree.

The distance from the reference points to the target points was measured using a Leica laser rangefinder. Based on the manufacturer's specifications the measurement accuracy is typically  $\pm 1.5$  mm, which Westrek considered adequate for the intended purpose. The points were surveyed on five occasions after initial establishment; three times on a five-day interval as initially planned; once in early June after workers on the alluvial fan noticed an increase in stream turbidity; and once in late autumn to determine if movement occurred after a major storm event on July 23, 2014. The data are summarized in Appendix C.

The results indicated that the detached mass did not experience any significant movement during the monitoring period. A follow-up monitoring trip is planned for the spring of 2015.

## 5.3 Adjustment of Evacuation Order Boundaries

The Evacuation Order boundaries were adjusted on two occasions to allow driveway access to properties on the periphery of the alluvial fan. Westrek provided advice to the CSRD on these occasions, as summarized in Technical Memorandum 3 in Appendix D.

## 5.4 320.080 Road

The 320.080 Road leads to Opening 81 and crosses McIntyre Creek main and tributary channels at elevation 1230 m. Both channels are crossed via an armoured cross-ditch. The tributary creek is comparatively minor. Canoe's staff reviewed the condition of the crossings on May 22, 2014 and no issues or concerns were reported. Photographs provided by Canoe staff are included in Appendix E.

## 5.5 Temporary Works On the Fan

The CSRD retained Kerr Wood Leidal (KWL) to manage the construction of temporary works on the fan. The works were intended to provide a degree of temporary protection to the properties should another debris flow initiate as a result of a sudden release of the detached earth mass. Westrek assisted KWL during this task. The temporary works consisted of the following:

- Low berms were built across the upper part of two draws that were felt to be vulnerable to debris flows on the middle area of the fan, below the public road.
- The creek draw was deepened through the two driveways that previously provided access to Civic 6088 and the other properties to the west (Civic 6060 to 6084).

The temporary works were completed on June 10, 2014. A construction summary report was also prepared by KWL, dated June 2014 (Appendix F). This report includes Westrek's input.

## 5.6 Debris Flow Hazard Bulletin

The temporary works along the creek, along with the detached earth monitoring and weather forecast monitoring, were part of a risk reduction strategy to allow the property owners to return to their homes. Upon completion of the temporary works the CSRD rescinded the Evacuation Order and expired the State of Local Emergency on the Public Information Meeting on June 11, 2014. To assist the community with managing the on-going landslide risk, the CSRD and EMBC asked KWL and Westrek to develop an information bulletin to describe the general nature of debris flows and the potential triggering factors, and to outline steps that the residents could consider to manage their landslide risk individually. The information bulletin is attached in Appendix G.

Westrek and KWL met with available property owners in the community on July 31, 2014 to present the bulletin, answer questions, and provide clarifications. Westrek was advised that those residents and owners not present on July 31 had the information bulletin sent to them by registered mail.

## 5.7 Further Investigation of Debris Flow Hazard

Tasks 3 and 4 in the Technical Memorandum #2 work plan included initial investigative work within the watershed to characterize the volume of debris available within the channel that could potentially be mobilized during a future debris flow. The objective of this work was to help develop concepts for permanent protective measures for the properties on the fan.

Fieldwork to determine the potential yield rates within McIntyre Creek was initiated in late May. The two channels of McIntyre Creek are contained in deep draws on the steep slopes below the plateau. Some till and colluvium is typically present in the sidewalls in the upper reaches, and rocky colluvium is present in the channel in the lower reaches. Yield rates were estimated to be as high as 2.5 to 4 m<sup>3</sup>/m in the upper reaches of the main channel, but were 1.5 to 2.5 m<sup>3</sup>/m farther downstream. A short section below the confluence of the two streams had yield rates of 1.8 to 3.3 m<sup>3</sup>/m. Yield rates in the west tributary were generally lower, and estimated to be 0.5 to 1 m<sup>3</sup>/m.

The initial work suggests that the main channel and west tributary have a potential yields of 3000 m<sup>3</sup> and 1000 m<sup>3</sup>, respectively, for a total yield of 4000 m<sup>3</sup>. This is about twice as large as the 2014 debris flow. It does not include bulking by entrained logs and organic material, nor adjustments for material if a debris flow initiated on a slope and entered the channel, as occurred during the 2014 debris flow.

During the Public Information Meeting on June 11, 2014, the CSRD advised the owners present that, if the full costs of permanent protective measures were to be borne by the CSRD, the process to fund the works would be through the establishment of a Service Area Bylaw, which would be subject to additional taxation. The Service Area would only encompass the affected properties and would be established via a referendum<sup>8</sup>. The owners present at the meeting decided to consider their options after the preliminary work (i.e. Tasks 1 to 4 of the work plan) was completed, and then determine whether or not to proceed with the additional investigation on the alluvial fan and the development of conceptual risk mitigation measures (Tasks 5 and 6 of the work plan). If the community was to proceed with the development of a conceptual risk protection system, then the additional investigation work on the alluvial fan will have to be done at that time.

---

<sup>8</sup> This is only a general summary of the process. Interested readers should refer to the statutes and regulations to obtain a more exact and comprehensive understanding of the legislation and its requirements.

## 6 Analysis and Assessment

The 2014 debris flow initiated as a small landslide in shallow deposits during a period of wet weather that coincided with snow pack ablation, which likely elevated antecedent soil moisture and created sensitive conditions. Other site factors include the very steep slopes; the presence of thin colluvial deposits overlying dense till or bedrock; and the characteristics of the upper fractured zone of the bedrock. The influence of the cross-ditch directly above the initiation zone was outside the scope of our services and has not been fully investigated by Westrek. This would require a great deal of work due to the complex terrain and the distance between the cross-ditch and the initiation zone.

The watershed has a ruggedness index of about 0.8, indicating it is susceptible to debris flows (Wilford *et al.*, 2004)<sup>9</sup>, and previous mapping indicates that the steep slopes are prone to landslides. Given its similarity to Hart Creek watershed, where at least two debris flows occurred in the past century, and the deposits on the alluvial fan that are likely from past debris flow(s)<sup>10</sup>, it is prudent to assume that the lots on the fan are potentially at risk from debris flows.

Based on the age of the trees along the channel, a debris flow as large or larger than the 2014 debris flow has probably not reached the lower part of the alluvial fan for at least 150 years. The 2014 event only affected the lower 200 m of the channel, which implies that a significant amount of material remains stored in the watershed that could be mobilized as an in-channel debris flow or, more likely, if a landslide from the adjacent slopes entered the channel as occurred in April 2014. Therefore, the debris flow hazard and the risk to the community remains the same as it was prior to 2014, i.e. the April 23 2014 event has not diminished the risk to the community. Future debris flows could have similar or even more severe results, i.e. the public road could be blocked, and one or more properties on the fan could be impacted. Figure 1 [Inset 1] shows that several of the houses or ancillary structures are within old channels, and these areas would be at the highest risk.

There does not appear to be a regulation or provincial policy to explicitly guide local governments when private property has been evacuated and it has subsequently been determined that a unacceptable landslide risk may exist. The only related guidance for landslide risk management is MoTI's criteria for land subdivision purposes, which is more of a planning tool. Their guidance states that the landslide risk must be mitigated if an area is not considered "safe for the use intended", which they indicate is the probability of a "damaging" event that exceeds "10% in 50 years" (or a return period of 1 in 475 years). Based on the work completed to date, the hazard level on the alluvial fan probably exceeds this criterion.

The MoTI guidance also implies that the risk of death to an individual is not to exceed 1:10,000, which is consistent with some international standards<sup>11</sup>. The risk to the people in the community has not yet been estimated but it likely approaches this value; therefore continued occupation of the alluvial fan should be carefully considered and managed until the risk is better understood and, if necessary, the residences with an unacceptable risk are adequately protected. The determination of the landslide hazard and risk on the alluvial fan requires a considerable level of investigation and engineering. The intent of Task 5 and 6 of the work plan is to better understand the hazard level and develop concepts for the necessary risk control measures.

---

<sup>9</sup> Wilford, D.J., M.E. Sakals, J.L. Innes, R.C. Sidle and W.A. Bergerud. 2004. *Recognition of debris flow, debris flood and flood hazard through watershed morphometrics*. Landslides. V1: pp. 61-66.

<sup>10</sup> Confirmation that these deposits are actually debris flow deposits has not yet been done.

<sup>11</sup> The risk of multiple deaths would have to be taken into account, and this may require even lower tolerances.

## 7 Risk Mitigation Options

If it is determined that an unacceptable landslide risk to the community exists and a decision is made to mitigate the risk to a level that is acceptable to government authorities, the community, and any other stakeholders (i.e. MoTI), several steps would be required:

- complete studies and surveys necessary to establish the desired level of safety, develop the risk mitigation strategy and prepare conceptual drawings and preliminary cost estimates;
- complete the detailed engineering of measures to achieve an adequate level of safety;
- establish ownership and responsibilities for the risk mitigation measures;
- acquire or secure any necessary land;
- carry out construction of the works; and
- commit to a maintenance program that includes basin cleaning or component replacement.

Outlined below is a conceptual risk management strategy for the community. Some of the risk mitigation measures will require works on private land, so portions of some lots may have to be transferred into common property or easements. An important consideration will be the appointment of an organization to assume responsibility for the operation and maintenance of the protection measures. Given all the complexities associated with this site, the planning, engineering and construction process is likely to require a few years. In the meantime, an interim risk management strategy should be implemented to protect the community.

### 7.1 Permanent Risk Mitigation Measures

Based on the limited investigation undertaken to date, options for risk mitigation could include one or more of the following measures.

#### Debris Flow Arresting Barrier

The shape and size of the bedrock canyon immediately above the apex of the fan and its proximity to the public road make this site very favourable for a flexible debris flow barrier. These barriers consist of high-tensile steel ring nets that are cable-stayed and anchored into the adjacent bedrock. They are fairly common in Europe and Japan, and are beginning to be adopted in Canada<sup>12</sup>. Their advantage is the minimal footprint they occupy, their efficiency in arresting debris flows, and the fact that they can be replaced if loaded. The design of this type of structure is relatively complex.

The canyon outlet is limited in size so a large enough barrier system to completely arrest a debris flow similar to the 2014 event is not likely feasible. Preliminary estimates indicate that a debris flow barrier (or two) could retain about 400 m<sup>3</sup> of debris at the outlet of the box canyon, i.e. a little less than the amount that arrested on the public road during the 2014 debris flow. There is a considerable amount of analysis required to model the debris flow loading and design the netting and restraining anchors. However, the barrier would reduce the energy of the remaining debris and this would allow less robust or smaller control structures to be built on the alluvial fan farther downstream.

---

<sup>12</sup> Examples of debris flow nets built for protecting residential areas include Mosquito Creek in the District of North Vancouver [<http://www.dnv.org/article.asp?c=1031>]; and Cougar Creek near Canmore, AB [<http://www.canmore.ca/Canmore-Flood-Information/Frequently-Asked-Questions-about-Cougar-Creek/>]. Others have been built to protect highways (i.e. Gladwin Creek near Lytton) or along other linear infrastructure.

Debris Catchment Basin Above the Public Road

A significant amount of the April 23, 2014 debris flow arrested on the public road, which reduced the amount of debris that reached the distal edge of the fan. In the meeting on July 31, 2014, some residents stated that, prior to the debris flow, a small basin was present above the road and in their opinion the debris was never fully removed following the event. A small debris catchment basin could be constructed above the public road to further arrest material that gets past the debris flow barrier described above. Preliminary estimates indicate that a small basin could probably contain an additional 100 m<sup>3</sup> of material and this would assist in removing some additional energy from the debris flow. There are many constraints or issues associated with a structure in this location, so consultation and co-operation with MoTI as well as operational / maintenance agreements for this option. This will require some additional surveying and design to plan the works.

Works on the fan (below the public road)

Tertiary control of any remaining debris that advances below the public road would require the installation of permanent deflection / training berms along the McIntyre Creek draw. These structures could be built from a variety of materials but may require land purchase or easements and maintenance agreements to be established. This will be an onerous process as it will involve multiple landowners and possibly a subdivision process.

New or alternative driveway configurations and creek crossings to access Civic 6060, 6072, 6076, 6084 and 6088 may also have to be considered, but options are likely limited due to the constrained space and steep grades that are present in that area. Re-configuration of the driveway access on the east side of the creek may also have to be considered, so that debris that carries past the capacity of the structure(s) above the public road is unable to travel a significant distance down the driveways.

Preliminary Cost Estimate

The greatest level of protection will be obtained if each of the elements is incorporated as a system. Based on the information currently available, which is limited, the following costs have been estimated for the three components described above. The cost of the system would be dependent on the degree of landslide safety that is desired, which has not yet been determined. At this time, the costs are difficult to estimate because of the limited amount of information collected to date and the site complexities, i.e. the steep slopes and driveways, and complex lot boundaries. Users of this information should therefore be extremely cautious.

Item	Component	Costs	Engineering	Contingency	Sub-total
1	Flexible debris flow barrier	\$140,000	\$30,000	\$30,000	\$200,000
2	Catchment basin above public road	\$40,000	\$7,500	\$7,500	\$55,000
3	Protective works on the fan	\$75,000	\$15,000	\$15,000	\$105,000
<b>Total (taxes excluded)</b>					<b>\$360,000</b>

A considerable amount of investigation and analysis is still needed to more clearly understand the debris flow hazard and risks to the community. No allowance has been made for legal surveying, legal representation or the complex issue of subdivision or easement establishment that will likely be needed to fully protect the community on the alluvial fan. This project will require significant and, as yet, undetermined contingencies for these issues. Projects with many complexities like this are best done in a staged approach.

## 7.2 Interim Risk Mitigation Measures

Until a decision is made regarding protection of the community, Westrek recommends consideration of the following strategies:

- Carry out a re-survey of the detached earth mass in the spring of 2015 to determine if the detached earth mass appears to have moved following freshet. A re-evaluation can be undertaken at that time after examination of the results.
- Remind the residents to remain vigilant of the debris flow hazard on the McIntyre Creek fan, as outlined in the information bulletin dated July 30, 2014. The community should continue to monitor the weather forecast, taking into account the time of year. Special emphasis and attention should be paid to the period when the snow pack is ablating from the steep slopes.
- Over the next few years, until the debris flow track re-vegetates, sediment will erode during freshet and storms that will be transported down McIntyre Creek. Although a new culvert and shaped channel was built in the public road crossing following the debris flow, residents indicate that the basin above the road is smaller than it was before the event. A larger basin would be beneficial in this location: it would arrest some future sediment and it may even arrest or diminish the impacts of another small debris flow if one were to occur. The feasibility of constructing a larger basin should be checked with MoTI.
- The CSRD should consider any available development control processes to restrict or manage future development on the fan until the debris flow hazard and landslide risks are more clearly understood.

## 8 Closure

Please contact the undersigned if there are any questions concerning this report.

***Westrek Geotechnical Services Ltd.***

Per:   
Kevin Turner PEng  
Senior Geotechnical Engineer



Reviewed:  
Peter Weisinger PGeo  
Geoscientist

Attached: Figure 1 (Site Map)  
Photographs  
Appendix A – Interpretation and Use of Study and Report and Limitations of Liability  
Appendix B – Snow and Weather Data (April 2014)  
Appendix C – Detached Earth Mass Monitoring Data  
Appendix D – Photos of the Upper McIntyre Creek crossing (Canoe Forest Products)  
Appendix E – Technical Memorandum 3 (alteration of SOLE boundaries)  
Appendix F – Technical Memorandum 4 and KWL report on Temporary Works  
Appendix G – Information Bulletin to McIntyre Creek community



# **CONCEPT PLAN: SHUSWAP PARK & BOAT LAUNCH**

**July 9, 2015**

**Prepared by:  
Rachel Sudbury, MSc, RPBio  
Ian Sudbury, MD  
[rdsfield@gmail.com](mailto:rdsfield@gmail.com)**

**Prepared for:  
Columbia-Shuswap Regional District**

## OVERVIEW

We propose the CSRD purchase the parcel associated with the former Herald Bay log sorting area and create a new waterfront/semi-waterfront park on the Salmon Arm of Shuswap Lake, BC. The overarching goals underlying the creation of this park are to:

- restore, protect, connect, and enhance the natural areas and water quality for the health and enjoyment of wildlife, ecosystems, and the public;
- increase the extent of protected natural lake shoreline in BC;
- minimize the potential adverse impacts of residential and recreational activities on the community and environment; and
- prevent additional high-density development on Shuswap Lake.

The proposed park area is located on a **19.5 ac** parcel located on the Salmon Arm of Shuswap Lake just east of **Herald Provincial Park**. The parcel is currently owned by [Federated Co-operatives Ltd.](#)<sup>1</sup> (FCL), and has been used for light industrial forestry activities for several decades. It can be divided into two key areas: a waterfront portion (where the light industrial activity took place) with ~**1,500 ft** of shoreline, and a semi-waterfront portion (natural forest). Currently, there is also a former log boom area associated with the parcel, maintained within a foreshore lease area of approximately **62.6 ac**. The parcel has been listed for sale at **\$2,995,000**. However, ***FCL has expressed interest in selling the parcel to the CSRD for a substantially reduced price, provided it is re-designated as a park.***

The proposed park area currently serves as a highly-trafficked wildlife corridor between upland areas and the lake, as an aquatic refugia for small mammals, birds, and fish, and one of the most coveted fishing areas on Shuswap Lake.

The creation of the park will require the purchase of the parcel, acquiring of existing environmental assessment reports, and potentially environmental remediation prior to land use re-designation, as well as park establishment and ongoing management efforts.

We are writing to request that the CSRD purchase and re-designate this parcel as a conservation park.

---

<sup>1</sup> <https://www.coopconnection.ca/wps/portal/fclretail/FCLInternet/AboutUs/FCL/>

## Table of Contents

<b>OVERVIEW .....</b>	<b>2</b>
<b>PURPOSE OF THE CONCEPT PLAN .....</b>	<b>4</b>
Concept Plan Area .....	4
<b>EXISTING SITUATION .....</b>	<b>7</b>
Regional Context .....	7
Threats to Health and Safety.....	8
Reclamation .....	8
<b>PARK ESTABLISHMENT .....</b>	<b>9</b>
<b>ENVIRONMENTAL CONSIDERATIONS.....</b>	<b>10</b>
Aquatic Habitat.....	10
Riparian (waterfront) Habitat.....	12
Upland (semi-lakefront) Habitat .....	12

## PURPOSE OF THE CONCEPT PLAN

This concept plan has been prepared to provide a high-level overview of the proposed acquisition and land use re-designation of the parcel located at 4990 Sunnybrae Canoe Point Road, Tappen, BC (referred to as “the parcel” herein). It is proposed that the parcel be re-designated as a **park** area.

The overarching goals of this plan are to:

- (1) protect the natural environment, water quality, ecological integrity and connectivity of the upland, riparian, shoreline, and adjacent aquatic area, and maintain and enhance existing natural areas (e.g., Herald Provincial Park) within and adjacent to the parcel for the health and enjoyment of wildlife and the public;
- (2) increase the protected extent of increasingly rare natural freshwater shoreline habitat on Shuswap Lake;
- (3) minimize potential adverse residential and recreational disruptions to the safety, peace, tranquility, and visual appeal of Shuswap Lake; and
- (4) prevent re-designation of the parcel to high-density residential land use.

This plan conforms to the local planning policies outlined in the Columbia Shuswap Regional District (CSR D) Electoral Area C Official Community Plan ([OCP<sup>2</sup>](#)) Bylaw No. 725. The OCP outlines objectives around maintenance of Shuswap Lake and watershed water quality, protection of people from contaminated water, maintenance and protection of shoreline habitats, directing development in existing settled areas and discouraging development outside these areas, discouraging residential development (unless co-located with an agricultural use) outside Village Centre and Secondary Settlement Areas, maintain nearshore areas of Shuswap Lake by focusing development away from the shoreline.

### Concept Plan Area

The parcel is located in CSR D Electoral Area C outside Village Centre and Secondary Settlement Areas. The parcel is currently designated as ‘Industrial’ (ID), with general land use identified as ‘Rural Resource’ (RSC). Under the OCP, “forestry, mineral and aggregate extraction, agriculture, and outdoor recreational uses are appropriate in the area designated Rural and Resource... [and] lands designated as Rural and Resource

---

<sup>2</sup> <http://www.csr d.bc.ca/node/1272>

should be maintained as large land parcels, with minimum parcel sizes of 60 hectares (148 acres) for subdivision (s. 3.11.1)". The parcel has no associated land zoning at present.

The parcel is 19.5 ac (7.89 ha) in total and can be conceptually divided into two sections:

- (1) **waterfront** (approx. 6.0 ac to the South of Sunnybrae Canoe Pt. Rd.) with ~1,500 ft of shoreline; and
- (2) **semi-waterfront** (approx. 13.5 ac to the North).

There is a foreshore lease (issued and managed by Ministry of Forests, Lands and Natural Resource Operations [FLNRO]) associated with the parcel (see Table 1 for details).

Additional property details (including legal description) are outlined in **Table 1** and **Map 1**.

**Table 1. Property details and legal description of the parcel.**

<b>Item</b>	<b>Description</b>
Address	4990 Sunnybrae Canoe Pt. Rd.
PID	013-671-502
Roll	78903868000
Electoral Area	Electoral Area C
Local Area	Canoe Point
Ownership	Private (Federated Co-operatives Ltd.)
Land Use	RSC – Rural Resource
Lakes Zoning	FG1 – Foreshore General 1
Zoning	N/A – No Zoning
OCP	ID - Industrial
CSRD Bylaw	725
GIS Lot Size	7.89 ha
Taxable Value	\$2,863,000
Percent in ALR	0
Legal Plan	B6878
Section	21
Township	21
Range	9
Meridian	6
Land District	Kamloops Division Yale District
Freeform	Parcel A, Part SE ¼, Meridian W6, (DD148402F)
Foreshore Lease (FL) Area	25.33 ha
FL Pricing	8% of taxable value
FL File #	0199698
FL Lessee	Federated Co-operatives Ltd.
FL Legal Description	District Lot 5997, Kamloops Division Yale District
FL Purpose; Sub-purpose	Industrial; Log Handling/Storage
FL Expiry	00:00:00 05/15/2016
FL Term	30 years

Map 1. Location of the parcel (adapted from [CSRD Property Information map<sup>3</sup>](#))



## EXISTING SITUATION

The parcel has been owned and (formerly) operated as an industrial site by Federated Co-operatives Ltd. for several decades. The owners primarily used the aquatic area adjacent to the site for log handling and storage, and formerly maintained a floating log boom adjacent to the parcel through a foreshore lease (through FLNRO).

### Regional Context

The CSRD has indicated that several "large" developers have expressed strong interest in purchasing and developing this lot as "high-density" residential. Wording in the OCP states that, in the parcel area, new residential development is generally discouraged unless co-located with

---

<sup>3</sup> <http://mapping.csr.bc.ca/html5/?viewer=property>

an agricultural use (s. 3.4.1.1) and that new development should be compatible with surrounding residential uses. Further, preserving wildlife habitat and corridors is an objective outlined in the OCP. However, in a meeting with the CSRD, it was indicated that abiding by the OCP may not result in an outcome in agreement with these guidelines and, essentially, a high-density development is possible. Further, developers have been able to circumvent bylaws, as has been evidenced by several other high-density residential developments that have been completed on Shuswap Lake (e.g., West Beach Village, Carmel Cove<sup>4</sup>).

### **Threats to Health and Safety**

A major concern around the eventuality of increased residential development on this parcel is the impact it would have on public safety related to increases in both road and lake traffic. Sunnybrae Canoe Pt. Rd. is a notoriously winding, narrow, sidewalk- and shoulder-less rural road that is currently at or near traffic capacity. The turn-off from this road onto the Trans Canada Hwy sees high incidents of heavy trauma traffic accidents, several of which have been experienced first-hand by one of our group members (i.e., as a physician first responder). Further, increases in boat traffic, as has been dramatically observed on Shuswap Lake over the past decade, may result in greater numbers and severity of boating-related accidents.

Concerns around public health exist in relation to the potential development of this parcel. Lakefront developments can impact water quality through human sewage effluent discharged into the lake and connected groundwater supplies. Many residential areas on BC's lakes are seasonally occupied which, in traditional septic systems, leads to sterilization and subsequent system failure during the offseason. When residents return in high numbers, these systems no longer have the ability to remove potentially pathogenic organisms. Even with the highest level of sewage treatment, effluent is still rich in nitrogen, phosphorus, and endocrine-disrupting compounds, which are directly responsible for algal blooms and have significant negative consequences for human health.

### **Reclamation**

The waterfront portion of the parcel and associated lake area has been subjected to industrial use under current ownership. As such, an environmental assessment is required prior to land use re-designation (completed), and full site reclamation may be necessary. The OCP states that "resource extraction operations, including forestry and mining, are

---

<sup>4</sup> <http://www.kamloopsnews.ca/the-mike-rink-story-1.1241083>

responsible for restoring the landscape upon completion of the operations” (s. 3.11.1.9). Therefore, site reclamation is the responsibility of the seller (Federated Co-operatives Ltd.) prior to the parcel changing hands (per the OCP). However, the transfer of this responsibility to the new owners may be negotiable as a condition of sale.

For more information regarding legislated reclamation regulations consult the BC Ministry of Environment (MoE) website<sup>5</sup>.

## **PARK ESTABLISHMENT**

The parcel can be re-designated as a park, either at the regional or provincial level. This will require purchase funds to be obtained. An application for land use re-designation must be made to the CSRD. As noted above, the extent of pre-purchase remediation required may be a negotiable condition of sale (i.e., if environmental assessment and/or remediation work is part of the park establishment efforts). If it is to be re-designated as a Conservation Park at the regional scale, the waterfront and semi-waterfront park area could be applied for re-designation as Parks and Open Spaces (PK, s.3.13, s.8.5). However, the park may be formed through other organizations (e.g., federal and/or provincial agencies, NGOs).

Aquatic coarse woody debris (i.e., floating and sunken pieces of wood) provides important habitat for aquatic species. The removal of such habitat has resulted in negative impacts on fish behaviour, growth rate, and abundance<sup>6</sup>. Rebuilding the log boom may provide a suitable environment for experimental habitat enhancement programs, which have been successful in increasing fish abundances in lakes<sup>7</sup>. Further, the log boom may limit boat traffic and human activities in the aquatic area adjacent to the parcel shoreline, which will protect against shoreline erosion (thereby facilitating shoreline restoration) and boom structures will provide unique habitat for fish, birds and wildlife. Options for rebuilding and maintaining the log boom, and/or experimental fish and wildlife habitat enhancement projects in the log boom area, could be explored through agency (e.g., FLNRO, MoE, Fisheries and Oceans Canada) and conservation partners, and potentially community and/or academic institutions.

---

<sup>5</sup> <http://www.env.gov.bc.ca/epd/remediation/real-estate/index.htm>

<sup>6</sup> <http://www.mallardlakeassociation.com/resources/Fish%20Habitat.pdf>

<sup>7</sup> [https://www.bchydro.com/pwcp/pdfs/reports/pwfwcp\\_report\\_no\\_299.pdf](https://www.bchydro.com/pwcp/pdfs/reports/pwfwcp_report_no_299.pdf)

To facilitate and maintain riparian shoreline restoration efforts a covenant should specify that no houseboat parking would be permitted on any shoreline associated with the parcel.

Opportunities for the public to access and enjoy the park could be explored in consultation with agency and NGO partners, as well as local conservation organizations. Notably, several such organizations have expressed great interest in donating efforts to provide public access and connectivity to the adjacent Herald Provincial Park.

## ENVIRONMENTAL CONSIDERATIONS

An objective outlined in the OCP is to “identify significant fish and aquatic habitat, including spawning habitat and protect these areas from human encroachment.” The OCP states that this will be achieved through implementation of the Riparian Areas Regulation (RAR) guidelines, an *expectation* that landowners and developers will refer to the Department of Fisheries and Oceans – Land Development Guidelines for the Protection of Aquatic Habitat when constructing near any watercourse, and through Shuswap Watershed Mapping Project to assist in decision-making (s. 2.4, CSRD 2014).

The proposed park area is located within biogeoclimatic Interior Douglas-fir Shuswap moist warm zone (IDFmw1), which is characterized by frequent stand-maintaining fires. It serves an important purpose as a wildlife and habitat corridor, as it is connected to Interior Cedar-Hemlock (ICHmw2) zone at higher elevations, which is characterized by frequent stand-initiating events. Given the high potential and frequency of natural disturbances in these zones, the maintenance of this land-water connectivity corridor likely plays an important role in providing wildlife opportunities to disperse, seek refuge, and re-colonize following disturbance events.

### Aquatic Habitat

The [Shuswap Watershed Atlas](#)<sup>8</sup> identifies the FIM Shore Type associate with the parcel as ‘Gravel’, and it is located near the sensitive ‘Stream Mouth’ habitat associated with Reinecker Creek. **According to the [FISS database](#)<sup>9</sup>, Sockeye Salmon (*Oncorhynchus nerka*) have been observed spawning** in Margaret Creek.

---

<sup>8</sup> [http://www.cmnbc.ca/atlas\\_gallery/shuswap-lake-watershed-atlas](http://www.cmnbc.ca/atlas_gallery/shuswap-lake-watershed-atlas)

<sup>9</sup> <http://www.env.gov.bc.ca/fish/fiss/background.htm>

The former (removed spring 2014) log boom associated with the parcel has been anecdotally observed to be used by an increased abundance and diversity of species in comparison to adjacent lake areas. Some species observed feeding, rearing, and seeking refuge in the log boom area include Great Blue Heron, Common Loon, mink, and river otters. According to the Shuswap Watershed Atlas, the [FIM Aquatic Habitat Index Rating](#)<sup>10</sup> associated with the parcel is 'Low'; however, it is sandwiched between shoreline with ratings of 'High' (Herald Provincial Park) and 'Moderate' (residential properties immediately East and toward Paradise Point). The 'Low' rating for the parcel is likely due to past and current industrial activities on the parcel shoreline, which has altered the natural shoreline habitat. **Remediation of this shoreline could result in a significant improvement of this habitat rating.**

Fishing is of important recreational, cultural, and sustenance value to First Nations, community members and tourists who use Shuswap Lake. One of the most frequented fishing sites on the Salmon Arm was the former log boom area, which is indicative of a more abundance adult fish population in this habitat compared to other areas on this arm. Surveys with depth sounders have revealed the lake bottom associated with the log boom site to be largely covered with sunken logs, a common occurrence in long-operating log boom areas on lakes. Sunken large woody debris in lakes may provide important habitat for juvenile and adult lake fish<sup>11,12</sup>.

Following the removal of fixed-floating log rafts which had been left untouched in the log boom area for over a decade, there was marked decrease in the numbers and diversity of small mammal and waterbird species using the log boom area. Experimental floating wood structures have been associated with increases in fish abundance in large lake habitats (e.g., [https://www.bchydro.com/pwcp/pdfs/reports/pwfwcp\\_report\\_no\\_299.pdf](https://www.bchydro.com/pwcp/pdfs/reports/pwfwcp_report_no_299.pdf)). However, it should be noted that bird, mammal, and angler presence was still higher in the log boom area compared to adjacent areas even after raft removal (C. Price and S. Presh, *pers. comm.*). Unfortunately, to date, no surveys of fish or wildlife populations associated with the log

---

<sup>10</sup> [http://www.kelowna.ca/CityPage/Docs/PDFs%5C%5CCouncil%5CMeetings%5CCouncil%5CMeetings%5C2011%5C2011-07-25%5CItem 5.09 - Foreshore Inventory and Mapping \(FIM\) Update.pdf](http://www.kelowna.ca/CityPage/Docs/PDFs%5C%5CCouncil%5CMeetings%5CCouncil%5CMeetings%5C2011%5C2011-07-25%5CItem%5C5.09%5CForeshore%5CInventory%5Cand%5CMapping%5C(FIM)%5CUpdate.pdf)

<sup>11</sup>

<http://www.ingentaconnect.com.proxy.lib.sfu.ca/content/umrsmas/bullmar/1989/00000044/00000002/art00007>

<sup>12</sup> [http://link.springer.com.proxy.lib.sfu.ca/chapter/10.1007/978-1-4612-0677-4\\_11#page-1](http://link.springer.com.proxy.lib.sfu.ca/chapter/10.1007/978-1-4612-0677-4_11#page-1)

boom area or log rafts have been conducted.

### **Riparian (waterfront) Habitat**

Although partially cleared and lightly used by forestry activities (e.g., log sorting and handling using heavy machinery) over the past several decades, the waterfront section of the parcel presents a unique opportunity to maintain and restore increasingly rare natural shoreline habitat, thereby increasing the total protected shoreline habitat in the province. Given that the parcel shoreline is adjacent to Herald Provincial Park further increases its value in preserving and connecting this shoreline habitat, which will facilitate movement of aquatic and terrestrial wildlife species between and within habitats.

### **Upland (semi-lakefront) Habitat**

The portion of the parcel located on the North side of Sunnybrae Canoe Pt. Rd. currently exists as natural forested habitat. There is no evidence of previous industrial, resource extraction, or any other type of alteration of this land away from its natural state.

The parcel currently serves as a wildlife corridor for terrestrial mammals moving between forested upland areas and the lake, such as otters, mink, deer, wolves, and black and Grizzly bears (C. Price and S. Presh, *pers. comm.*). Preserving wildlife habitat and corridors is an objective outlined in the OCP (s. 6.5). It also contains a groundwater aquifer, which serves as a water source for various wildlife species (C. Price and S. Presh, *pers. comm.*). Notably, a neighbouring ~40 ac parcel to the northeast has been privately purchased and is in the process of being re-designated as protected land, which will aid in the development of a wildlife corridor.



## **Summary of Emergency Response Activities and Initial Geotechnical Assessment of the 2017 Robinson Creek Debris Flow**

Sunnybrae – Canoe Point Road,  
Columbia Shuswap Regional District

***Prepared for:***

**Emergency Management BC / Shuswap Emergency Program**  
c/o Columbia Shuswap Regional District  
555 Harbourfront Drive NE  
Salmon Arm, BC V1E 4P1  
Attention: Darcy Mooney

***Prepared by:***

**Westrek Geotechnical Services Ltd.**  
101 – 1285 Dalhousie Drive  
Kamloops, BC V2C 5Z5  
[www.westrekgeotech.com](http://www.westrekgeotech.com)

September 27, 2017  
File No. 017-053

## Table of Contents

<b>1</b>	<b>Introduction .....</b>	<b>1</b>
<b>2</b>	<b>Methods .....</b>	<b>2</b>
<b>3</b>	<b>Background Information .....</b>	<b>3</b>
3.1	Setting.....	3
3.2	Geology .....	3
3.3	Development and Landslide History .....	4
3.4	Weather Synopsis.....	5
<b>4</b>	<b>The May 5, 2017 Debris Flow .....</b>	<b>6</b>
4.1	Conditions on the Plateau .....	6
4.2	Initiation Zone.....	6
4.3	Transport Zone.....	7
4.4	Debris Deposition .....	7
4.5	Other Information .....	8
<b>5</b>	<b>Discussion and Assessment .....</b>	<b>8</b>
<b>6</b>	<b>Recommendations.....</b>	<b>10</b>
<b>7</b>	<b>Closure.....</b>	<b>11</b>

Attached:     Tab 1 – Figures 1 to 5  
                  Tab 2 – Weather data  
                  Tab 3 – Site Photographs  
                  Tab 4 – Lab test data  
                  Appendix A   *Interpretation and Use of Study and Report and Limitations*

## 1 Introduction

Around midnight on May 5, 2017, a debris flow<sup>1</sup> initiated in the upper reach of Robinson Creek, located about 11 kilometers northeast of Sunnybrae, BC (Figure 1, Tab 1). The debris flow descended almost 1000 m in elevation and travelled over 2 km to the north shore of the Salmon Arm of Shuswap Lake. It blocked the Sunnybrae – Canoe Point Road (the public road) and impacted residences located at address numbers 5921 and 5932, causing one fatality.

At the request of the Shuswap Emergency Program (SEP), in support of Emergency Management BC (EMBC) and the Columbia Shuswap Regional District (CSR), Westrek Geotechnical Services Ltd. (Westrek) completed a rapid assessment of the landslide using helicopter and ground-based field reviews. Based on site observations and forecasted unsettled weather patterns, Westrek recommended immediate evacuation of residences located on the Robinson Creek fan, which included 5866, 5874, 5882, 5890, 5900, 5921, 5922, 5932, 5933, 5940, 5941, 5947, and 5948 Sunnybrae – Canoe Point Road. A map showing the properties is attached.

Westrek attended a public meeting on May 8, 2017, to summarize the information that had been collected at that time. Following improved weather conditions and supplementary aerial and field reconnaissance, Westrek provided advice to the CSR to support the decision to rescind the Evacuation Order on May 15, 2017. Over the following weeks, Westrek attended meetings and provided geotechnical input to assist agencies in managing aspects of the response and recovery process. On May 29, 2017, Westrek assisted the RCMP and Kerr Wood Leidal (KWL) the recovery of the deceased person at 5921 Sunnybrae – Canoe Point Road.

Westrek submitted written correspondence during the course of the emergency response. These documents included:

- *Rapid Assessment and Recommendations for Evacuation Order, Robinson Creek Debris Flow, Sunnybrae – Canoe Point Road.* Memorandum to Shuswap Emergency Program, dated May 8, 2017.
- *Robinson Creek Debris Flow.* E-mail to Shuswap Emergency Program providing advice to support removal of the evacuation order, dated May 15, 2017.
- *Worker Safety Guidance during Excavation of Debris 5921 Sunnybrae – Canoe Point Road, near Sunnybrae, BC.* Memorandum to Kerr Wood Leidal, dated May 30, 2017.

This report summarizes the information that has been collected to date by Westrek. It is not intended to be a detailed landslide hazard or risk analysis for the properties on the Robinson Creek fan; rather it provides a general assessment of the site and includes recommendations for further work that will be needed to manage the landslide risk. The information provided in this report is considered preliminary in nature, and therefore, anyone using this report will need to verify its appropriateness for their own purposes.

The services provided by Westrek are subject to the terms and conditions set out in the *Interpretation and Use of Study and Report and Limitations*, which is attached in Appendix A and incorporated by reference.

---

<sup>1</sup> Debris flow is a rapid landslide comprised of earth material, water and often organic material that flows in a defined channel.

## 2 Methods

Westrek personnel collected field information on May 6, 9, 15, and 29, 2017. Site observations were referenced to waypoints (Wpt) obtained using a handheld GPS receiver. The horizontal accuracy of the waypoints is typically 5 to 10 m, but it can be less in steep terrain. Unless otherwise noted, elevations referenced in this report are based on 1:20,000 scale terrain resource inventory (TRIM) maps. No topographic surveying or subsurface investigation has been undertaken to date. Laboratory testing was undertaken on one sample of the debris to determine its grain size distribution. No other investigation or testing was completed.

The following background information was used:

- 1:2000 scale and 1:800 scale orthophoto images annotated with the legal boundaries and civic numbers, provided by the CSRD dated May 6, 2017.
- Thompson, R.I. (compiler). *Geology – Sorrento, British Columbia*. Geological Survey of Canada. Open File 4383. NTS map sheet 82L/14. Scale 1:50,000.
- Geology map on-line database, BC Ministry of Energy and Mines, [<http://webmap.em.gov.bc.ca/mapplace/minpot/bcgs.cfm>], retrieved May 23, 2014.
- Terrain mapping: *Terrain Stability Mapping for the Salmon Arm Forest District – Bastion & Mount Ida / Canoe*, by EBA Engineering Consultants Ltd. and JM Ryder and Associates Terrain Analysis Inc. March 1998. Scale 1:20,000.
- Forest cover map – BC Ministry of Forests, Resource Inventory Branch. Map sheet 82L.085. Scale 1:20,000. Map updated in 1998.
- Forest cover information from the Province of BC’s on-line iMap program, retrieved September 15, 2017.
- Weather data for Salmon Arm Fire Station, and Turtle Valley Fire Station for April and May 2017, gathered on line.
- Weather data for Salmon Arm weather station provided by Environment Canada, gathered on line.
- Snow survey data, Anglemont Snow Survey (F102), retrieved from obtained from the BC Web Mapping Service [<http://openmaps.gov.bc.ca/mapserver/base2>].
- Streamflow data for the BC River Forecast Centre on-line data server.
- Air photographs:
  - 15BCC07010, #92-93 (digital thumbnail only), 2007;
  - 15BCC01024, #043-045 (2001);
  - 15BCB97020, #135 (1997);
  - 30BCC94042, #017-019 (1994);
  - 30BCC1047, #87-89 and 138-139(1989);
  - 30BC78061, #047 (1978);
  - BC7647, #157-159 (1974);
  - BC2615, #2-4 (1959);
  - BC1292, #83-85 (1951); and
  - A368, #26-27 (1928).
- Google Earth™ imagery from 2004 and embedded geographic analysis applications.

## 3 Background Information

### 3.1 Setting

Robinson Creek drains part of a small upland plateau overlooking the north shore of the Salmon Arm of Shuswap Lake. The plateau is bordered on the north side by Bastion Creek and on the west side by Knight Creek [Figure 1]. Robinson Creek is the middle of three similar creeks that drain off the south side of the plateau [Figure 2]. McIntyre Creek lies 0.6 km to the east and Hart Creek lies 0.5 km to the west.

The plateau is bedrock controlled and consequently the watershed boundary for Robinson Creek is somewhat uncertain, but an estimate is illustrated on Figure 2. Based on TRIM maps, the catchment rises to about elevation  $\pm 1600$  m is likely no wider than 0.6 km. The catchment area draining to the fan apex is about 1.2 km<sup>2</sup>, of which 0.55 km<sup>2</sup> is contributed by the plateau. The upper part of the catchment is moderately sloped and drains to the southeast. The terrain in the lower part of the catchment is irregular and is broken by sub-lineal ridges and depressions, with drainage generally to the south. The catchment drains over the plateau edge at elevation  $\pm 1380$  m. On the western side, the edge is defined by a near-vertical cliff, but the cliff diminishes towards the east where the edge is more rounded.

The TRIM mapping indicates that Robinson Creek has three small tributaries, none of which extend onto the plateau. The two main tributaries, named the east and west branches for this report, start just below the plateau edge and converge at elevation  $\pm 920$  m to form the main stem. The gradients of these streams are 75% to 85% ( $37^\circ$  to  $40^\circ$ ), respectively. The third tributary is lower on the steep slope and is small and also very steep. It starts below a rock cliff at elevation  $\pm 970$  m and merges with the main stem at elevation  $\pm 765$  m. All three streams are controlled by the bedrock structure and appear to have a cascade morphology. The average gradient of the stream channels from the plateau edge to the fan apex is  $\pm 60\%$  ( $\pm 31^\circ$ ).

The creek exits the watershed through a deep V-shaped gully and onto an alluvial fan at elevation  $\pm 520$  m. The upper fan is relatively narrow and steep, and appears to be confined on the east and west sides by bedrock ridges. At elevation  $\pm 410$  m, the fan spreads out rapidly and the slope gradient flattens. The lower part of the fan likely coalesces with the fans from Hart Creek and other draws that drain the steep slopes to the east and west. The public road crosses the lower part of the fan between elevation  $\pm 370$  to 375 m. The fan extends down to Shuswap Lake at elevation  $\pm 347$  m.

### 3.2 Geology

Thompson (2004) indicates there are two main bedrock formations in the area. Bedrock on the plateau is mapped as the Sicamous Formation, comprised of grey re-crystallized limestone with black argillaceous partings. The steep slopes below the plateau are mapped as the Silver Creek Formation, comprised of biotite-muscovite-garnet schist, carbonaceous schist, micaceous quartzite, quartzite and minor marble. The contact between the two formations lies along the edge of the plateau. Other bedrock mapping sources indicates that the two formations are separated near the plateau edge by mudstone, siltstone, shale and fine-clastic sedimentary rocks of the Mount Ida Assemblage.

The terrain mapping indicates the steep slopes in the upper part of Robinson Creek are comprised of steep bedrock with minor colluvium<sup>2</sup> and thin till<sup>1</sup>. These slopes are rated as “unstable” and noted as a potential source area for rockfall. Although this rating is specifically defined for forestry operations, it provides an indication of the landslide hazard in the area.

Air photo review indicates that the steep slopes below the plateau are stepped, which suggests they were formed by ancient bedrock slope failures or by differential weathering of the foliated bedrock, or both. Relief is very high. Thick colluvial slopes are present below the cliffs, and the toe slopes along the lake are comprised of coalesced fans from the main creeks and several draws that are present in the lower part of the valley.

### 3.3 Development and Landslide History

On the earliest (1928) air photos there are three short, discontinuous erosion or landslide scars visible in each of the three tributary creek channels [Figure 3]. They appear to be associated with small rock or debris slides that triggered debris movement in the channels. Despite the very high creek gradient, these debris flows arrested in the channels a relatively short distance downstream. The erosion scars slowly re-vegetated but remain visible on the recent air photos.

The only other natural landslide of note in the area occurred in Hart Creek prior to 1928, when a debris flow initiated in the channel in the upper steep slopes. It travelled down to the lake and left a prominent landslide track along the path [Figure 3].

The forest cover map indicates that a large wildfire occurred on the plateau between 1929 and 1939. It burned a significant portion of the Hart Creek catchment on the plateau, but only a minor portion of the plateau draining into Robinson Creek. No obvious impact on its channel was noted in the early air photos.

The public road was extended north across the Robinson Creek area sometime between 1951 and 1959. The first houses in the area were built below the road between 1959 and 1974, and by 1978, the lots above the road were fully built up.

The absence of a defined stream channel for Robinson Creek on the fan is notable in the air photos. Possible evidence of a short channel section on the upper fan is visible on the 1974 air photos, but no obvious channel was visible on the lower part of the fan on any of the air photos.

Forestry development on the plateau within the Robinson Creek catchment started in 1983, when Opening 26 was clear-cut logged (Figure 2). The canopy opening within the catchment was about 0.25 km<sup>2</sup>. Opening 80 was logged in 2001 and it included the timber between Opening 26 and the edge of the cliff. Only about 0.05 km<sup>2</sup> lies in the Robinson Creek catchment. Both these blocks are accessed by a narrow forestry road from the north. No effect on the creek channels were noted on the air photos subsequent to this development.

Another debris flow occurred in Hart Creek just prior to 1994. Like the 1928 event, it initiated in the upper part of the channel and it travelled down to the lake. Conversations with local residents suggest that another debris flow occurred in Hart Creek in 1997, with the same outcome, but this has not been corroborated from other sources.

---

<sup>2</sup> Colluvium is a surficial deposit emplaced primarily by gravity (erosion) processes, such as slope wash, creep, landslides, or rockfall. Till is a non-stratified deposit emplaced by glacial activity.

### 3.4 Weather Synopsis

Weather data was analyzed to determine the antecedent conditions leading to the flood and landslide events throughout the area in 2017<sup>3</sup>. Environment Canada weather data from Salmon Arm indicated that most of 2016 was much drier than normal, but it was followed by a relatively wet autumn (see data table attached in Tab 2). The data shows that September 2016 had about average rainfall, October received about twice the average amount, and November was slightly below average. December was very cold and dry and these conditions persisted throughout the first months of 2017.

The snow survey station nearest to Robinson Creek is at Anglemont (elevation 1190 m). The snow pack at Anglemont was well below normal over most of the winter, and reached a peak near the beginning of April. Depressed average temperatures delayed snow pack ablation and by May 1 it was slightly above average. Snow survey results at Silverstar, which has a similar elevation as the upper watershed, shows a similar pattern (see snow survey graphs in Tab 2).

Very cold temperatures and below normal precipitation persisted throughout January and February 2017. The precipitation in March was twice the recorded average and in April it was almost 2.5 times the average. This weather pattern likely created high soil antecedent moisture levels and raised groundwater levels. The severe temperatures and low snow cover may have allowed deeper frost penetration and affected runoff patterns during the early freshet period.

An unsettled weather system moved through the area on May 2 and 3, 2017. Temperatures were cool and total daily rainfall over the period was 6.0 mm at the Turtle Valley Forestry station and 4.2 mm in Salmon Arm Forestry Station (see attached data and graphs in Tab 2). Environment Canada's station at Salmon Arm recorded 9.9 mm of rain. This was followed by a frontal system that moved inland on May 4 and brought mild temperatures and heavy rainfall showers over a 2-day period. Rainfall appears to have been showery and locally intense. Nearby forestry weather stations recorded hourly rainfall of 4.5 to 8.2 mm/hour, which is significant. The total rainfall in this period was 12.8 mm in Turtle Valley, 25.0 mm at Fintry, and 34.5 mm in Salmon Arm Forestry station. At the Salmon Arm Environment Canada station, 22.8 mm of rain was recorded<sup>4</sup>.

The elevated temperatures and heavy rain likely caused a rapid depletion of the snow pack, which induced an extreme peak flow in the local streams. Peak flow data from three nearby streams (Chase Creek, Coldstream Creek, and Salmon River) is attached in Tab 2. Not only was the peak flow in this period near the maximum ever recorded in these stations, it occurred 2 to 3 weeks earlier than usual. Analysis to determine the statistical significance of the peak flow, i.e. its return period, has not been carried out at this point.

---

<sup>3</sup> Very simple analysis was undertaken using readily available data. This information should only be used for general information purposes not be used for any other statistical or engineering purposes.

<sup>4</sup> The various agencies use different time references for their daily summaries, so a direct comparison between data sets for each date requires a review of the actual data, which has not been done at this time.

## 4 The May 5, 2017 Debris Flow

The following sections are a summary of site observations made following the May 5, 2017 debris flow. The section is subdivided into four discrete areas including the plateau, the initiation zone, the transport zone, and the debris fan. Photographs from the air are provided in Tab 3 [Photos 1 to 6].

### 4.1 Conditions on the Plateau

On the morning of May 6, 2017, Westrek observed between 0.5 and 0.75 m of snow cover within the logging block (Opening 80) near the edge of the plateau. An estimated 0.3 to 0.4 m of snow was present in the mature forest above the landslide site. By May 15, 2017, the snow pack in the logging block had reduced to about 0.3 m and was patchy [Photo 7]. The snow pack in the mature forest had also depleted but to a lesser extent, and was probably 0.2 to 0.3 m.

The forestry road from Opening 26 to Opening 80 crosses rolling / ridged, bedrock-controlled terrain. It is narrow and has minor cuts and fills, and generally there was no ditch [Photo 8]. No significant runoff along the forestry road and no drainage diversions were observed.

The lower slopes in Opening 80 were checked, and there was no evidence that the east branch of Robinson Creek extended up onto the plateau [Figure 4].

The west side of the catchment drains southwards into a small bowl-shaped landform on the west side of Opening 26 [Figure 4]. Surface runoff in this area drains through this feature and into a broad, flat-bottomed draw that eventually drains into the west branch of Robinson Creek. A small stream with a poorly defined channel was present in the draw, starting at Wpt 66. The base of the draw was benched in places and the gradient gradually increases downstream. The stream infiltrated into the draw floor at Wpt 64. At about 15 m below at Wpt 039, the draw drains over a distinct break where the slopes increase from 35% to 65%. The slope break is about 50 m above the debris flow initiation zone. The draw narrows and becomes significantly deeper below this, and bedrock is more prominent on the southeast sidewall.

### 4.2 Initiation Zone

The landslide initiated within the base of a bedrock crevice / gully within the upper reach of the west branch of Robinson Creek, just below the edge of the plateau [Figure 4]. The initiation point co-ordinates were Z11 349515E 5632745N, and the elevation was  $\pm 1340$  m.

Immediately above the debris flow initiation point, the draw slopes at 75% to 85%. The forest floor in the base of the draw was frozen on May 6, but by May 15 it had thawed. The scarp was about 6.5 m wide and about 2.5 m high [Photo 9]. The initiation zone widened to 12 m on the right (west) bank about 20 m downstream from the scarp, where a slope failure occurred in the gully sidewall deposits. In total, the initiation zone was an estimated 35 to 40 m long but the length is somewhat arbitrary. Initiation volume was likely 300 to 500 m<sup>3</sup>.

The landslide initiated in the thick layer of colluvium in the floor of the draw. The colluvium consisted of platy, angular rubble and block sized fragments with some sand and minor silt. Fragment size was generally less than 250 mm on the intermediate axis. The colluvium was interpreted to be material that had weathered from the adjacent bedrock cliffs [Photo 10]. The left bank of the crevice exposed weak schistose bedrock cliffs, which were 30 to 60 m high and

near-vertical to overhung. Water was dripping down the rock face. Bedrock was also exposed above the right side of the draw as well, but the cliffs are not as high or prominent.

Tension cracks were noticed in the colluvium along the right sidewall near the scarp on May 15, 2017 [Photo 11], indicating some subsequent slope movement had occurred in the sidewall colluvium after the initial failure.

A small stream was flowing from the coarse angular colluvial deposits in the base of the initiation zone about 15 m downstream from the scarp [Photo 12]. This flow constituted the majority of the flow observed downstream in the west branch. Bedrock was exposed in the base of the initiation zone below this point.

### 4.3 Transport Zone

The transport zone below the scarp was not traversed due to safety concerns and lack of accessibility. Observations made from the air are summarized below.

The draw containing the west branch has long, relatively straight and steep reaches, and it likely follows a major bedrock structure discontinuity. Bedrock appears to be present along most of the channel in this reach, but erosion along the channel and side walls as the debris flow descended resulted in the entrainment of additional material.

A small stream was discharging from the east branch gully: as noted above, this stream was not present in Opening 80, so it appears to be fed by a spring emerging from the bedrock below the plateau edge. Below the confluence, the channel changes direction regularly and significant super-elevation occurred as the debris flow travelled around bends during its descent. A few sidewall failures were noted along the gully, which contributed additional material.

### 4.4 Debris Deposition

Fan deposition began at approximate elevation  $\pm 520$  m (Wpt 87), about 1.2 km from the initiation zone. A large debris lobe formed behind a logjam about 130 m below the apex [see Figure 5 and Photos 13-14]. The deposit was about 60 m across and its surface sloped at 23% to 26% ( $13^\circ$  to  $15^\circ$ ). Debris thickness of up to 3 to 4 m was deposited upstream of the logjam. This deposition appeared to deflect the debris flow to the west at this location.

Below the logjam, the debris plume was relatively narrow (15-20 m) along the narrow portion of the upper fan [Photo 15]. The channel had incised 3 to 4 m into the debris or pre-event fan deposits in this section, and had a deep V-shape or in some cases box-like morphology. Classic debris flow levees were present along the debris margins. The levees were usually 1 to 2 m higher than the adjacent terrain, but in a few areas the levees were only about 0.5 m high.

Channel incision decreased to 1.5 to 3 m in the middle part of the fan. At elevation  $\pm 400$  m, or about 500 m below the fan apex, the debris flow split into two lobes, just above the 5921 Sunnybrae – Canoe Point Road property [Figure 5]. A minor lobe travelled southwest and arrested just above the public road and the 5890 and 5900 Sunnybrae – Canoe Point Road properties. The main lobe turned slightly east and flowed through the 5921 Sunnybrae – Canoe Point Road property, destroying the residence and killing its occupant. Channel incision reduced to 0.5 to 1.5 m through this area. Minor debris deposited on the 5933 Sunnybrae – Canoe Point Road property, but there was no damage to primary structures [Photos 16-19].

A large fraction of the main debris flow lobe arrested on the public road, where it spread out into a 90 m wide deposit that reached an estimated thickness of 3 to 4 m [Photo 20]. The remainder of the debris flow continued below the public road and covered a large part of the 5932 Sunnybrae – Canoe Point Road property [Photo 21-23]. Debris passed through the primary residence and caused severe structural damage. The stream now flows beneath this residence. Some metre-scale boulders were noted immediately downstream of the primary residence but it is not certain if they were part of the debris flow or had been placed there when the property was developed [Photo 22]. Debris also impacted an ancillary residence on the lakeshore, and shifted it off its foundation [Photo 23].

Debris also deposited on the 5922 Sunnybrae – Canoe Point Road property but there was no damage to the residential structure there.

#### **4.5 Other Information**

The angle-of-reach of the debris flow was measured to be 28° (53%). About 15% of the fan was covered by the debris flow. A preliminary estimate of the total debris deposition on the fan was 15,000 to 25,000 m<sup>3</sup>.

The debris was coarse grained and sandy. A grain size distribution test on the 75 mm minus fraction of this material indicated it consisted of 38% angular to sub-angular gravel-sized material, 46% sand, and 16% fines, interpreted to be mainly silt. The grain size distribution curve is attached in Tab 4. An additional 10%-20% angular to sub-angular sized fragments between 150 and 250 mm were also present in the deposit.

Field traverses to date have identified a number of old, discontinuous draws or levees throughout the fan, but little indication of the former stream channel. If a stream channel existed in the upper part of the fan, it was likely covered by the recent debris flow. It appears likely that the stream formerly infiltrated in the upper part of the fan, and that a channel has not existed in the lower part of the fan for many years.

### **5 Discussion and Assessment**

The May 5, 2017 debris flow initiated as an in-channel debris flow in a bedrock crevice just below the edge of the plateau. Once mobilized, the debris flow entrained additional material from the channel in its descent to the fan. Debris deposited along most of the fan and a new stream channel formed that now extends down to the lake.

Debris flows require three main components to initiate: sufficient material to form a mass capable of maintaining momentum, a steep channel confined in a gully, and sufficient water to saturate the mass. Thick deposits of rubbly colluvium had accumulated in the channel, likely from weathering and shallow rock slides from the bedrock cliffs above. The channel gradient was more than sufficient for in-channel debris flow initiation. The triggering factor appears to be the rain-on-snow event that was coincident with elevated antecedent soil moisture and groundwater levels caused by the above-average precipitation in the fall of 2016, which significantly increased the susceptibility of the site to landslide initiation. The frozen ground present in the sheltered draw just above the scarp may have also contributed to the susceptibility to debris flow initiation, i.e., it may have confined drainage and increased pore pressures within the sediments buried in the channel.

The influence of the two logging blocks near the edge of the plateau is uncertain. Opening 26 has been re-generating for over 30 years and there would be some appreciable but, as of yet, undetermined hydrological recovery. Very little of Opening 26 lies within the Robinson Creek catchment. There was no obvious diversion of runoff by the forestry road accessing these blocks<sup>5</sup>. The influence of the two openings on the local groundwater regime cannot even be speculated at this time and it would require a detailed hydrogeological analysis to understand. Unlike surface runoff, groundwater flow does not necessarily correspond with landforms or topographic expression, and watershed boundaries can be irrelevant. Hydrogeological studies are extremely complex and can often only make general conclusions.

Air photo interpretation and previous mapping and studies confirm that these slopes have been built by landslide processes that extend back to the last glacial period. These processes include periodic debris flows and rock slope failures, and have resulted in the formation of a relatively large fan at the outlet of the gully. Debris flows will occur again in the Robinson Creek gully, once the channel has accumulated sufficient material and the conditions are again right for initiation. There is also the possibility that a debris flow could initiate in another tributary channel or side gully, or that there could be other hazards like rockslides that impact the slope below. The effect of climate change on the magnitude and frequency of such events is uncertain.

There does not appear to be a policy framework to explicitly guide government agencies when private property has been evacuated and/or it has subsequently been determined that an unacceptable landslide risk may exist. The only related guidance for landslide risk management is the BC Ministry of Transportation and Infrastructure's criteria for land subdivision. It states that the landslide risk must be mitigated if an area is not considered "safe for the use intended", which they indicate is the probability of a "damaging" event that exceeds "10% in 50 years" (or a return period of 1 in 475 years). Their guidance also implies that the probability of death to an individual is not to exceed 1:10,000, which is consistent with a number of international landslide risk standards<sup>6</sup>. Based on the work completed to date, the current landslide hazard and risk on the Robinson Creek fan probably exceeds these criteria. Therefore, continued inhabitation of the Robinson Creek fan (and adjacent areas) should be carefully considered and cautiously managed until the risk is better understood.

The risk to specific properties on the fan has not been determined and would require further study. Such studies require a significant level of investigation and analysis and the entire fan and the steep slope above must be considered, i.e. not just individual properties. It also requires the establishment of an acceptable level of risk to the stakeholders. It can be difficult to gain consensus on an acceptable level of risk and implement risk management strategies when an area is already developed, because of the complexity and costs associated with assessing the hazard and risk, engineering the risk mitigation strategy, securing land and constructing the measures, and assigning responsibility for operations and maintenance.

---

<sup>5</sup> Drainage interception, diversion and concentration is a recognized cause of landslides in gentle-over-steep conditions, which describe the plateau morphology at this site. Refer to Paddington, S. (2004). *The characterization of drainage related landslides on gentle over steep forest terrain in the interior of British Columbia*. Thesis for the Master of Science in the Department of Earth Sciences, Simon Fraser University.

<sup>6</sup> The risk of multiple deaths would need to be taken into account, which requires lower tolerances. Societal risk tolerances are typically established by governments.

For the Robinson Creek fan, there may be a few options available for risk mitigation should the current level of risk be considered unacceptable. These include either a debris catchment basin, creek channel enhancement, or a flexible catchment fence that can arrest the design debris flow. The benefits, constraints and costs of these options would be part of a more comprehensive engineering study.

To some degree, the residents on the Robinson Creek fan have the benefit of time to consider this, as the recent debris flow hazard has cleared the channel and reduced the potential debris flow magnitude in the near future. However, material will accumulate in the channel as the bedrock cliffs weather and the steep gully sidewalls erode and slough, and over time the debris flow hazard will again build. Time frames for this are decades or possibly even centuries, and there are many factors that control it, but at some point, another debris flow event can be expected as the cycle repeats.

Over the next few years or decades, the residents on the fan can also expect elevated sediment transfer through the new channel during storms or significant runoff, as the newly recruited sediment is transported through the creek system. Avulsions may occur that cause the channel to migrate laterally to other parts of the fan. This could occur without warning. The presence of multiple abandoned gullies or channels throughout the fan is an indication of its geomorphological history and the generally unstable nature of these landforms. Avulsions may also affect the new stream crossing on the public road. All stakeholders on the fan should consider a stream channel enhancement program to address this hazard.

There have been a number of recent landslides on the steep slopes along this part of the lake. A month before the Robinson Creek debris flow, a landslide occurred about 8 km to the west (4500 block of Sunnybrae – Canoe Point Road). A debris flow in McIntyre Creek occurred in 2014, which only affected the lower part of the channel. There have been at least two debris flows and possibly a third one in the Hart Creek in the past century, although the third one has not been verified. Other localized slope stability issues have also occurred. Westrek is not aware of any studies that have looked into these events on a regional basis to determine common causal factors and issues, but such information would be beneficial to a landslide hazard and risk analysis for this area.

In summary, there are a number of issues that have to be considered as a result of this event. Westrek has provided several recommendations for consideration in the following section.

## **6 Recommendations**

The following is recommended:

1. This report should be provided to the residents on the Robinson Creek fan for their information. They should be advised to remain vigilant of the debris flow hazard, and continue to monitor weather forecasts and patterns, taking into account the time of year, e.g. special attention should be paid to the period when the snow pack is ablating from the plateau. They should also be made aware that the new channel may not be stable and it could migrate to other parts of the fan with little warning. It would be beneficial for the stakeholders to set up a channel monitoring program to help detect changes.

2. The recent landslides along this area of the lake should be investigated by the relevant government agencies and stakeholders to determine if there are common factors and issues. This study would assist in managing the risk to the various stakeholders along this part of the lake.
3. A more comprehensive landslide risk analysis should be completed on the Robinson Creek fan by the relevant government agencies and stakeholders. If the risk to the stakeholders is confirmed to be unacceptable, then either risk mitigation measures should be considered to reduce landslide risk to an acceptable level, or consideration should be given to the permanently evacuating these properties and making the area uninhabitable. As the cost of a such a risk analysis can be significant, consideration should be given to coupling the study area to include the entire section of inhabited lakeshore from Sunnybrae to Bastion Creek, as there are similar landslide risk concerns to address.
4. The CSRD should consider development of a planning and control processes to restrict or manage future development on the Robinson Creek fan until the debris flow hazard and landslide risk is clearly understood. This should be extended to include the entire steep slope along this side of the lake from Sunnybrae to Bastion Creek.
5. The Ministry of Transportation and Infrastructure should consider the observations and comments in this report when designing the new crossing for Robinson Creek beneath the Sunnybrae – Canoe Point Road. Design of the new crossing may have to consider a channel upgrading project that extends up the fan to increase its capacity and stability, and the hydraulic capacity of the crossing should consider the sediment and debris passage that is likely to be an issue. The new crossing is likely to require a higher level of maintenance in the first few years as sediment moves through the channel system.
6. The Ministry of Forests, Lands, and Natural Resource Operations and Rural Development should investigate this landslide to assess if logging on the plateau may have had an influence on the debris flow initiation, and make recommendations as appropriate.

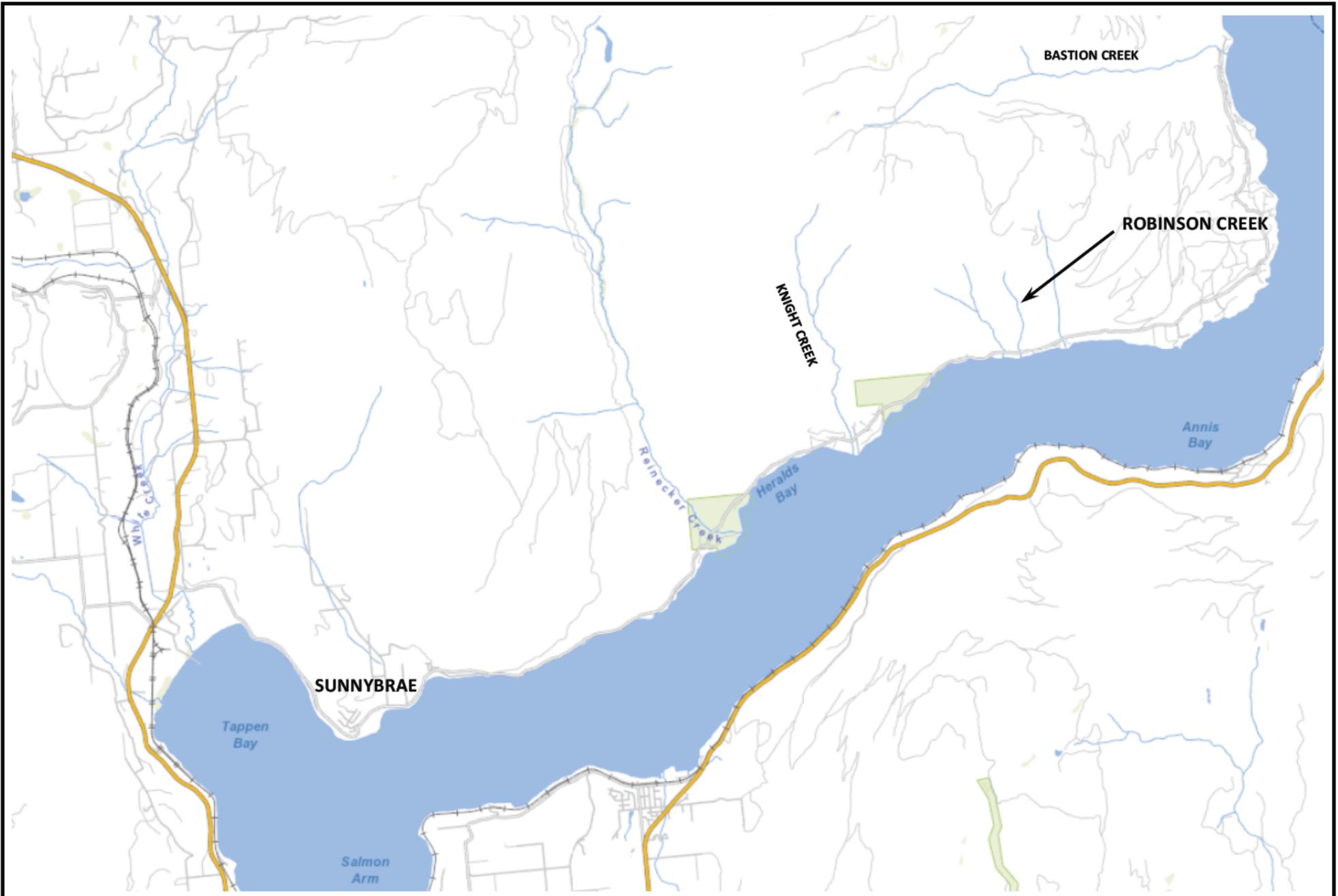
## 7 Closure

*Westrek Geotechnical Services Ltd.*

Per:     
Kevin Turner PEng  
Senior Geotechnical Engineer  
*Sept 27, 2017*

Reviewed by:  
Greg Reid PEng PGeo  
Senior Geological Engineer

TAB 1



**SITE LOCATION MAP  
ROBINSON CREEK DEBRIS FLOW**

Scale: 1:10,000

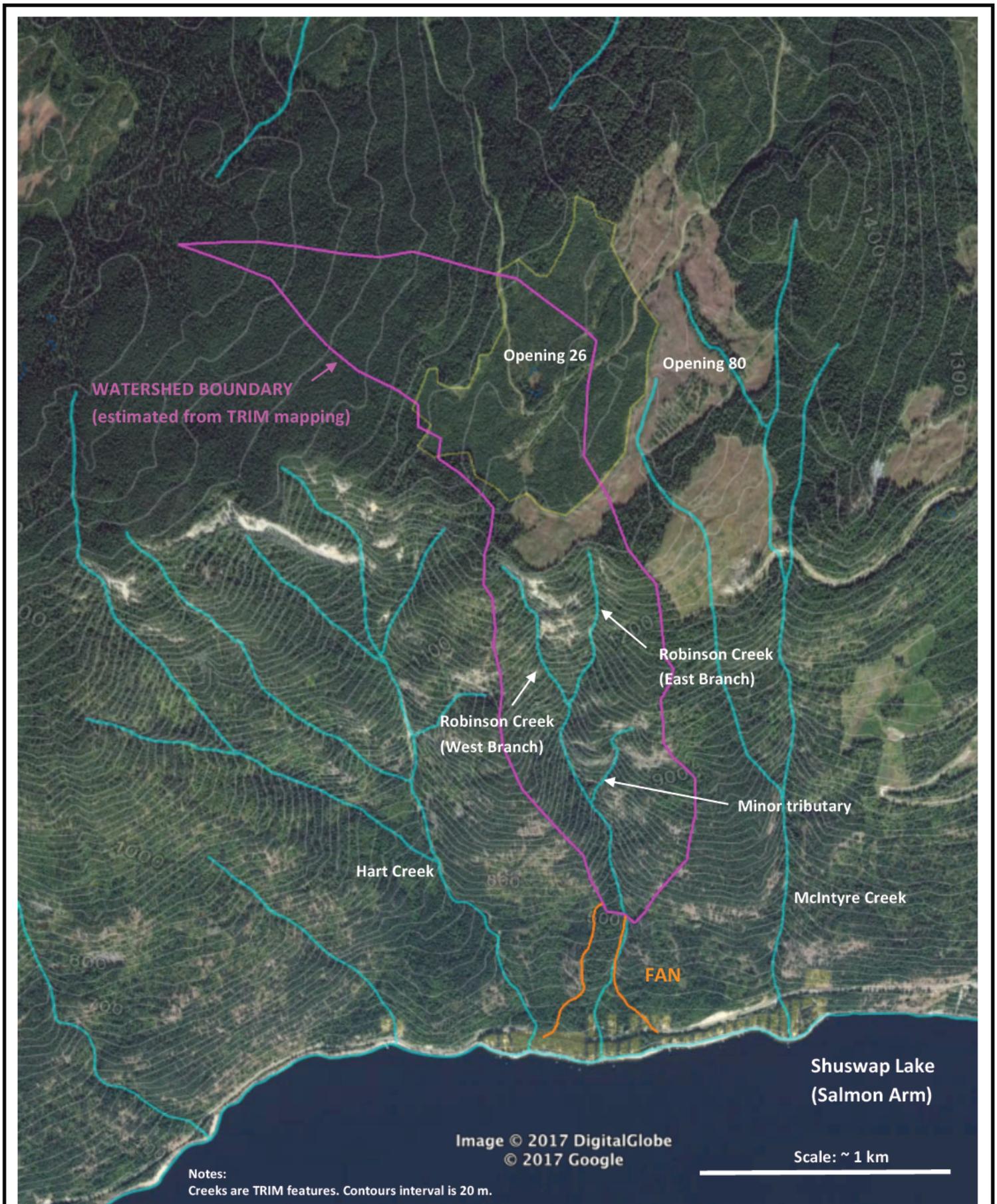
North is to the top

Project: 017-053

**FIGURE 1**

Source: Map BC (BC government map service)





**WATERSHED MAP  
ROBINSON CREEK**

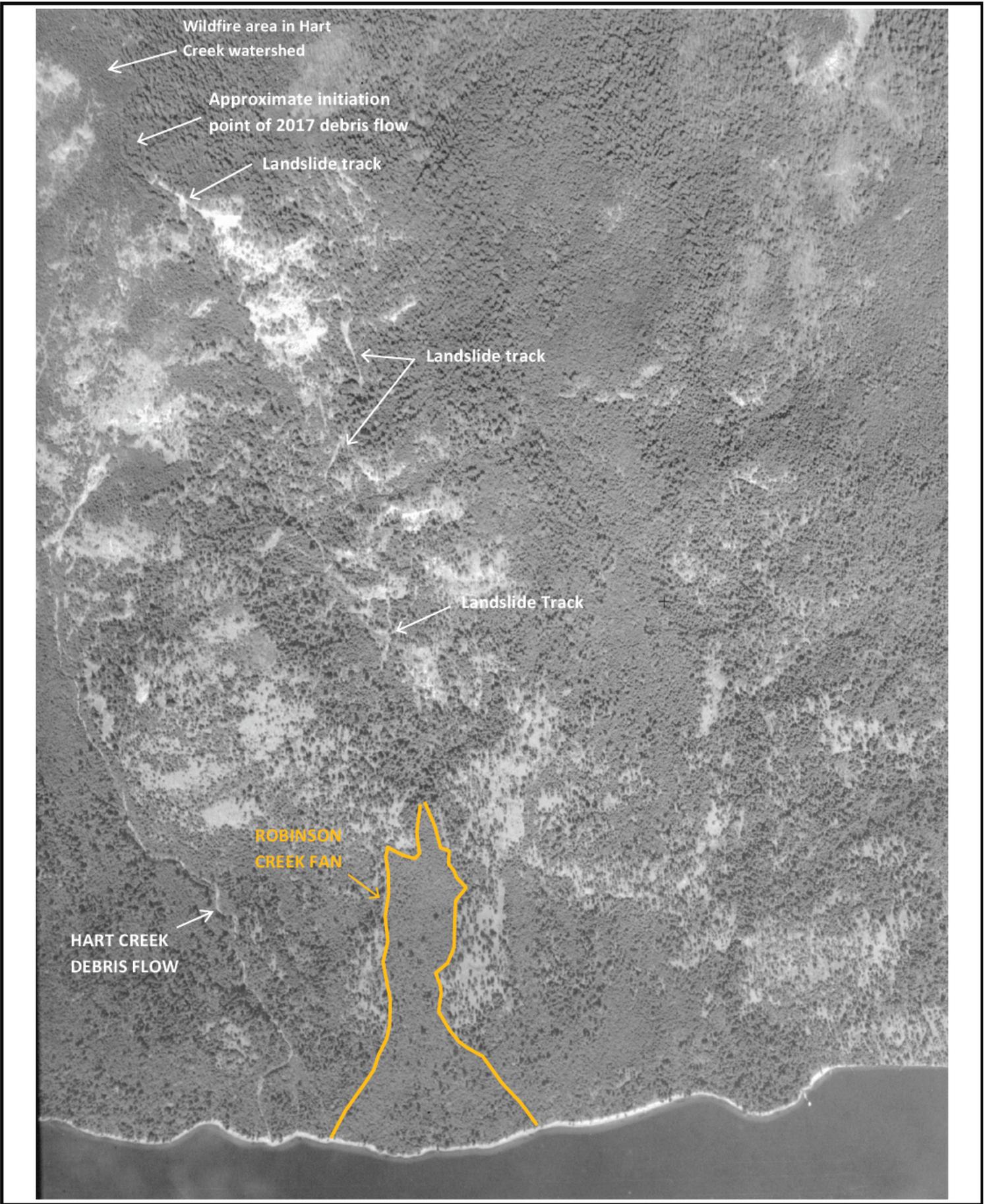
Source: Google Earth™ imagery from 2012

Scale: As noted

North is to the top

Project: 017-053

**FIGURE 2**



**1928 AIR PHOTO  
ROBINSON CREEK DEBRIS FLOW**

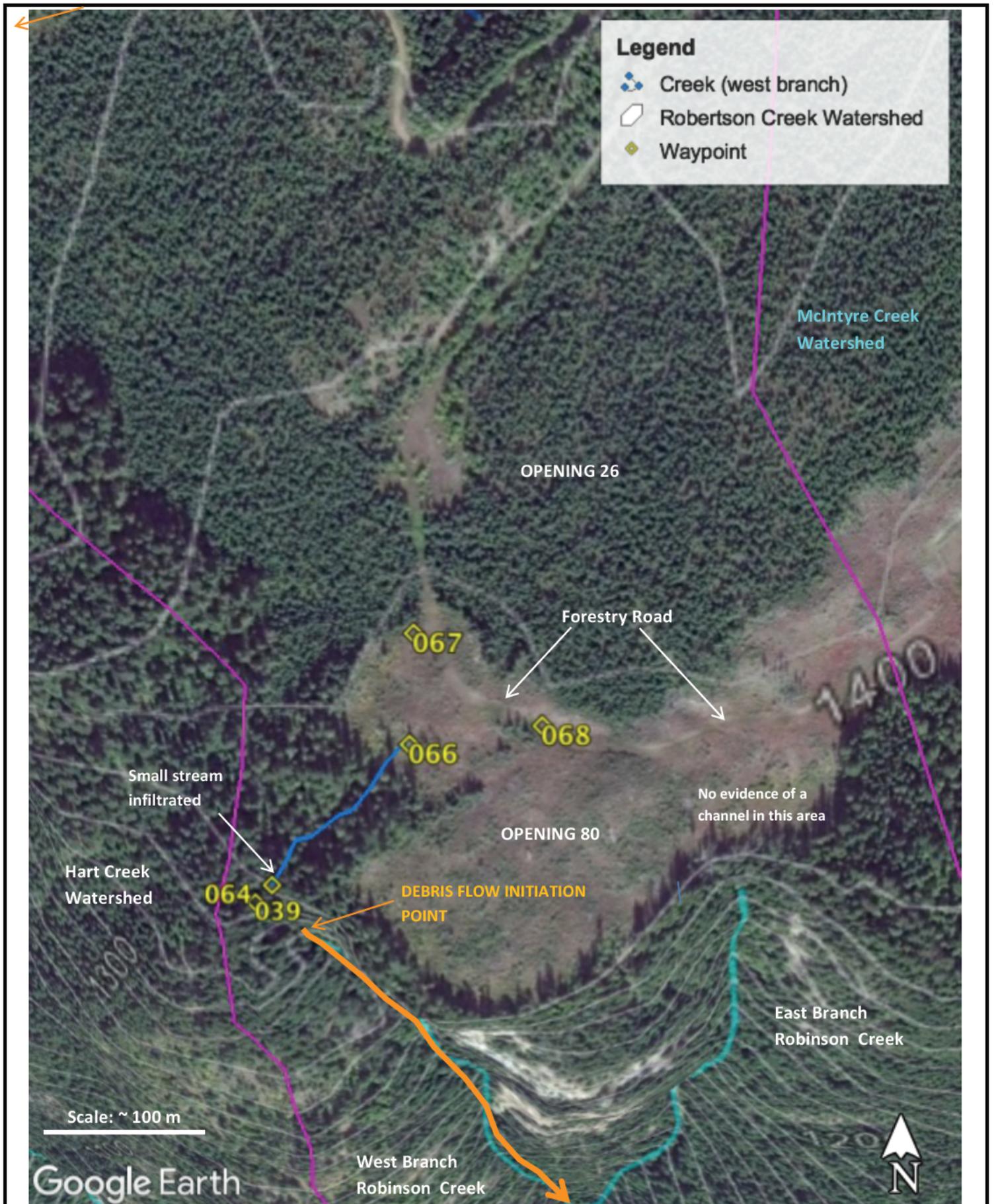
Source: National Air Photo Library, Photo A368-107

Scale: Not to scale

North is to the top

Project: 017-053

**FIGURE 3**



**SITE PLAN MAP - PLATEAU  
ROBINSON CREEK DEBRIS FLOW**

Source: Google Earth™ Image of 2012 Coverage = 20 m

Scale: As noted

North is to the top

Project: 017-053

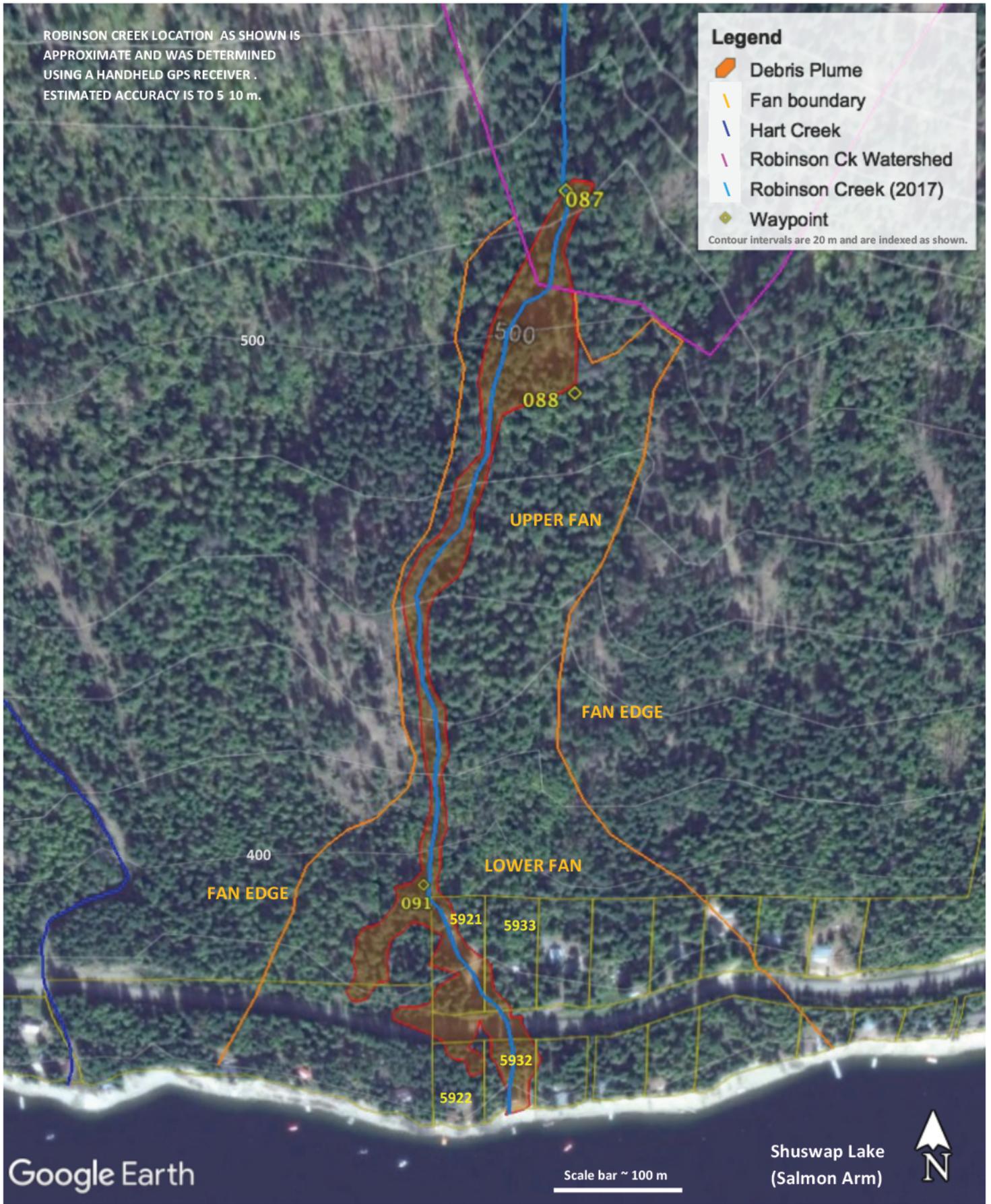
**FIGURE 4**

ROBINSON CREEK LOCATION AS SHOWN IS APPROXIMATE AND WAS DETERMINED USING A HANDHELD GPS RECEIVER. ESTIMATED ACCURACY IS TO 5-10 m.

**Legend**

-  Debris Plume
-  Fan boundary
-  Hart Creek
-  Robinson Ck Watershed
-  Robinson Creek (2017)
-  Waypoint

Contour intervals are 20 m and are indexed as shown.



Google Earth

Scale bar ~ 100 m

Shuswap Lake  
(Salmon Arm)



**SITE PLAN MAP – DEBRIS AND FAN  
ROBINSON CREEK DEBRIS FLOW**

Source: Google Earth™ Image of 2022 Contour interval = 20 m

Scale: As Noted

North is to the top

Project: 017-053

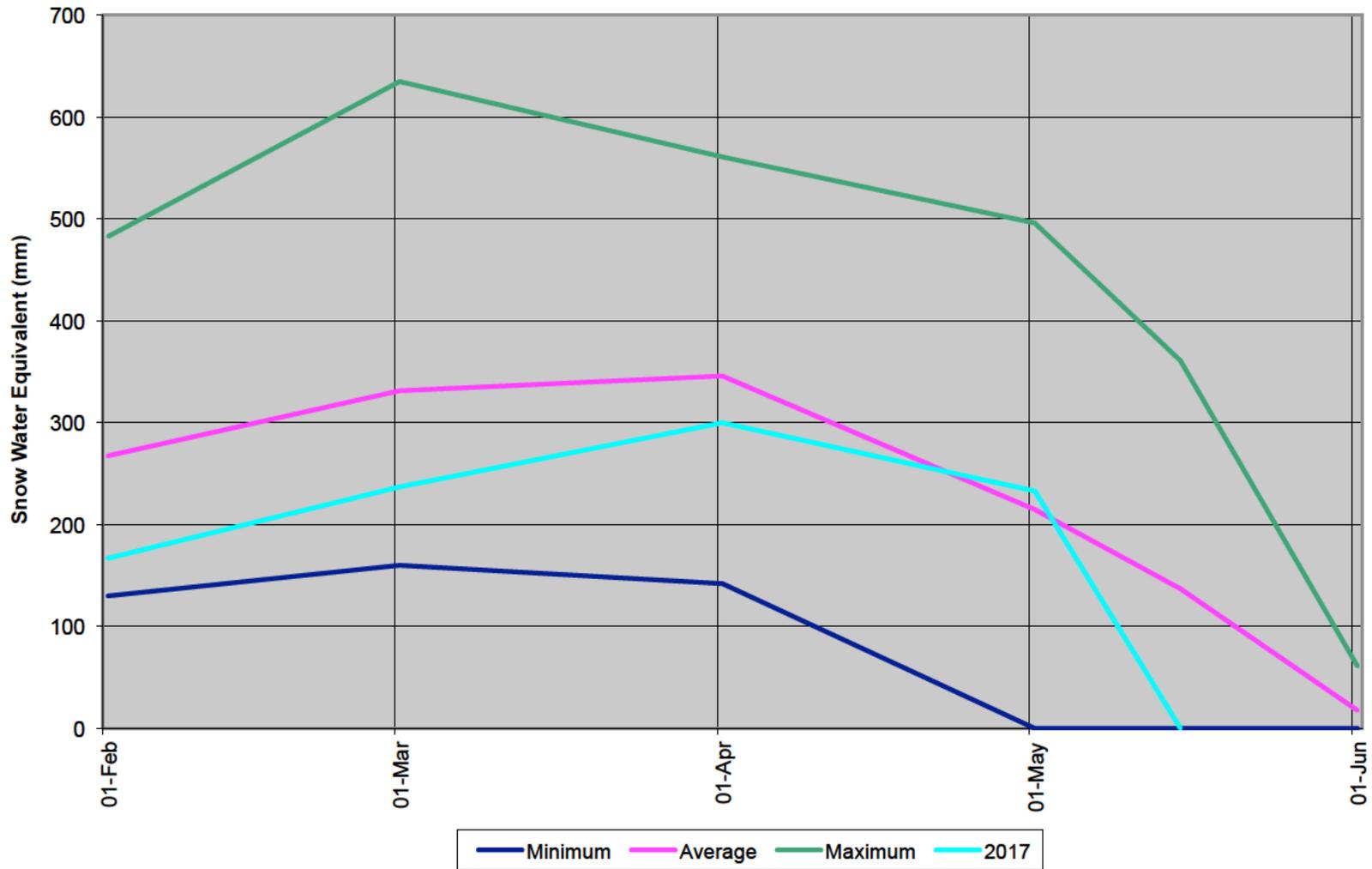
**FIGURE 5**

TAB 2

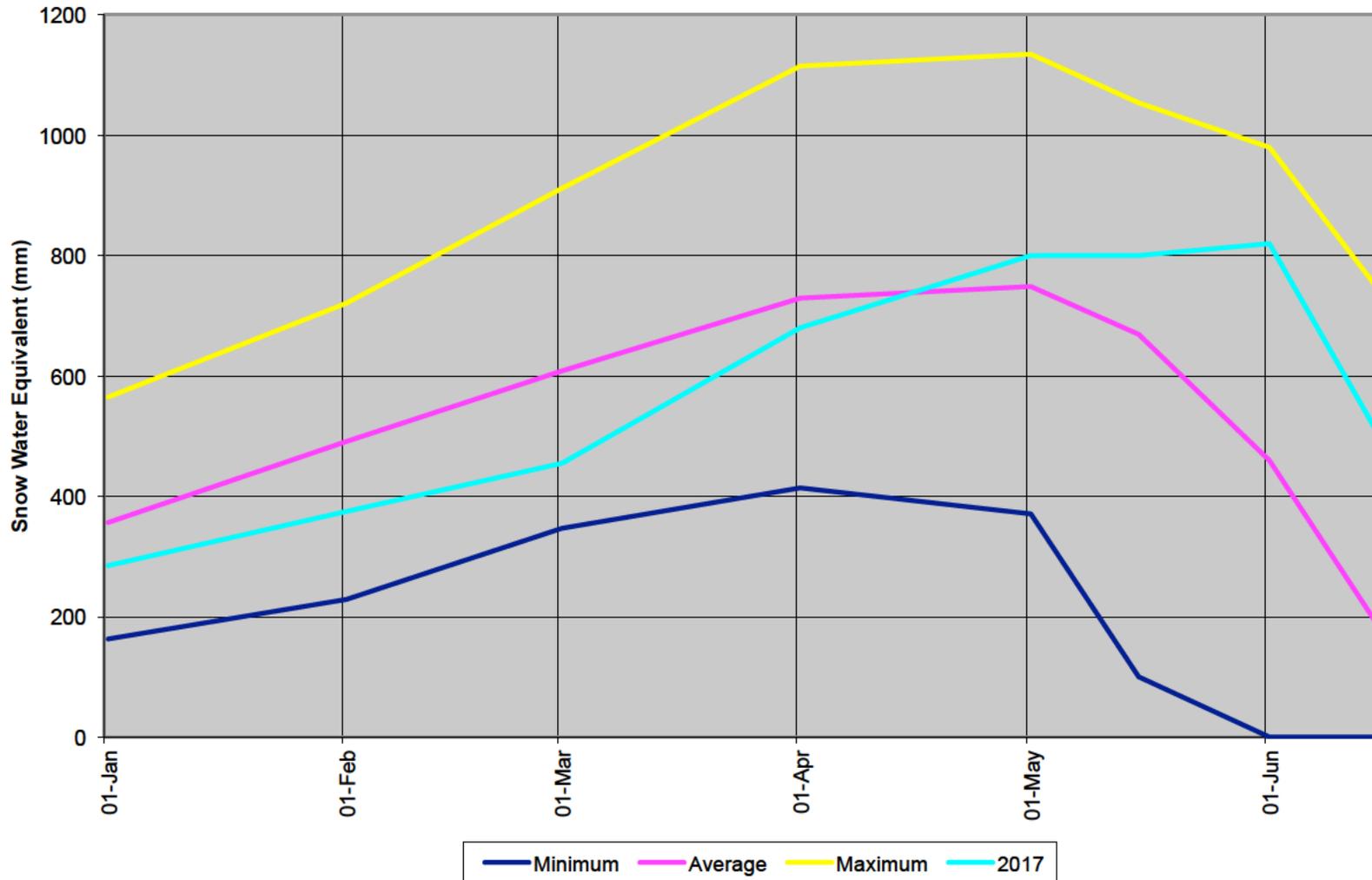
Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1166945	1911													
	1912				26.7	9.6	22.1	50.9	71.9	19.0	13.5	53.2	46.5	
	1913	80.0	22.9	13.0	13.2	31.9	69.1	46.5	19.8	44.2	46.7	33.4	19.9	440.6
	1914	91.3	36.8	25.1	22.7	24.4	36.2	19.4	8.1	41.1	30.5	64.9	29.1	429.6
	1915	54.7	11.4	24.4	48.9	89.2	64.7	65.0	12.7	18.5	33.6	29.4	76.2	528.7
	1916	21.5	57.9	39.4	19.4	27.6	48.2	72.8	25.4	8.1	4.8	39.9	57.9	422.9
	1917	92.3	39.4	39.5	60.1	27.6	43.5	1.8	32.9	35.9	35.8	27.3	92.9	529.0
	1918	165.2	46.8	11.2	9.0	15.9	37.1	20.1	71.4	5.3	64.9	52.4	45.6	544.9
	1919	52.1	58.6	43.3	21.6	27.0	16.2	17.8	12.0	39.4	38.3	79.3	71.4	477.0
	1920	61.8	11.7	44.6	41.3	28.6	70.5	9.6	45.1	66.8	71.4	61.0	73.6	586.0
	1921	79.8	56.4	20.4	21.8	27.0	44.5	9.2	21.6	32.1	35.6	85.9	37.3	471.6
	1922	60.2	54.7	50.4	29.3	18.1	1.5	7.5	38.6	52.0	67.3	15.2	81.4	476.2
	1923	77.3	28.3	29.4	20.3	55.9	127.6	19.4	32.8	19.8	25.3	40.6	85.7	562.4
	1924	73.7	24.8	6.6	7.2	7.2	28.0	21.6	54.5	41.3	29.5	53.9	92.5	440.8
	1925	112.1	53.9	15.5	12.4	16.8	23.3	9.4	27.9	10.5	21.8	16.6	77.7	397.9
	1926	82.2	23.5	5.6	10.1	28.9	14.7	1.5	19.4	25.2	22.5	42.9	67.8	344.3
	1927	51.6	35.8	14.0	12.0	53.2	24.9	36.1	68.9	56.4	42.8	78.7	61.5	535.9
	1928	19.1	11.4	44.8	35.1	19.0	54.5	8.6	6.6	1.3	19.4	66.5	27.2	313.5
	1929	30.5	2.6	23.3	47.2	24.5	82.2	14.5	34.1	32.4	39.1	21.8	63.3	415.5
	1930	38.2	60.1	23.2	29.3	51.6	37.1	5.9	17.8	22.9	72.9	51.2	20.0	430.2
	1931	51.2	20.5	30.2	22.3	19.2	73.7	7.4	10.6	46.7	47.1	52.7	70.0	451.6
	1932	48.8	36.8	62.9	53.6	31.7	33.6	25.8	29.5	20.0	57.3	83.9	54.7	538.6
	1933	42.0	33.1	59.6	7.3	38.8	33.6	24.4	15.7	52.6	101.5	37.1	77.7	523.4
	1934	45.1	6.6	57.1	11.9	28.6	13.0	28.3	11.4	88.3	35.6	74.1	77.8	477.8
	1935	95.3	28.7	34.0	19.6	34.3	43.4	108.9	12.6	25.6	47.2	37.4	48.0	535.0
	1936	111.1	69.4	59.4	52.0	25.5	57.8	12.7	23.1	49.5	15.0	17.0	101.2	593.7
	1937	63.2	97.0	19.8	72.0	29.7	62.0	39.4	29.4	12.3	24.1	113.5	70.4	632.8
	1938	44.3	58.3	19.7	10.8	13.9	43.9	36.9	26.8	37.9	32.1	46.8	114.3	485.7
	1939	75.4	39.2	24.5	4.2	42.2	87.2	12.3	5.8	25.7	46.6	22.1	103.5	488.7
	1940	53.5	74.5	113.2	18.9	55.1	14.8	30.2	10.7	13.5	56.6	43.7	59.8	544.5
	1941	37.8	49.6	10.8	12.9	71.9	85.2	46.1	31.9	90.2	31.8	43.9	48.1	560.2
	1942	12.0	10.9	8.2	25.9	78.3	48.4	123.0	29.1	22.3	42.5	11.5	25.0	437.1
	1943	27.6	11.2	16.6	21.0	27.6	49.4	28.3	22.6	8.8	69.9	19.9	57.0	359.9
	1944	40.1	58.0	27.0	38.2	33.9	27.3	25.4	49.9	64.2	35.2	72.4	33.3	504.9
	1945	93.5	42.8	28.4	36.1	15.2	33.4	39.2	26.0	49.0	84.6	79.5	68.8	596.5
	1946	114.2	51.5	21.4	31.4	34.9	67.5	11.5	32.5	36.4	44.2	76.8	57.7	580.0
	1947	60.1	37.5	30.8	31.5	33.0	70.7	49.4	31.2	20.8	96.5	53.6	61.3	576.4
	1948	27.9	72.6	32.2	72.6	99.2	19.7	61.2	68.8	38.4	32.0	68.3	54.6	647.5
	1949	22.1	87.6	26.7	18.1	46.4	49.8	39.5	32.7	17.3	48.2	27.5	92.1	508.0
	1950	42.0	43.9	39.4	37.2	32.1	16.0	37.4	17.1	9.9	78.2	63.1	78.4	494.7
	1951	73.2	75.5	56.9	15.7	21.0	9.2	36.8	31.8	32.2	96.5	45.8	116.0	610.6
	1952	62.3	24.6	15.5	22.7	20.5	59.6	17.1	4.3	8.4	7.3	9.9	106.2	358.4
	1953	42.9	45.2	29.8	46.5	16.5	112.2	24.6	87.6	19.2	33.1	54.3	67.4	579.3
	1954	93.5	28.6	41.6	28.0	70.7	44.5	49.5	86.9	21.2	16.4	107.6	46.4	634.9
	1955	49.5	37.0	27.5	11.4	35.7	41.0	56.0	11.2	23.6	57.2	75.0	82.8	507.9
1956	77.8	23.1	33.9	9.3	13.1	67.2	31.5	48.8	29.3	58.2	65.0	94.6	551.8	
1957	58.8	26.4	57.3	25.7	41.5	96.1	25.8	82.8	10.2	34.1	36.0	40.7	535.4	
1958	90.7	86.2	37.8	52.2	28.5	46.2	15.7	20.9	64.5	38.1	64.0	64.0	608.8	
1959	64.7	40.7	20.5	13.8	45.1	64.3	25.6	57.4	128.0	63.1	43.2	22.3	588.7	
1960	64.5	52.3	17.3	28.9	73.3	35.2	3.3	73.0	31.0	34.9	42.1	52.7	508.5	
1961	23.2	59.4	36.7	35.1	46.3	44.7	80.2	36.6	30.5	72.9	32.6	62.3	560.5	
1962	59.5	6.9	21.6	32.5	29.8	34.3	34.0	46.3	32.9	49.0	45.8		392.6	
1963	27.2		43.7	70.0	15.5	38.7	33.9	40.6	34.2	19.5	69.5	50.9	443.7	
1964	92.8	29.0	43.2	9.2	32.6	64.1	72.4	62.1	85.1	8.6	45.9	57.4	602.4	
1965	80.1	48.5	9.0	31.5	27.4	29.1	15.2	107.1	28.4	19.1	43.8	68.1	507.3	
1966	79.9	22.2	24.2	36.8	44.2	69.3	66.8	33.6	13.8	32.2	42.6	69.6	535.2	
1967	79.7	18.6	34.1	21.3	20.8	26.7	8.1	15.2	20.2	124.4	36.7	70.0	475.8	
1968	63.9	31.6	37.5	13.5	31.7	33.4	17.1	60.5	33.5	45.8	43.6	97.7	509.8	
1969	110.4	21.7	24.6	47.7	21.4	44.3	39.0	22.9	94.6	32.1	60.2	56.5	575.4	
1970	71.6	15.0	28.0	16.3	26.5	21.5	29.7	24.4	41.1	50.6	66.5	57.6	448.8	
1971	88.5	55.5	47.7	22.9	42.0	73.1	24.5	26.2	26.6	59.4	71.6	153.8	691.8	
1972	78.3	41.2	81.9	38.6	29.7	35.7	65.1	20.2	81.2	25.9	33.4	60.7	591.9	
1973	17.0	80.8	33.4	4.8	17.9	55.9	8.9	12.5	31.3	68.1	93.0	61.0	484.6	
1974	76.2	45.5	54.2	40.3	52.3	13.6	47.5	18.5	10.2	4.9	69.8	101.1	534.1	
1975	94.2	84.1	20.0	15.8	30.0	50.9	21.3	46.6	9.7	86.3	76.4	45.8	581.1	
1976	68.0	20.6	27.2	23.3	44.9	54.8	38.6	142.5	16.1	32.1	13.8	35.1	517.0	
1977	24.5	40.2	28.2	13.3	25.0	30.5	55.9	32.2	45.6	23.0	96.1	106.7	521.2	

Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	1978	55.6	21.0	21.3	41.7	67.3	31.1	22.9	62.6	71.8	30.5	39.3	19.5	484.6
	1979	30.1	46.6	14.5	39.9	25.8	19.2	13.2	34.4	40.8	55.8	11.2	30.6	362.1
	1980	23.8	46.8	15.8	40.0	58.8	83.6	41.7	35.6	52.4	32.6	63.2	75.0	569.3
	1981	12.8	52.6	14.4	43.7	65.8	70.6	95.0	32.8	47.2	85.8	55.0	69.3	645.0
1166R45	1982	125.6	44.2	25.0	24.8	36.4	58.8	93.8	36.5	35.9	32.4	87.7	73.0	674.2
	1983	73.1	95.3	75.2	56.2	23.3	71.9	127.2	14.0	30.6	30.5	111.0	58.3	766.6
	1984	49.7	19.0	52.4	25.9	85.1	58.1	20.3	28.3	34.3	41.2	102.0	54.0	570.3
	1985	12.0	30.0	12.4	30.2	51.3	41.5	22.8	41.0	67.5	86.3	32.2	49.6	476.8
	1986	43.5	46.4	48.2	60.9	47.9	87.6	69.1	3.8	79.4	21.4	54.6	54.0	616.8
	1987	44.6	29.0	37.6	36.3	26.6	17.9	58.4	34.4	22.2	12.2	52.8	78.1	450.1
	1988	17.0	48.5	40.6	80.8	53.3	87.1	48.5	48.1	87.8	49.2	94.9	51.0	706.8
	1989	43.0	34.0	51.3	28.5	98.7	56.6	50.4	75.9	50.8	46.4	55.4	64.4	655.4
	1990	87.5	27.5	32.2	21.4	73.2	122.4	48.6	82.4	3.8	72.4	85.8	90.4	747.6
	1991	52.0	34.8	25.6	43.4	52.8	43.8	29.8	72.6	13.4	23.6	96.0	15.4	503.2
	1992	115.0	27.6	25.4	43.5	23.8	47.0	49.0	13.8	65.0	47.4	122.8	138.0	718.3
	1993	95.0	6.0	47.4	70.6	51.2	60.6	57.2	30.8	15.4	54.0	55.6	65.6	609.5
	1994	62.3	40.5	32.9	30.5	38.4	49.5	36.6	69.8	21.6	66.0	80.0	72.2	600.3
	1995	96.8	33.8	58.2	48.9	20.0	63.2	33.0	63.2	36.7	84.0	124.1	65.7	727.6
	1996	57.6	51.0	37.6	55.8	119.6	32.6	34.6	31.0	114.2	118.2	156.2	148.2	956.6
	1997	81.0	50.0	51.6	47.0	71.1	69.8	150.0	21.2	97.2	75.2	47.8	58.8	820.7
	1998	95.2	32.4	47.8	36.8	11.6	51.0	7.6	7.2	22.4	61.8	101.0	114.8	589.6
1999	63.2	40.5	50.2	34.6	71.9	99.4	58.2	60.0	37.0	59.8	87.6	90.7	753.1	
2000	86.0	39.0	89.6	36.8	77.4	61.0	51.3	29.5	24.1	50.2	26.4	89.0	660.3	
2001	42.0	19.0	29.5	39.0	67.2	80.1	61.0	34.9	18.7	83.0	57.3	145.5	677.2	
2002	60.0	37.0	25.0	41.7	87.5	52.2	11.2	9.5	19.6	16.6	46.4	58.6	465.3	
2003	85.3	8.7	42.3	58.0	51.4	83.3	5.9	5.2	41.6	62.8	49.0	54.0	547.5	
2004	87.0	13.0	15.5	28.9	81.3	68.2	21.0	70.5	51.3	40.2	58.0	68.3	603.2	
2005	63.7	39.6	20.6	31.2	54.3	101.9	19.0	25.7	38.9	102.2	55.4	29.2	581.7	
2006	63.5	30.0	22.6	47.0	55.2	54.0	18.3	14.7	37.0	18.5	126.6	74.3	561.7	
116FRMN	2007	63.7	39.5	41.2	13.2	19.4	94.6	25.4	59.4	49.0	74.0	58.8	68.1	606.3
	2008	63.7	39.5	22.8	15.8	59.2	28.8	15.6	33.8	12.4	51.6	58.8	68.1	470.1
	2009	63.7	39.5	15.6	16.0	33.0	10.6	20.4	36.5	37.8	48.0	58.8	68.1	447.9
	2010	63.7	39.5	33.7	31.5	46.2	50.6	29.2	28.0	67.0	25.4	15.6	68.1	498.5
	2011	63.7	39.5	33.7	34.2	54.2	57.8	52.0	13.4	15.4	35.2	22.2	19.2	440.5
	2012	27.5	33.6	36.1	33.0	23.3	94.4	30.0	14.0	2.8	44.0	59.3	71.7	469.7
	2013	27.5	8.7	31.1	36.6	50.8	95.3	0.7	21.4	38.2	3.5	55.1	45.2	414.1
	2014	35.4	25.5	47.8	35.7	40.0	31.5	50.9	35.5	42.3	50.3	62.8	69.7	527.4
	2015	86.6	41.1	23.9	9.3	21.8	85.5	27.6	13.4	35.5	30.2	47.7	90.7	513.3
	2016	124.4	47.0	41.1	7.7	35.4	32.0	35.1	15.5	44.8	85.3	59.6	41.9	569.8
	2017	18.3	43.2	68.1	74.2	76.3	12.4							
	Maximum	165.2	97.0	113.2	80.8	119.6	127.6	150.0	142.5	128.0	124.4	156.2	153.8	956.6
	Average	63.1	39.1	34.2	31.5	41.4	51.8	36.3	35.7	37.4	47.1	57.9	67.3	539.9
	Minimum	12.0	2.6	5.6	4.2	7.2	1.5	0.7	3.8	1.3	3.5	9.9	15.4	292.5

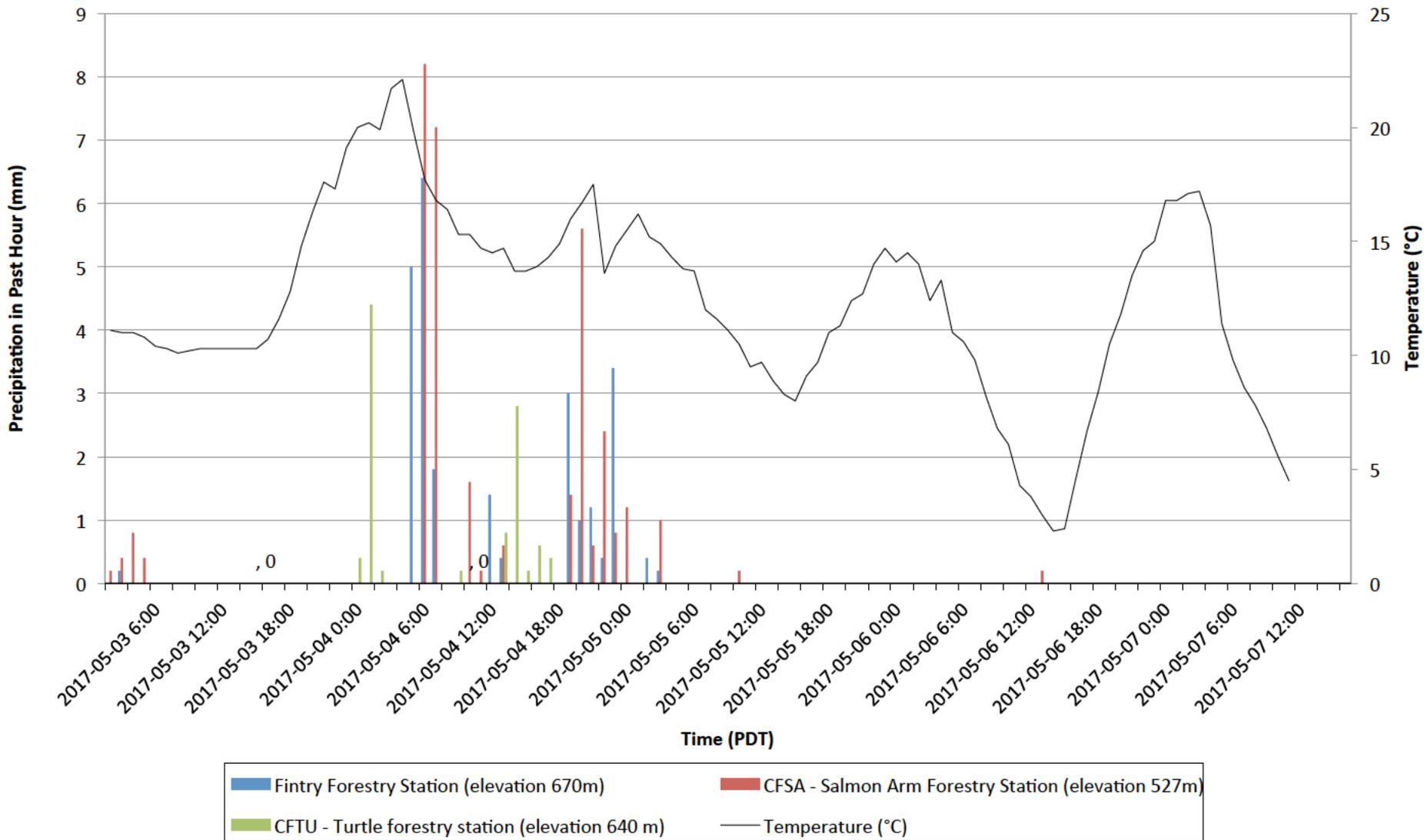
Anglemont (Sta 1F02)  
Snow Water Equivalent (1956 to 2017)



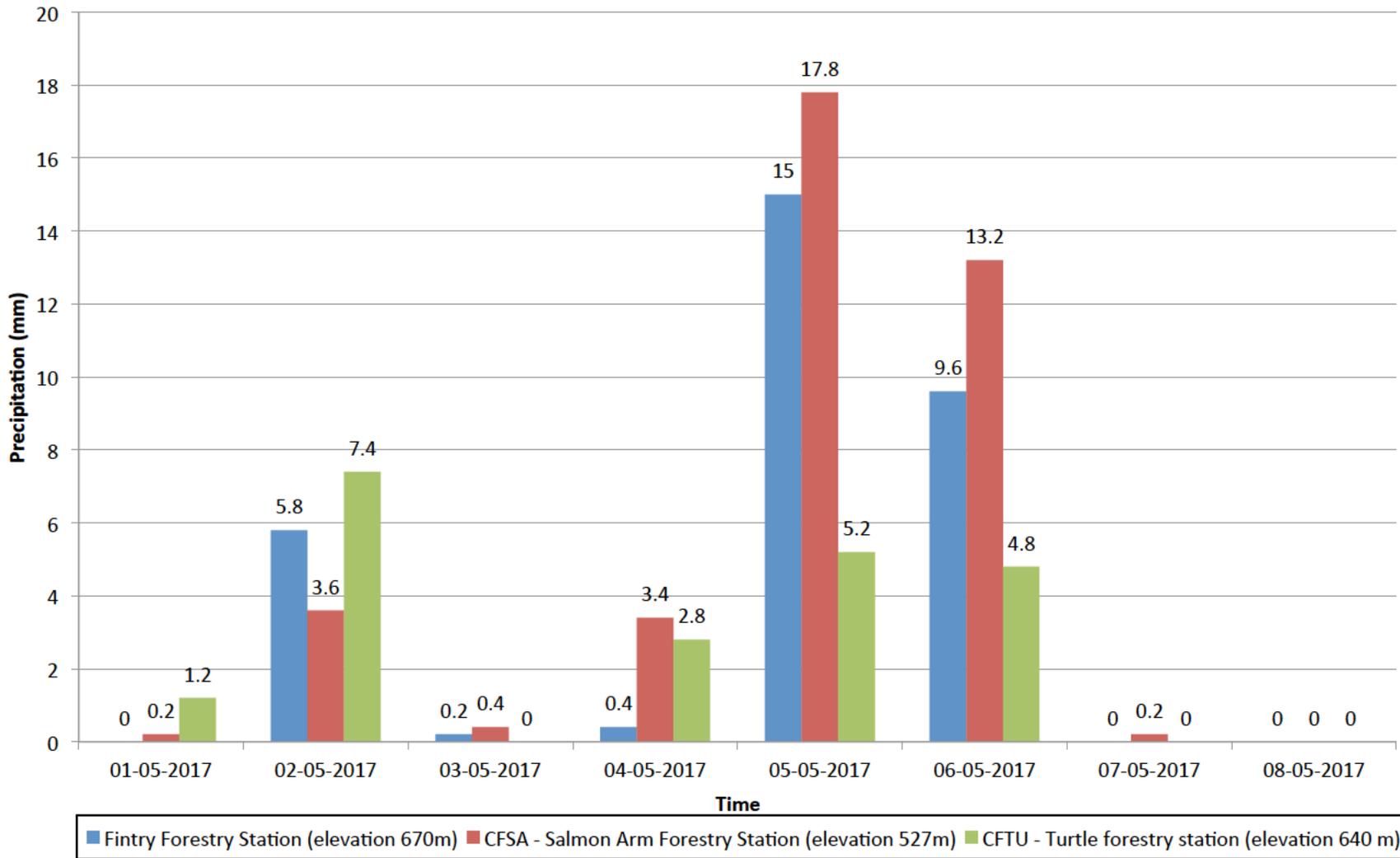
Silverstar (Sta 2F10)  
Snow Water Equivalent (1959 to 2017)



## Hourly Precipitation and Temperature - May 5-6, 2017



# Daily Precipitation





Government of Canada

Gouvernement du Canada

[Home](#) → [Environment and natural resources](#) → [Weather, Climate and Hazard](#) → [Past weather and climate](#) → [Historical Data](#)

## Daily Data Report for May 2017

### SALMON ARM CS BRITISH COLUMBIA

<b>Latitude:</b>	50°42'10.800" N	<b>Longitude:</b>	119°17'26.440" W	<b>Elevation:</b>	350.50 m
<b>Climate ID:</b>	116FRMN	<b>WMO ID:</b>	71218	<b>TC ID:</b>	WSL

DAY	Max Temp °C 	Min Temp °C 	Mean Temp °C 	Heat Deg Days 	Cool Deg Days 	Total Rain mm 	Total Snow cm 	Total Precip mm 	Snow on Grnd cm 	Dir of Max Gust 10's deg	Spd of Max Gust km/h 
<u>01</u> †	13.3	2.2	7.8	10.2	0.0	<u>M</u>	<u>M</u>	0.0		34	32
<u>02</u> †	16.8	2.7	9.8	8.2	0.0	<u>M</u>	<u>M</u>	0.0			<31
<u>03</u> †	11.3	7.7	9.5	8.5	0.0	<u>M</u>	<u>M</u>	9.9			<31
<u>04</u> †	23.6	10.1	16.9	1.1	0.0	<u>M</u>	<u>M</u>	0.0			<31
<u>05</u> †	18.0	11.2	14.6	3.4	0.0	<u>M</u>	<u>M</u>	22.8			<31
<u>06</u> †	15.6	7.9	11.8	6.2	0.0	<u>M</u>	<u>M</u>	0.0		18	35
<u>07</u> †	17.5	1.8	9.7	8.3	0.0	<u>M</u>	<u>M</u>	0.0			<31
<u>08</u> †	13.1	2.2	7.7	10.3	0.0	<u>M</u>	<u>M</u>	0.2			<31
<u>09</u> †	19.2	5.0	12.1	5.9	0.0	<u>M</u>	<u>M</u>	0.0			<31
<u>10</u> †	23.1	9.8	16.5	1.5	0.0	<u>M</u>	<u>M</u>	0.0			<31
<u>11</u> †	16.8	7.9	12.4	5.6	0.0	<u>M</u>	<u>M</u>	11.3			<31
<u>12</u> †	15.2	7.1	11.2	6.8	0.0	<u>M</u>	<u>M</u>	3.1			<31
<u>13</u> †	16.5	3.2	9.9	8.1	0.0	<u>M</u>	<u>M</u>	0.0			<31

<u>14</u> †	14.7	6.6	10.7	7.3	0.0	<u>M</u>	<u>M</u>	0.0		<31
<u>15</u> †	13.8	2.9	8.4	9.6	0.0	<u>M</u>	<u>M</u>	9.9	36	46
<u>16</u> †	13.5	7.0	10.3	7.7	0.0	<u>M</u>	<u>M</u>	6.6		<31
<u>17</u> †	20.1	4.0	12.1	5.9	0.0	<u>M</u>	<u>M</u>	0.2		<31
<u>18</u> †	19.1	8.5	13.8	4.2	0.0	<u>M</u>	<u>M</u>	0.4		<31
<u>19</u> †	21.7	5.4	13.6	4.4	0.0	<u>M</u>	<u>M</u>	0.0		<31
<u>20</u> †	26.2	8.2	17.2	0.8	0.0	<u>M</u>	<u>M</u>	0.0		<31
<u>21</u> †	28.2	7.3	17.8	0.2	0.0	<u>M</u>	<u>M</u>	0.0		<31
<u>22</u> †	27.5	9.1	18.3	0.0	0.3	<u>M</u>	<u>M</u>	0.0		<31
<u>23</u> †	30.7	11.1	20.9	0.0	2.9	<u>M</u>	<u>M</u>	0.0	1	80
<u>24</u> †	15.1	7.5	11.3	6.7	0.0	<u>M</u>	<u>M</u>	0.0	31	54
<u>25</u> †	23.4	5.9	14.7	3.3	0.0	<u>M</u>	<u>M</u>	0.0		<31
<u>26</u> †	24.7	5.8	15.3	2.7	0.0	<u>M</u>	<u>M</u>	0.0		<31
<u>27</u> †	27.6	8.0	17.8	0.2	0.0	<u>M</u>	<u>M</u>	0.0		<31
<u>28</u> †	28.9	9.2	19.1	0.0	1.1	<u>M</u>	<u>M</u>	0.2		<31
<u>29</u> †	29.3	10.7	20.0	0.0	2.0	<u>M</u>	<u>M</u>	0.0		<31
<u>30</u> †	29.6	12.3	21.0	0.0	3.0	<u>M</u>	<u>M</u>	0.0	34	35
<u>31</u> †	24.3	14.8	19.6	0.0	1.6	<u>M</u>	<u>M</u>	11.7		<31
<b>Sum</b>				137.1	10.9	<u>M</u>	<u>M</u>	76.3		
<b>Avg</b>	20.6	7.2	13.9							
<b>Xtrm</b>	30.7	1.8							1	80

Summary, average and extreme values are based on the data above.

### Legend

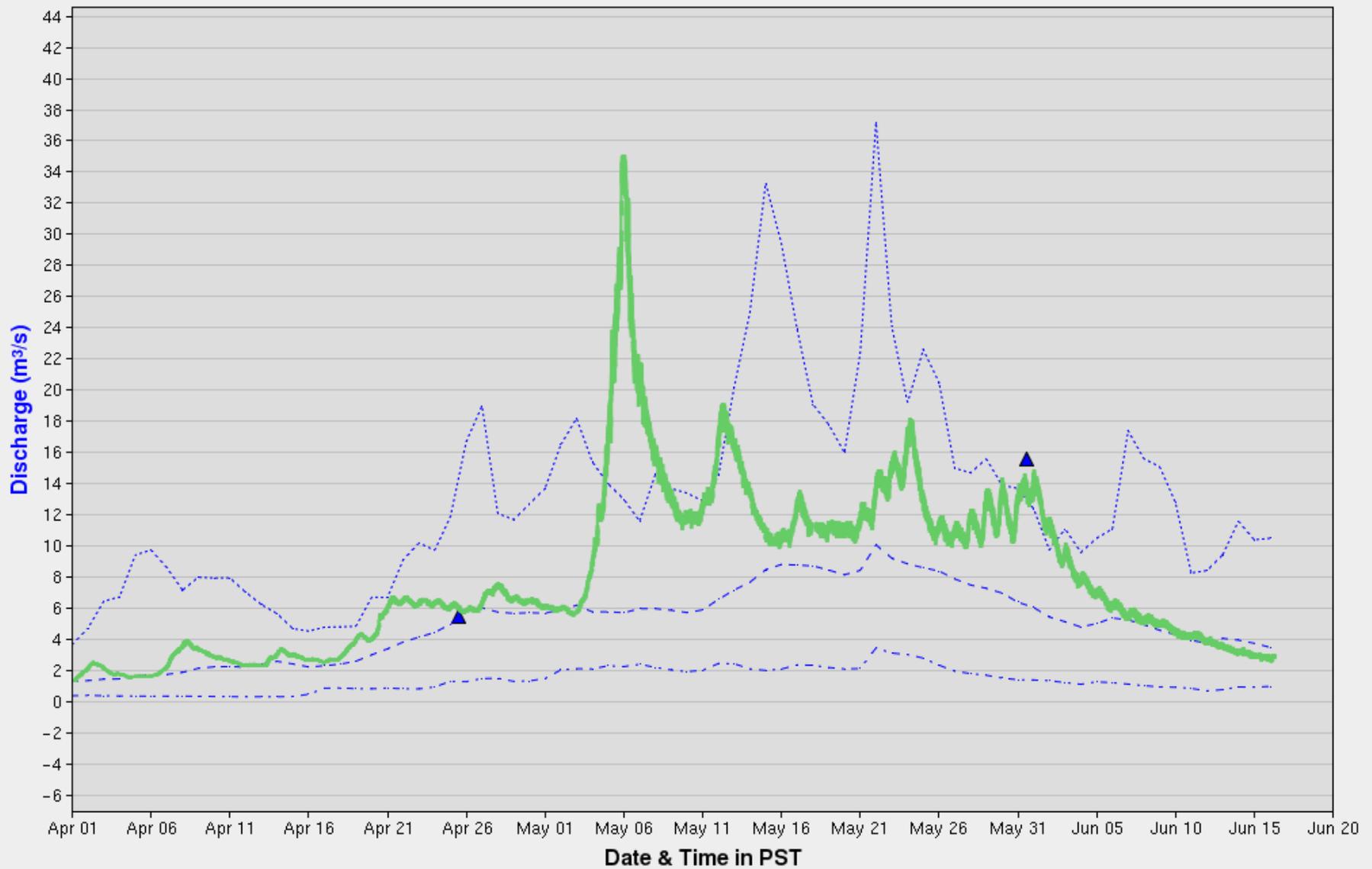
- A = Accumulated
- C = Precipitation occurred, amount uncertain
- S = More than one occurrence
- T = Trace
- Y = Temperature missing but known to be

- E = Estimated
- F = Accumulated and estimated
- L = Precipitation may or may not have occurred
- M = Missing
- N = Temperature missing but known to be > 0
- < 0
- [empty] = No data available
- ^ = The value displayed is based on incomplete data
- † = Data for this day has undergone only basic quality checking
- ‡ = Partner data that is not subject to review by the National Climate Archives

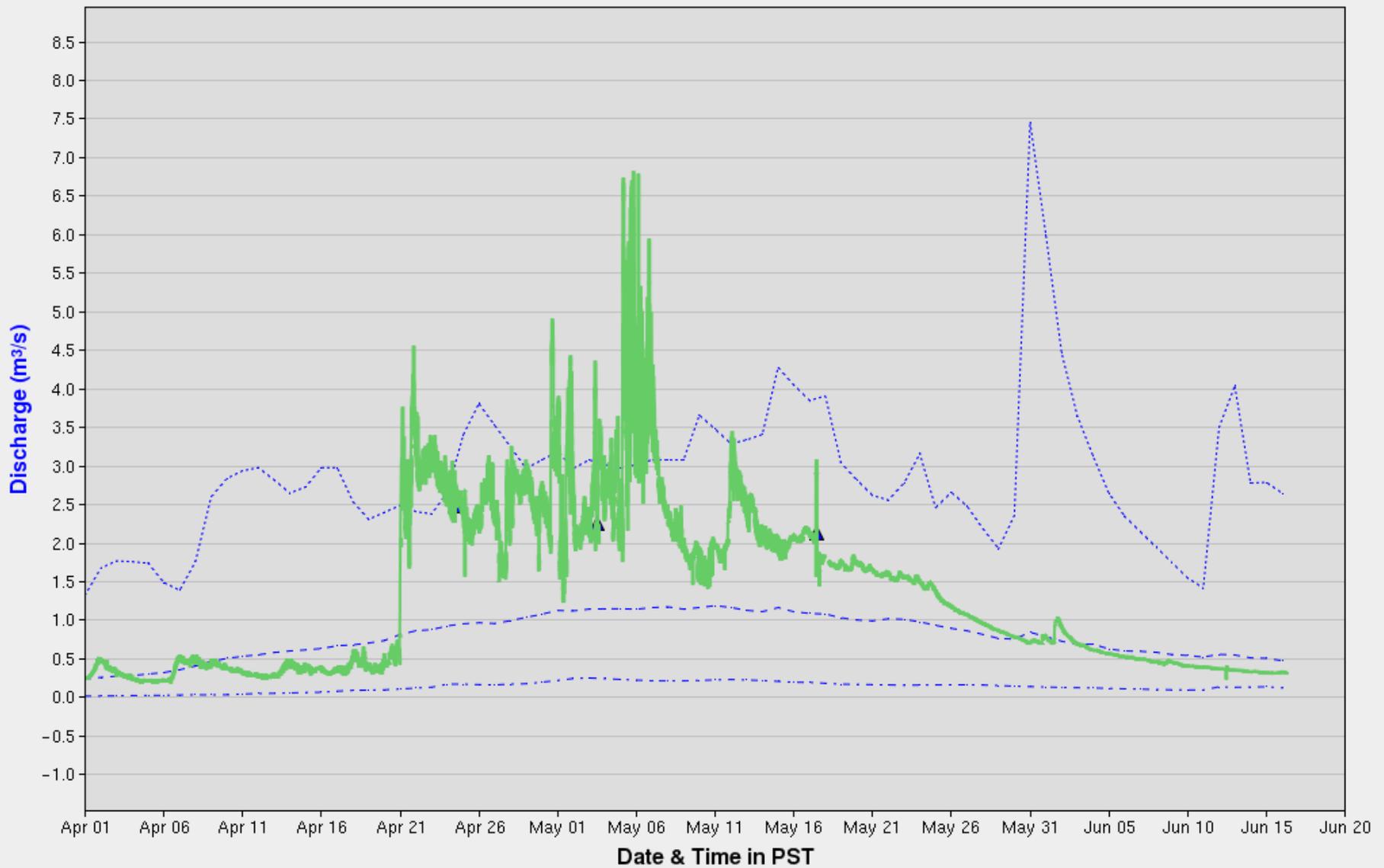
**Date modified:**

2016-08-09

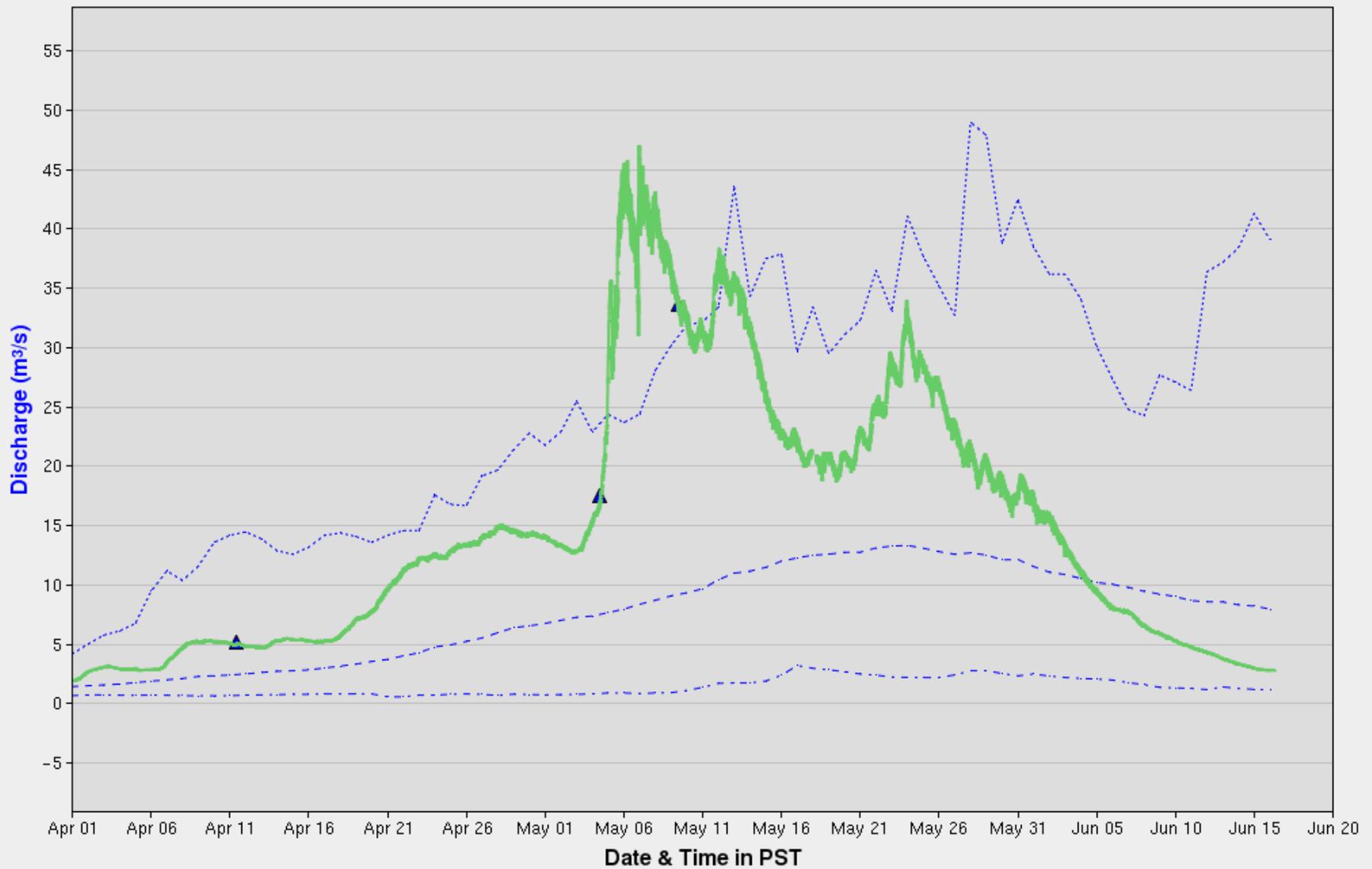
— Discharge Approved (100% Quality Controlled)    — Discharge Provisional (subject to change)    - - - Maximum (Discharge)    - - - Minimum (Discharge)  
- - - Mean (Discharge)    ▲ Discharge Measurements



— Discharge Approved (100% Quality Controlled)    — Discharge Provisional (subject to change)    ····· Maximum (Discharge)    - - - Minimum (Discharge)  
- - - Mean (Discharge)    ▲ Discharge Measurements



— Discharge Approved (100% Quality Controlled)    — Discharge Provisional (subject to change)    - - - Maximum (Discharge)    - - - Minimum (Discharge)  
- - - Mean (Discharge)    ▲ Discharge Measurements



TAB 3

**ROBINSON CREEK DEBRIS FLOW**



*Photo 1 – View north of the Robinson Creek drainage on the morning of May 6, 2017, showing the extreme relief and the key features.*

**SITE PHOTOGRAPHS**



*Photo 2 – View northwest into the bedrock crevice / draw showing the debris flow initiation point (orange arrow), taken May 6, 2017.*



*Photo 3 – View of the steep gully channel in the upper part of the west branch of Robinson Creek, taken May 6, 2017.*



*Photo 4 – View downstream (south) of the upper part of the logjam and debris deposit, just downstream of the fan apex. This deposit may have deflected the debris away from the east side of the fan.*



*Photo 5 – View downstream of the residence on 5921 Sunnybrae – Canoe Point Road that was destroyed on May 6, 2017. The debris flow bifurcated as shown and a small lobe of debris travelled through the trees to the right.*



*Photo 6 – View southwest of the debris that covered the Sunnybrae – Canoe Point Road. The impacted residence at 5932 Sunnybrae – Canoe Point Road is visible below the road.*

**ROBINSON CREEK DEBRIS FLOW**

**SITE PHOTOGRAPHS**



*Photo 7 – View northeast over the two logging blocks on the plateau. This photo was taken on May 15 after a lot of the snow had melted in the opening. The initiation point is noted.*



*Photo 8 – Typical view of the forestry road in Opening 80, taken May 15, 2017.*



*Photo 9 – View up to the scarp taken on May 15, 2017. Note the bedrock present on the right side of the photo, which extends up a high cliff to the plateau edge. A stream emerges from the rubble below the person. Tension cracks were observed to the left behind the tree (Photo 11).*



*Photo 10 – View downstream from the scarp showing the transition between the initiation zone and the debris flow translation zone in the very steep gully below. Sidewall slope failures are visible in the right side of the photo. The photo was taken on May 6, 2017.*



*Photo 11 – This photo shows tension cracks that had formed in the colluvium on the right bank near the scarp. Photo was taken on May 15, 2017.*



*Photo 12 – View of the coarse angular fragments in the gully channel, in the lower part of the initiation zone. The gradation on the shovel is 10 cm. A spring was emerging from the coarse sediment. Photo was taken on May 15, 2017.*

## ROBINSON CREEK DEBRIS FLOW



**Photo 13** – View upstream at the large accumulation of debris arrested by the large log jam at Wpt 088 (see also Photo 4). The debris deposit was about 60 m wide at this location. Photo was taken on May 29, 2017.



**Photo 14** – View downstream at the large accumulation of debris arrested by the large log jam at Wpt 088 (see Photo 4). This caused the creek to turn to the west. Photo taken on May 29, 2017.



**Photo 15** – View downstream of the typical creek channel eroded into the new debris and possibly old fan deposit. Location is in the upper part of the fan. Note the over-steep sidewalls. Photo taken on May 29, 2017.



**Photo 16** – View upstream showing the typical debris deposit and levees in the lower part of the fan. The photo was taken on May 6, 2017.



**Photo 17** – View east of a deposit of debris along the west margin in the lower part of the fan near Wpt 091. The shovel reference is about 1.3 m high. Photo was taken on May 6, 2017.



**Photo 18** – View of the typical debris flow deposit in the minor southwest lobe below Wpt 091. Photo was taken on May 6, 2017.

## SITE PHOTOGRAPHS

## ROBINSON CREEK DEBRIS FLOW



*Photo 19 – View downstream from the upper part of the 5921 Sunnybrae – Canoe Point Road property near Wpt 091, showing the approximate original location of the residence and the destroyed structure. A minor lobe of debris travelled to the southwest as indicated by the orange arrow.*



*Photo 20 – View east along the public road on May 6, 2017. The debris piled to the right was present prior to the debris flow (see also Photo 24).*



*Photo 21 – View downstream of the primary residence on the 5932 Sunnybrae – Canoe Point Road, showing debris piled up against the north wall. The debris flow passed through and around the residence, and the stream (blue arrow) now flows under the structure.*



*Photo 22 – View east on the downhill side of the primary residence on the 5932 Sunnybrae – Canoe Point Road property, showing the stream flowing out from beneath the structure. The large boulders may have passed through the residence, but this is unconfirmed.*



*Photo 23 – View northeast of the ancillary residence on the 5932 Sunnybrae – Canoe Point Road. Debris passed through and may have been displaced the building. The creek now passes along the west side of the structure (foreground).*



*Photo 24 – View of the typical fan material that was piled up on the public road shoulder from a local excavation. It shows the gradation of the material. A gradation analysis on the minus 75 mm fraction of the debris deposit is attached in Tab 4.*

## SITE PHOTOGRAPHS

TAB 4

# GRAIN SIZE DISTRIBUTION



Westrek Geotechnical Services Ltd  
 101- 1285 Dalhousie Drive  
 Kamloops, BC  
 V2C 5Z5

Project No: KX13690  
 Date: May 26, 2017

Attn: Jeffrey Pisiso / Kevin Turner

Project Name: Robinson Creek Debris Flow

Test No.: 17- 054-3

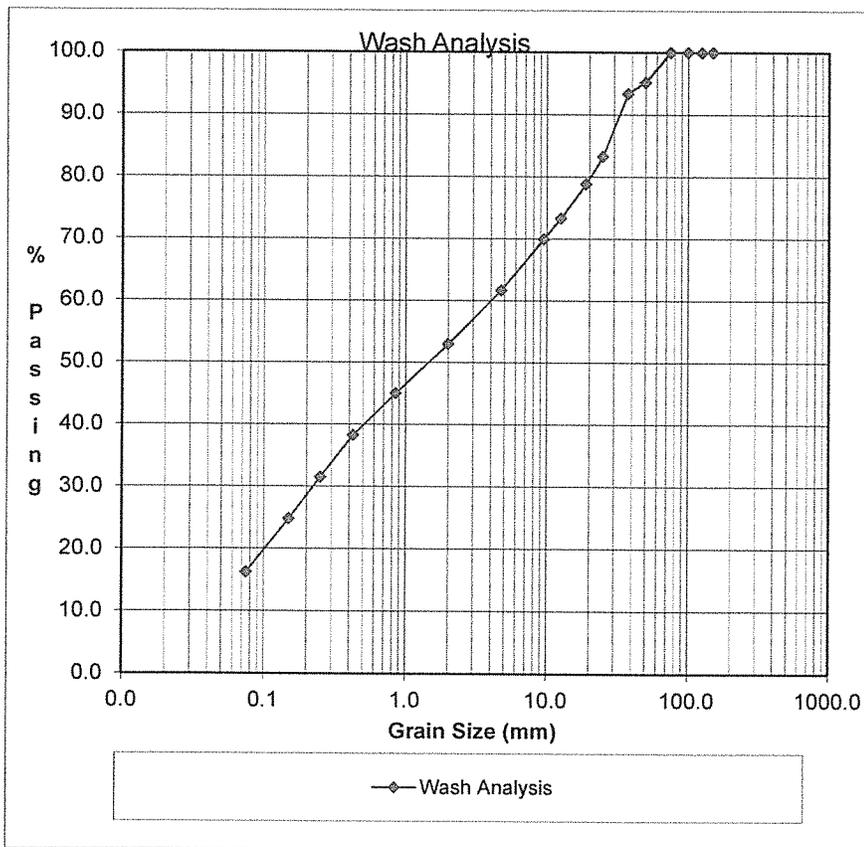
Source: Debris on road (South) @ 0.3m

Sample Type:

Date Rec'd : May 17, 2017

By: Client

Date Tested: May 25, 2017



Wash Sieve Analysis				
Sieve Size(mm)	Percent Retained	Percent Passing	Limits	
			Upper	Lower
150.0	0.0	100.0		
125.0	0.0	100.0		
100.0	0.0	100.0		
75.0	0.0	100.0		
50.0	4.8	95.2		
37.5	1.8	93.4		
25.0	10.1	83.3		
19.0	4.5	78.8		
12.5	5.6	73.3		
9.5	3.3	69.9		
4.75	8.2	61.7		
2.000	8.7	53.0		
0.850	8.0	45.0		
0.425	6.8	38.2		
0.250	6.8	31.5		
0.150	6.7	24.8		
0.075	8.6	16.2		
PAN	16.2			

Sieve Mass (g): 4710.8

Gravel	38.3 %
Sand	45.5 %
Fines	16.2 %

## COMMENTS

Amec Foster Wheeler Environment & Infrastructure

Per: B. Shearer

Reporting of these test results constitutes a testing service only.  
 Engineering interpretation or evaluation of the test results is provided only on written request.

August 10<sup>th</sup>, 2018  
CSRD  
555 Harbourfront Dr. NE,  
PO Box 978, Salmon Arm, BC  
V1E 4P1

Re: DP Submission – DP No. 725-133

Dear Sirs:

We received notification from you on 8/8/2018 of a proposed development of a waterfront parcel in Heralds Bay between Heralds Park and Paradise Point and wish to offer our comments, questions and concerns as we live, on the Lake, within 100m of the proposed development. In general we find the application devoid of many pertinent details and not in compliance with the existing CSRD regulations per the following:

- 1) It is our understanding that the applicant has proposed 14 water front lots on the approximate 1900 feet of lakefront. The applicants proposed plan would add considerable boat traffic on the Lake and more traffic congestion on our already busy Sunnybrae Canoe Point Road. This is significantly more development than the CSRD Community Plan Bylaw No. 725 accepts which “allows new water development if it is residential in nature and a maximum density of 1 unit/4.94 acres.” Per this Bylaw less than 4 lakefront properties could be built.
- 2) We understand there is a proposed park on the East end of the development. We believe that a park is unnecessary considering how close the proposed development is to Heralds Park.
- 3) Living within 100m to the proposed development, we are concerned that the proposed park will incur many parties at night by nonresidents, as it most likely would not be supervised and access controlled. It would also facilitate parking along this stretch of shore for many houseboats. This would be very disturbing for our nearby neighbours and us due to the partying and associated noise. We do not want another “beer bottle bay” close to us! Also the park could give unrestricted access for nonresident people to walk down on the beach allowing them to walk in front of the lakefront homes that is especially disconcerting at night.
- 4) What is the plan for each of the lots? Will they have their own water source and their own septic system or is there going to be a community system? Will the access to the new homes from Sunnybrae Canoe Pt. Rd, be individual or shared? Will there be a shared community dock (preferred by the CSRD) or individual docks allowed for each of the approved properties?
- 5) In light of the recent slide events along Sunnybrae Canoe Pt. Rd. will there be a requirement for a geotechnical assessment of this area?
- 6) What is the plan to clean up the bottom of the lake where the Co-op had their log boom for many years and where many logs sunk and we still believe remain on the bottom?
- 7) Is there going to be future residential development allowed above the new relocated road?

For all of the above stated concerns and the lack of definitive information we are not in favour of reconsidering the previous decision, made by the CSRD Manager of Development Services, to deny the Permit Application No. 725-133. We support the decision to deny the application based on the lack of compliance with the Community Plan Bylaw No. 725 and other reasons and concerns as stated above.

Sincerely

[REDACTED]  
[REDACTED]  
[REDACTED]

I have the following concerns about this development:

Since this land was used by a logging operation, is the soil contaminated? It may need remediation before any development is considered.

14 waterfront residential lots is too high-density for this 19-acre property. In the future, could the owners subdivide the property further?

Sunnybrae-Canoe Point Road is the only access. It is a narrow + dangerous road, already overcrowded during the summer.

This area serves as a wildlife corridor. What will the impact be on the waterfowl, loons, otters, bears, deer, + others that use this undeveloped shore?

A thorough independent study of the impact on the environment needs to be made;

How will the sewage be handled?

Is there an adequate source of water?

Will air quality be affected if each residence uses wood-burning heat?

What are the owner's plans for the remainder of the property? Will there be a high-density residential development added there later?

Submitted by

Address

**DP Submission #725-133**

To: CSRD Director of Development Services and CSRD Board of Directors  
RE: DP No. 725-133

I am a permanent resident in this area. I wish to oppose this application. I wish to support the decision of the Manager of Development Services regarding DP 723-133.

The following are some of my concerns. There are more.

\* It is very important to stay within the OCP Guidelines. These have been very carefully and thoughtfully put together to help protect this area now and in the future. This proposal goes against these guidelines and the area is zoned industrial, not residential.

\* Traffic density on Sunnybrae-Canoe Point Road is already excessive and often dangerous, especially with the milder weather which tends to bring out more people and animals, tame and wild, frequenting the road. This narrow, winding road with hills has many areas of rock cuts, narrow shoulders and at times, steep embankments sometimes with houses and the lake below adding to the danger.

The additional trucking that would support the needs of the development in question's construction needs could be very detrimental to the road structure itself while increasing the hazards to others using the road.

\*I have serious concerns about the toxicity of the soil there where logging has gone on for many years with much heavy duty equipment and fuel et al in use.

\* What about septic issues and drinking water issues?

\*What about slope stability? What role has logging impacted and will impact mud debris slides along this road? So much destruction has already occurred, including the tragic death of Roy Sharp, a much loved and respected member of our community. If logging roads feeding into the Totem Resort direction of Sunnybrae Canoe-Point Road are closed...for how long, and what about the impact from logging which may be continuing on the White Lake side of Sunnybrae? Will there be an environmental assessment made on the hillside as relates to stability of the land above this road before any new residential applications can even be considered?

\*A new park is included in this application agreement. This could easily result in excessive partying on the land and in the lake. Noise contamination extends far beyond the source disturbing this quiet neighbourhood. Damage inflicted from carelessness/thoughtlessness might well increase. Supervision of this area would be costly and police are already stretched beyond their limits. With marijuana now being legalized, we, in this area might be inflicted with that very unpleasant odour drifting over our neighbourhood as well as other associated problems including more dangerous use of the road which already is a challenge.

Thank you for your consideration of this letter expressing some of my concerns.

Regards,

[Redacted Signature]

[REDACTED]

[REDACTED]

[REDACTED]

**Email:** [REDACTED]

To whom it may concern;

**Re: DP submission 725-133**

We are concerned about the proposed development noted above for the following reasons;

1. the current zoning is for industrial use. The application is for residential use. Application has not been made to change the zoning, thereby not meeting the classification of the current zoning or for the proposed residential zoning.
2. The Official Community Plan (OCP) has recommended a maximum of 3 five acre lots on this site. This plan was recommended for the safe and reasonable use of this parcel of land. The work done to provide this report should be respected.
3. Due to the previous industrial use, has consideration been given to clean up of possible contaminants on this site that could affect land, water and fish habitat.
4. The proposed increase to fourteen units will have a significant impact on the access road. This will affect not only the current inhabitants but also the wildlife in the area.
5. The proximity of this proposed development to the Provincial park (Herald Park) will cause conflict in the use of this area due to the current high volume of visitors in the summer months at this Park.
6. The new proposed development will require the relocation of the existing road. Has a Geotech survey been undertaken to determine the stability of the land for this proposed new roadway?
7. Other smaller issues but none the less important, would be septic disposal, water use, docking and mooring issues for boats.

We would like these concerns to be considered in the evaluation of this application process as we support the Manager of Development and the OCP.

[REDACTED]

## Jennifer Sham

---

**From:** Loreen Matousek  
**Sent:** August 13, 2018 8:42 AM  
**To:** Jennifer Sham  
**Cc:** Planning Public Email address  
**Subject:** FW: DP SUBMISSION - NO. 725-133 NOTICE OF RECONSIDERATION

For you as well.

**Loreen Matousek**  
Clerical Assistant  
Development Services  
Columbia Shuswap Regional District  
T: 250.833.5930 | TF: 1.888.248.2773  
E: [lmousek@csrd.bc.ca](mailto:lmousek@csrd.bc.ca) | W: [www.csrd.bc.ca](http://www.csrd.bc.ca)



 Please consider the environment before printing this e-mail

This e-mail is CONFIDENTIAL. If you are not the intended recipient, please notify me immediately and delete this communication, attachment or any copy. Thank you.

---

**From:** [REDACTED]  
**Sent:** Saturday, August 11, 2018 10:28 AM  
**To:** Planning Public Email address <Plan@csrd.bc.ca>  
**Subject:** DP SUBMISSION - NO. 725-133 NOTICE OF RECONSIDERATION

DP SUBMISSION - NO. 725-133

Greetings,

My name is [REDACTED], and I am a property owner residing at [REDACTED] for the past 11 years.

I was very pleased to hear the first refusal of this Application, "because it is not supported in the CSR District Electoral Area C official Community Plan Bylaw #725. Now seeing the property owners have file a Notice to Reconsider, I felt it is imperative to express my views on this Development Project.

Firstly, I cannot believe the recent Purchaser's of the subject property, did not seek approval for the proposed 14 UNIT Development, from the CSR District and Ministry of Forestry & Lands, prior to I what am sure was a substantial financial investment to these Investors.

When Federated Co-op ceased operation of the "Log Boom" and listed the property for sale, it of course became a topic of many discussions with property owners beyond Herald's Park along Sunnybrae Canoe Point Road, of what will happen with this property once sold. Majority of us would have liked to see the BC Province Parks purchase it, as boundaries onto existing Provincial Park. I guess that was not in their budget.

My main concern is to the Wildlife Corridor and Riparian Area/Fish Habitat which is on or runs through the piece of land. By approving this request, it will interfere with this natural flow of nature causing habitat fragmentation, no area to facilitate the re-establishment of the wildlife population which then may be reduced or even eliminated. If they lose their habitat and the ability to move to various regions in order to survive, we and many generations to come will not be able to partake in the natural beauty, life, and activities their presence they provide to us now and many generations to come. This is clearly laid out In SECTION 6 of Bylaw 725 - RESPECTING OUR SENSITIVE ENVIROMENTS.

My next comment is clearly covered in Section 3 of Bylaw 725 -GROWING GRADUALLY AND WISELY The subject property is located in the Secondary Settlement Areas, and certainly does not adhere to 3.4.1 Policies .3 and almost borderlines as a Residential Resort located on the Waterfront ! I can only imagine 14 new buoys, and 14 new docks in that Bay, we would be kissing our wildlife goodbye. So much for the Vision Statement... “Looking forward 100 years, the vast majority of the South Shuswap will remain rural, with productive agriculture, extensive forests, rugged terrain, and natural shorelines”...I will seriously consider selling my property if this is approved, in order to reside in a quiet rural area which would have to be elsewhere.

I could go on & on, but SECTION 1 PLAN VISION & FRAMEWORK and the 9 Sustaining Principles clearly support this DP Submission No 725-133 should be refused again. I have great respect and appreciate the time, commitment and well researched data which went into our Community Plan, and feel it must be followed and upheld. In the event further consideration is given to their proposal I strongly feel a Public Hearing would be required.

Thank you for your time and will be looking forward to see the decision.

Regards



## Jennifer Sham

---

**From:** Loreen Matousek  
**Sent:** August 13, 2018 8:51 AM  
**To:** Jennifer Sham  
**Cc:** Planning Public Email address  
**Subject:** FW: DP Submission - No. 725-133

This one as well.

**Loreen Matousek**  
Clerical Assistant  
Development Services  
Columbia Shuswap Regional District  
T: 250.833.5930 | TF: 1.888.248.2773  
E: [lmatousek@csrd.bc.ca](mailto:lmatousek@csrd.bc.ca) | W: [www.csrd.bc.ca](http://www.csrd.bc.ca)



 Please consider the environment before printing this e-mail

This e-mail is CONFIDENTIAL. If you are not the intended recipient, please notify me immediately and delete this communication, attachment or any copy. Thank you.

---

**From:** [REDACTED]  
**Sent:** Sunday, August 12, 2018 9:50 PM  
**To:** Planning Public Email address <[Plan@csrd.bc.ca](mailto:Plan@csrd.bc.ca)>; [jsham@csrd.bc.ca](mailto:jsham@csrd.bc.ca)  
**Subject:** DP Submission - No. 725-133

I have property in Herald's Bay. In reading and discussing the above-noted permit application in the Herald Bay area for the old Canoe Coop lands I have some views. I am totally objecting to the change of the road thru that property. No roads can be changed unless everyone along the road get the same opportunity and that is a firm "no". Secondly, each cottage and/or house should have 150 feet x 200 feet for each lot. That would give each home a good space. 14 homes seems excessive. Good luck and I hope the situation is handled for the good of all residents in the area. Thank you for your time.

[REDACTED]

## Jennifer Sham

---

**From:** Loreen Matousek  
**Sent:** August 14, 2018 8:19 AM  
**To:** Jennifer Sham  
**Cc:** Planning Public Email address  
**Subject:** FW: Re NOTICE OF RECONSIDERATION OF DEVELOPMENT PERMIT NO. 725-133

Here is another one for you.  
I have put into CV.

**Loreen Matousek**  
Clerical Assistant  
Development Services  
**Columbia Shuswap Regional District**  
T: 250.833.5930 | TF: 1.888.248.2773  
E: [imatousek@csrd.bc.ca](mailto:imatousek@csrd.bc.ca) | W: [www.csrd.bc.ca](http://www.csrd.bc.ca)



 Please consider the environment before printing this e-mail

This e-mail is CONFIDENTIAL. If you are not the intended recipient, please notify me immediately and delete this communication, attachment or any copy. Thank you.

---

**From:** [REDACTED]  
**Sent:** Tuesday, August 14, 2018 8:14 AM  
**To:** Planning Public Email address <Plan@csrd.bc.ca>  
**Subject:** Re NOTICE OF RECONSIDERATION OF DEVELOPMENT PERMIT NO. 725-133

We as property owners at [REDACTED] are opposed to the reconsideration of this plan because of the following points:

1. The property is zoned industrial.
2. The development does not fit in with the quiet beauty of the area.
3. The development will result in increased traffic on an already busy windy rural road.
4. The development will result in increased boat traffic pollution on the lake.
5. The site has toxic contaminants from when it was used as a booming ground.
6. The development will interfere with an existing wildlife corridor.
7. The site does not provide enough room to create a proper riparian zone set back.

Regards

[REDACTED]

## Jennifer Sham

---

**From:** Laura Janssen  
**Sent:** August 14, 2018 3:54 PM  
**To:** Jennifer Sham  
**Cc:** Planning Public Email address  
**Subject:** FW: re-devopment scheme on SBCPR

**Categories:** CityView Planning Attachment

I think this is regarding 725-133?

Laura

---

**From:** [REDACTED]  
**Sent:** Tuesday, August 14, 2018 8:30 AM  
**To:** Planning Public Email address <Plan@csrd.bc.ca>  
**Cc:** [REDACTED]  
**Subject:** re-devopment scheme on SBCPR

To whom it may concern,

I am a permanent resident, living 15 minutes down this No Exit, lake-shore, country road off the TransCanada Highway. This re-development will totally turn the SBCPR into a crazy zone of traffic, not only in the process of build these homes, but for the owners' creating a housing estate, where there needs to be no such urban development on a country 'lane' against the shore line where wild life need access and the pollution from the past booming ground, both on the shore and the lake front beaches is obvious and will need much remediation. This is crazy, and the developers need to think again and make their money and pull the millionaires into a less environmentally friendly town setting.

Traffic on Sunnybrae Canoe Point Road is already very heavy in the summer time, there is little room on the narrow, unguarded lake shore and cliff side boundaries for the large camping vans and large boats on trailers as it is. It is a beautiful drive, with views to die for, but when chased by work trucks, logging trucks, motorbikes and lines of cars and holiday makers rushing to get to the parks, it is quite dangerous and there are places where the corners are sharp, and the road surface is not cambered well. Walking groups, dog walkers, cyclists and others, already have to be very watchful, staying at high alert for traffic in both directions on the narrow roadway with no sidewalks.

Nearby Herald Park is a large area where many people already enjoy the facilities for launching their boats and spending a day on the beach. Why allow an influx of people into the area who may not appreciate the quiet beauty of Sunnybrae?

From a concerned Sunnybraian,  
[REDACTED]

To: CSRD Manager of Development Services & CSRD Board of Directors:  
Re: Application DP No. 725-133

We are permanent residents of this area. We are the owners of [REDACTED] and our address is [REDACTED]. We wish to oppose this application. We wish to support the decision of the Manager of Development Services regarding DP 723-133.

The following are some of our concerns:

- 1.) We are aware that it is very important to stay within the OCP Guidelines. These have been carefully prepared to help protect this area now and in the future and this proposal goes against these guidelines. The area in question is zoned Industrial, not residential. New waterfront property as designated in the OCP would allow for a maximum of 1 home per 4.94 acres which would only then be 3 residences, not 14 for this property.
- 2.) Traffic density on Sunnybrae-Canoe Point Road is already excessive and often dangerous. The road is winding, with narrow shoulders, some rock cliffs, and partially as well as unprotected drop offs into the lake or down cliffs. Especially in the warmer months many people, including children, like to frequent the road on foot or bike, sometimes with their pets, and wild animals use it at random anytime. The construction vehicles that would have to be used to support this development would put a heavy strain on this road's structure as well as on the safety of the road users.
- 3.) What is being done about the toxicity of the soil on the site where so much heavy equipment machinery have been used over many years and prior to regulations being in place?
- 4.) What about septic issues?
- 5.) What about drinking water issues?
- 6.) We are concerned that the new park which would be added on the East end of this development might bring unwanted partying and the resultant noise contamination which extends much further than the source. This park would be unsupervised and thus more damage could be inflicted from carelessness. With marijuana now legalized, and alcohol readily available at the Tappen Coop, we might be inflicted with that very unpleasant marijuana odour drifting over our neighbourhood, destruction of property, and more dangerous driving on this hazardous road etc.
- 7.) Logging above Sunnybrae and impacts related to mud and debris slides along this road are very much a concern. Many of us in this community grieve the death of Roy Sharp when his home was wiped out by a slide in recent years. Recent mud slides have caused much destruction to properties along the road as well. What is the policy for logging above Sunnybrae-Canoe Point Road, from this side and from the White Lake side? Will there be an environmental assessment made with adequate stipulations before any applications can even be considered?
- 8.) More traffic would be entering and exiting Sunnybrae Canoe Point Road at the Trans Canada Highway which is already dangerous and there is no firm date when this serious situation will be rectified.

Regards,  
[REDACTED]  
[REDACTED]