Clarke Geoscience Ltd.

October 21, 2013

Regional District of East Kootenay
#19 – 24 Ave. South
Cranbrook, BC
V1C 3H8

Attention: Mr. Jim Maletta, AScT
Engineering Services Technician

RE: Overview-Level Hazard Assessment of Cold Spring Creek (2013)

Clarke Geoscience Ltd. (CGL) is pleased to provide the Regional District of East Kootenay (RDEK) with an overview-level hazard assessment of Cold Spring Creek[1]. The purpose of the overview-level assessment was to inspect and report on current watershed conditions that influence the potential for future occurrence of hazardous debris flow, large-scale landslide, and/or sediment-laden flood. Of particular relevance are processes that have the potential to impact the populated areas of Fairmont Hot Springs situated downstream on the fan.

Background:
This spring, a major storm system moved across south-eastern BC. The closest BC Fire Weather Station to Fairmont Hot Springs (Emily Creek Station, elev. 1190 m) recorded 105.6 mm total storm rainfall between June 18 and 21, 2013 (data provided by Ministry of Forests). The storm caused problems on streams and rivers throughout the east Kootenays and triggered flood events on Fairmont Creek, Cold Spring Creek and Dutch Creek on June 20. This resulted in a local State of Emergency for the Fairmont Hot Springs Community due to debris-blocked culverts and ditches, local channel diversions, and sediment infilling of areas such as the Cold Spring Creek reservoir and debris trap and the Mountainside Golf Course pond.

The Community of Fairmont Hot Springs is situated on the coalesced fans of Fairmont Creek and Cold Spring Creek and is designated a flood hazard area (RDEK Official Community Plan, Bylaw 1734, 2004). The Community is subject to flooding and debris flow hazards associated with both creeks.

Prior to this year, Cold Spring Creek experienced significant sedimentation associated with a flood event in July 2011. Observations by RDEK personnel in 2011 indicated that the event caused infilling of the Cold Spring Dam reservoir (Photo 1), partial infilling of

[1] A separate overview assessment was submitted to RDEK to document conditions in Fairmont Creek, located adjacent to Cold Spring Creek (Clarke Geoscience Ltd., 2013)

5217 Benmore Court
Kelowna, BC
V1W 4Z3
Tel. 250-826-4367

the lower debris trap (Photo 2), and led to reconstruction of the FHSR water intake structure (Photo 3). (J. Maletta, RDEK, *personal communication*)

Last year, on July 15, 2012, a large debris flow event occurred on Fairmont Creek. The debris flow had an estimated volume of 65,000 m^3 and caused considerable damage to the Fairmont Hot Springs Resort and the community of Fairmont Hot Springs. At the time, Cold Spring Creek experienced a flood event that resulted in infilling above the dam and other local flow diversions downstream.

A debris flow hazard and risk assessment was completed for Fairmont Creek to characterize the 2012 event, determine the hazard and risk of future events, and identify mitigation measures (Clarke Geoscience Ltd. and Golder Associates, 2013). Although a full assessment of Cold Spring Creek was not completed, a helicopter overview in 2012 provided video footage that allows for comparison with 2013 conditions.

Methods:

An aerial reconnaissance of the watershed was conducted by helicopter on July 29, 2013 by Ms. J. Clarke, accompanied by Mr. Dwain Boyer (Ministry of Forests Lands and Natural Resource Operations) and Mr. Jim Maletta (RDEK). The flight centered along the mainstem creek and significant tributary channels. No ground-based field work was conducted.

The flight was recorded by video camera (GoPro) and additional photographs were taken. Digital copies of all video and photographs are provided to RDEK as part of this project.

Observations were limited to what was visible from a moving helicopter, from Google Earth imagery, and from other background information sources. Noted conditions included evidence of recent debris flow or flood activity, within-channel sediment storage, debris jams, valley landslides and large tension cracks. Where conditions warrant further investigation, rationale for further ground-based work is provided. The overview assessment provides evidence upon which to base future comparisons of watershed condition. It also provides rationale and support for future funding applications.

Observations and Results:

The following summarizes observations from the overview assessment. An annotated map of the watershed is provided as Figure 1 and comparable video frame shots from 2012 and 2013 helicopter flights are provided as Figures 2 to 5.

The aerial reconnaissance confirms that Cold Spring Creek experienced a sediment-laden flood event on June 20, 2013 that largely infilled the Cold Spring Creek Dam reservoir. The reservoir appears to have contained the sediment mobilized by the 2013 flood event and has since been excavated. It is reported that downstream culverts and ditches were overwhelmed by floodwaters and/or debris, causing flooding through the residential areas on the fan (www.e-know.ca; *East Kootenay online news source*) and infilling of the debris trap located adjacent to the Columbia River (RDEK personnel).

The Cold Spring Creek watershed (7.7 km^2) is comparable to the Fairmont Creek watershed in size, aspect, slope and geology. Based on the similarities, Cold Spring Creek is considered likely to have a similar susceptibility to sediment-laden floods and/or debris flows. The alpine headwaters are characterized as steep bedrock-controlled channels subject to rockfall, snow avalanche and debris flow processes. The 2013 overview flight indicates recent scour and sediment transport in at least four headwater tributaries with a noticeably wider stream channel in 2013 (Figure 2). The steep tributaries converge into a mainstem channel that has a gradient sufficient for debris flow initiation and transport.

Mid-watershed reaches of Cold Spring Creek are moderately steep and considered a transition zone between debris flow transport and deposition. Steep valley side slopes comprised of erodible bedrock, colluvium, and/or glacial deposits characterize the mid-watershed reaches. In several places, exposed slopes contribute sediment directly to the mainstem channel. Although forest cover partially obscures the channel, the mid-watershed reaches appear to be heavily sediment-laden. Water works associated with an intake structure registered to Fairmont Hot Springs Utilities Ltd., are situated in the mid-elevation reach (see Photo 3). Comparable imagery indicates that the intake site experienced sedimentation and scour associated with the 2013 flooding (Figure 3).

A concrete dam structure is situated on Cold Spring Creek at the apex of the fan. The 3 m high Cold Spring Dam is owned by Fairmont Hot Springs Resort Ltd. and functions to divert water for consumptive purposes. The upstream reservoir is fairly small but also functions to detain sediment transported downstream. At the time of the overview assessment, approximately 1000 m^3 of material had recently been excavated and stockpiles were evident in the reservoir area. Comparable imagery of the dam site is provided in Figure 4.

Immediately above the reservoir, Cold Spring Creek is heavily aggraded with sediment. To reduce the potential for channel avulsion at this location, RDEK will be excavating material from a 30 m long section of the creek channel (J. Maletta, RDEK, *personal communication*).

Downstream of the Cold Spring Creek Dam, the channel traverses the fan area, which includes residential/commercial development and three golf courses. Cold Spring Creek flows through three (3) culverts, one of which crosses the sole access road to the Fairmont Hot Springs Resort, before flowing under Highway 93/95. Downstream of the highway, Cold Spring Creek flows through a residential area and the Riverside Golf Course into a diked section of channel and a debris trap before reaching the Columbia River. The dike is a flood protection structure registered to RDEK that extends 484 m along the channel (Provincial Flood Control Structures database). The dike functions in conjunction with a debris trap to contain approximately 1000 m^3 of sediment transported below the dam through the downstream reach of Cold Spring Creek. At the time of the overview assessment, the sediment trap was partially infilled with approximately 500 m^3 of sediment (Figure 5) (B. Funke, RDEK, *personal communication*). Photo 4 shows the

lower debris trap on Cold Spring Creek after the recently accumulated sediment was excavated.

Summary and Conclusions:

The 2013 overview assessment was conducted four weeks after a flood event on Cold Spring Creek. The flood event was triggered by a locally-intense rainstorm, which mobilized abundant sediment within the channel and infilled the Cold Spring Creek Dam reservoir.

The aerial reconnaissance identified recent instability along several headwater tributaries, including several tributaries with abundant sediment load. Where the headwater tributaries converge on the mainstem channel, Cold Spring Creek appears to be wider. It is judged that the headwater tributaries are active, and significant, sources of sediment and debris to the mainstem channel.

It is concluded that the Cold Spring Creek watershed is similar to the Fairmont Creek watershed and is subject to debris flow and flood hazards. Similar to Fairmont Creek, it is apparent that there is an abundant sediment supply along Cold Spring Creek. It is judged that the volume of sediment stored within the channel is sufficient to generate large debris flows (comparable to the 2012 Fairmont Creek event). Based on the abundance of sediment, the likelihood of debris flow initiation is dependant on the occurrence of a critical rainstorm or streamflow threshold. Other potential debris flow triggers include landslides or avalanche from valley side slopes, or the development and failure of instream debris jams.

The nature of this overview-level assessment makes it difficult to comment on the potential presence of in-stream debris jams or other features that might affect the potential magnitude of future flood or debris flow events. It is also difficult to comment on the presence and influence of water intake structures, the Cold Spring Dam, and other downstream drainage structures on the creek. Understanding the role of these components is important to assessing the potential risks associated with future flood and/or debris flow events on Cold Spring Creek.

Recommendations:

Based on the short-term potential for future flood and/or debris flow hazards on Cold Spring Creek, further assessment is recommended. A detailed ground-based field assessment, similar to what was completed for Fairmont Creek, would determine the hazard and risk of future debris flow and flood events to the downstream Fairmont Hot Springs Community. The detailed assessment would allow for the development of a hazard and risk map for the fan area of Cold Spring Creek and the results would be used to identify mitigation measures if required.

It is recommended that the assessment methods should be consistent with the Association of Professional Engineers and Geoscientists of BC's (APEGBC) *Guidelines for Legislated Landslide Assessments for Residential Development* (updated, 2010) and the BC Ministry of Water, Land and Air Protection *Flood Hazard Area Land Use*

Management Guidelines (2005). In addition, *Professional Practice Guidelines for Legislated Flood Hazard Assessments in the Changing Climate of BC* (APEGBC, 2012) together with debris flow analysis methods presented in published literature should also be referenced.

The detailed assessment should utilize historical air photos, records, anecdotal information, and a ground-based field investigation. The field investigation would include a foot traverse of the mainstem channel, recreational trails and roads, and downstream areas on the fan. If warranted, additional information on historical debris flow activity may be obtained from a subsurface test pitting program.

Relevant to the downstream risk to the Fairmont Hot Springs Community is the function of the Cold Spring Creek Dam. It is recommended that this function be reviewed in the context of an integrated flood control system. It is also recommended that jurisdictional responsibilities be clarified and that a review of dam safety documentation, including inspections and audits be completed.

A more detailed assessment would provide baseline information on watershed condition and would better define the level of risk to the downstream community. Upon completion, periodic overview inspections are recommended after significant flood/debris flow events, or approximately every 5 years. These inspections will provide information that may be used to update the debris flow hazard and risk assessment.

We trust that this report meets your current requirements. If you have any questions, please contact the undersigned.

Sincerely,

CLARKE GEOSCIENCE LTD.

Jennifer Clarke, M.Sc., P.Geo.
Director and Project Geoscientist

Encl.
Helicopter Video (electronic file; separate CD)
Photographs 1 to 4 (all photos provided as electronic files; separate CD)
Figure 1: Cold Spring Creek Watershed Overview
Figure 2: Headwater Tributaries of Cold Spring Creek
Figure 3: FHSR Water Intake Site
Figure 4: Cold Spring Creek Dam
Figure 5: Lower Reach of Cold Spring Creek

cc.
Brian Funke, RDEK
Brian De Paoli, RDEK
Dwain Boyer, MFLNRO

Closure:

This report was prepared for the exclusive use of the Regional District of East Kootenay. This includes distribution as required for the purposes for which this assessment was commissioned. The assessment has been carried out in accordance with generally accepted practice. Conclusions and recommendations presented herein are based on visual aerial site inspection only. Professional judgment has been applied. No other warranty is made, either expressed or implied. Clarke Geoscience Ltd. does not in any way accept responsibility for the potential hazard identified and the corresponding consequences.

References:

APEGBC. 2010 Guidelines for Legislated Landslide Assessment for Proposed Residential Development in British Columbia. Association of Professional Engineers and Geoscientists of British Columbia. Vancouver, BC.

APEGBC. 2012. Professional Practice Guidelines – Legislated Flood Assessment in a Changing Climate in BC. Association of Professional Engineers and Geoscientists of British Columbia. Vancouver, BC.

Clarke Geoscience Ltd. 2013. Overview-Level Hazard Assessment of Fairmont Creek (2013). Submitted to the Regional District of East Kootenay, Kelowna, BC

Clarke Geoscience Ltd. and Golder Associates. 2013. Fairmont Creek Debris Flow Hazard and Risk Assessment. Final Report. Dated January 11, 2013. Submitted to the Regional District of East Kootenay. Kelowna, BC.

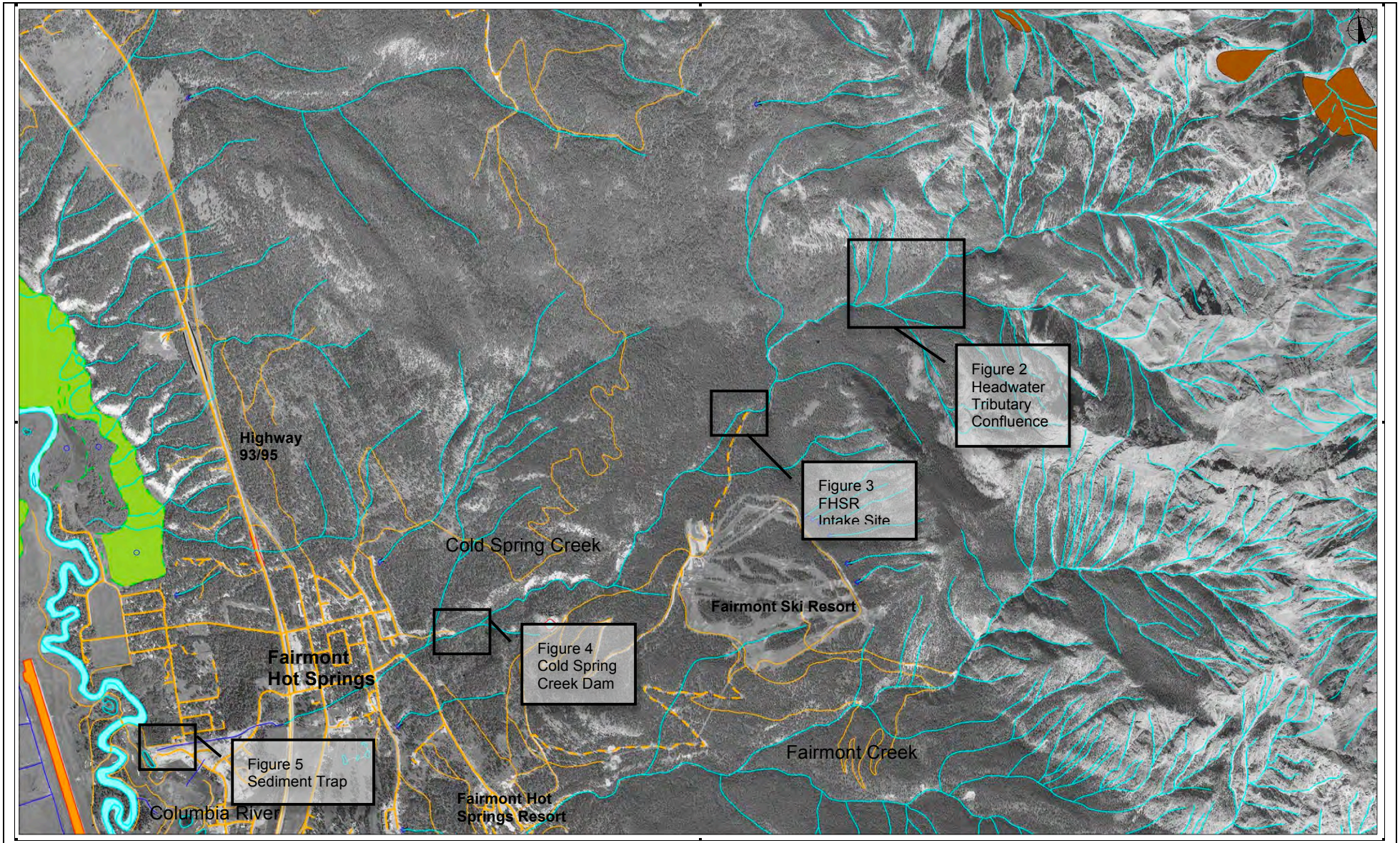
Ministry of Water Land and Air Protection. 2005, Flood Hazard Area Land Use Management Guidelines. Guidance for Selection of Qualified Professionals and Preparation of Flood Hazard Assessment Reports. Victoria, BC.

Photo 1: Sediment infilling of Cold Spring Dam reservoir after flood event in 2011 (photo from RDEK)

Photo 2: Sediment infilling of lower debris trap on Cold Spring Creek after flood event in 2011 (photo from RDEK)

Photo 3: Reconstruction of water intake on Cold Spring Creek after 2011 event (exact date of photo unknown) (photo from RDEK)

Photo 4: Lower debris trap after sediment removal in 2013 (photo from RDEK)

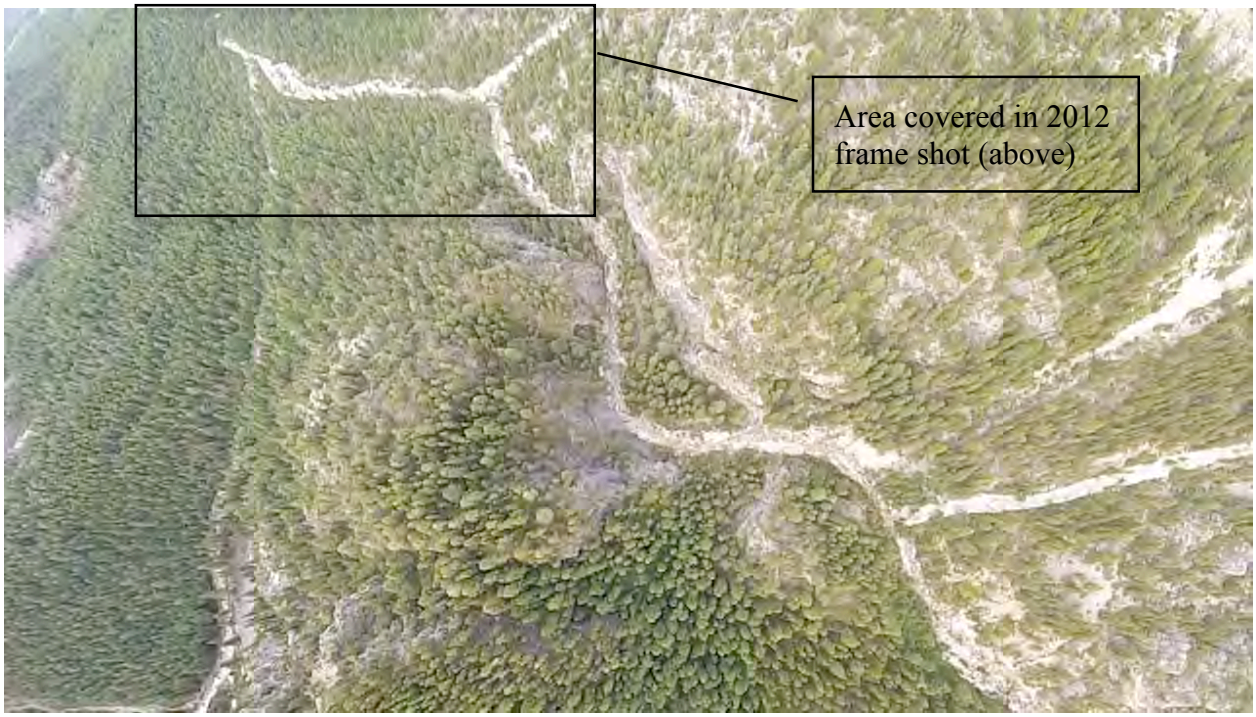


Base map obtained from iMapBC

Project: Overview-Level Hazard Assessment of Cold Spring Creek (2013)	
Date: October 21, 2013	Figure No.: 1
Title: Cold Spring Creek Watershed Map	

Clarke geoscience ltd.

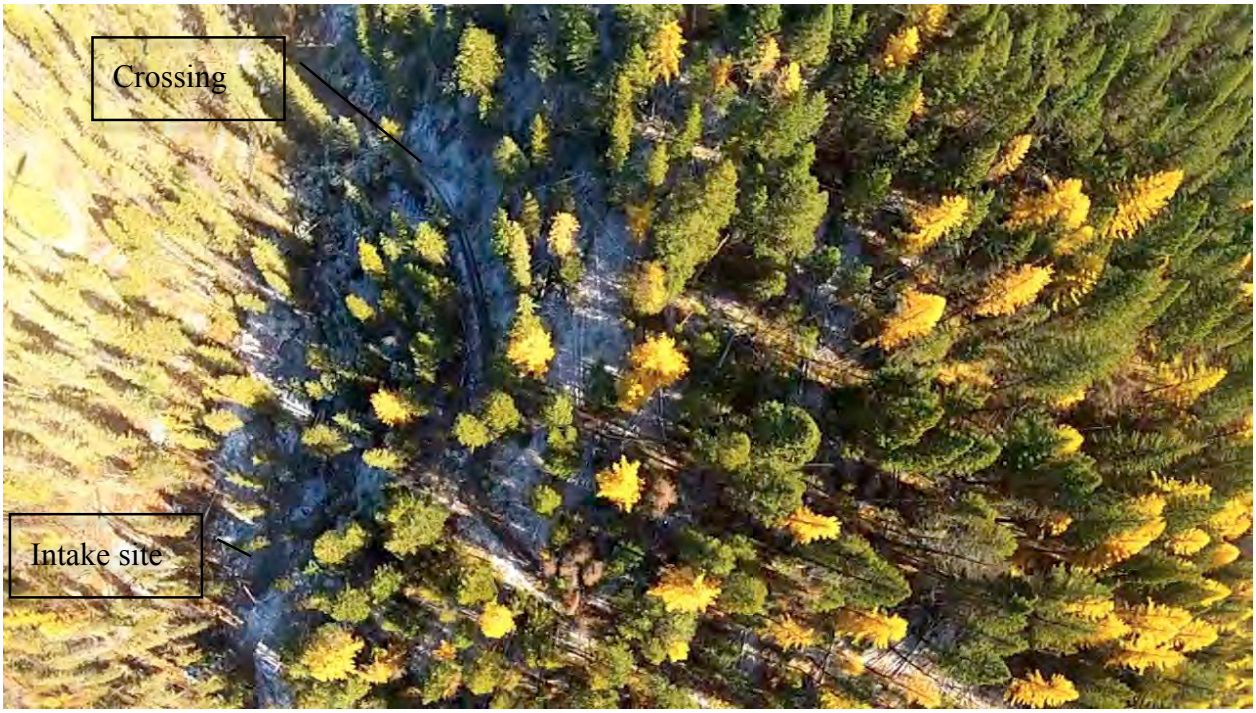
October 2012 Confluence of Headwater Tributaries



July 2013 Confluence of Headwater Tributaries – Noticeably increased sediment load

Video frame shots obtained from helicopter overview flights.

Project: Overview-Level Hazard Assessment of Cold Spring Creek (2013)	
Date: October 21, 2013	Title: Headwater Tributaries
Scale: n.t.s.	Figure No.: 2
Clarke Geoscience Ltd.	

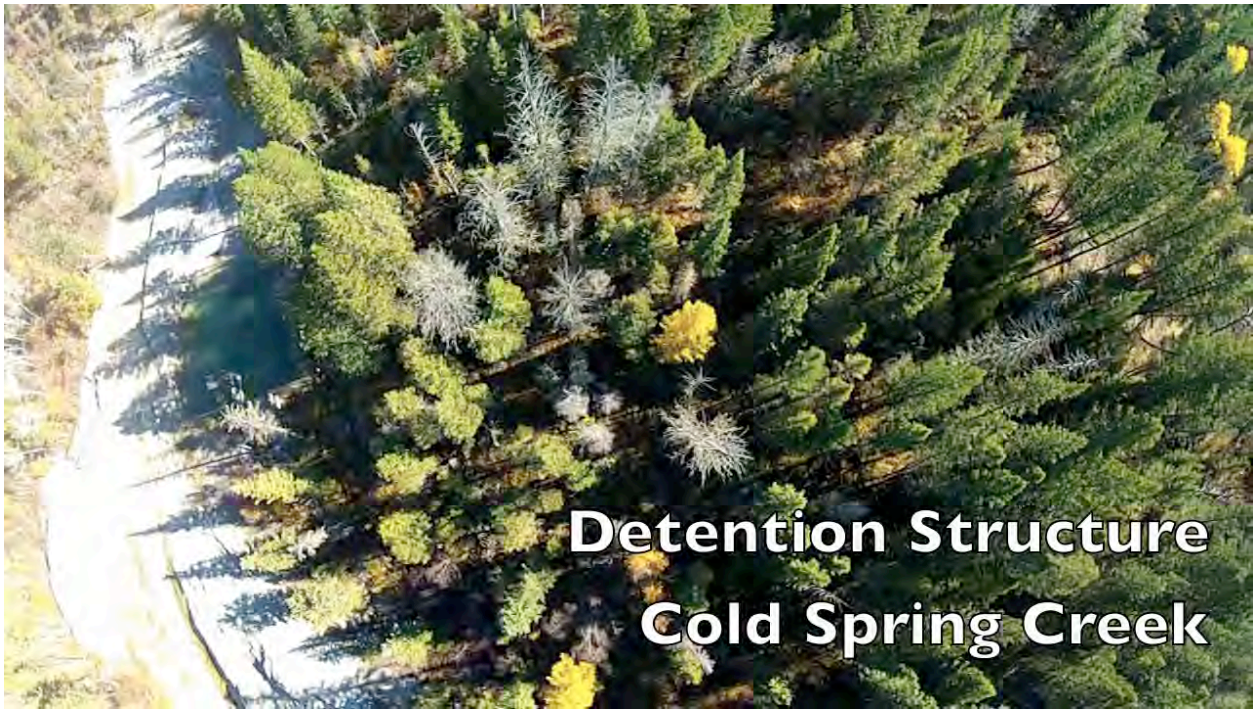


October 2012 FHSR Intake Site and Road Crossing (indicated with arrows)

July 2013 FHSR Intake Site and Road Crossing

Video frame shots obtained from helicopter overview flights.

Project: Overview-Level Hazard Assessment of Cold Spring Creek (2013)	
Date: October 21, 2013	Title: Intake Site
Scale: n.t.s.	Figure No.: 3
Clarke Geoscience Ltd.	

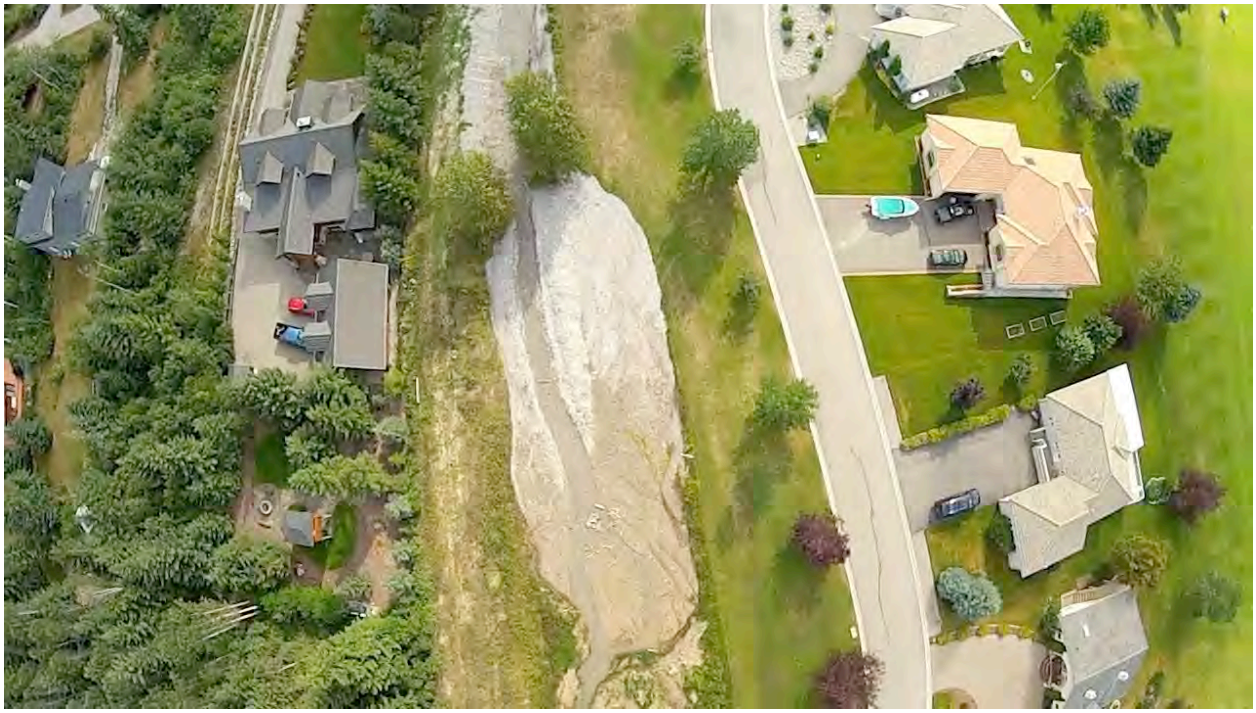


October 2012 Cold Spring Creek Dam

July 2013 Cold Spring Creek Dam

Video frame shots obtained from helicopter overview flights.

Project: Overview-Level Hazard Assessment of Cold Spring Creek (2013)	
Date: October 21, 2013	Title: Cold Spring Creek Dam
Scale: n.t.s.	Figure No.: 4
Clarke geoscience ltd.	



July 2013 Lower Reach of Cold Spring Creek showing partially infilled sediment basin

Video frame shot obtained from helicopter overview flight.

Note: unable to obtain the comparable 2012 image.

Project: Overview-Level Hazard Assessment of Cold Spring Creek (2013)	
Date: October 21, 2013	Title: Lower Reach of Cold Spring Creek
Scale: n.t.s.	Figure No.: 5
clarke geoscience ltd.	