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Kelowna, BC
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Firvale Wilderness Camp
4330 Highway 20
Firvale, BC

April 28, 2022

Attention: Bobby Sherlock
Firvale Wilderness Camp

Re: Ratcliffe Creek Stream Channel Remediation
Construction Review

Further to our letter report of April 12, 2022 outlining our Preliminary Recommendations for the remediation of the Ratcliffe Creek channel in Firvale, BC, we have attended the site and reviewed the construction of the remedial works and provided guidance for adjustments and additional works. The following is a summary of our observations, recommendations and concurrence that works meet the intent of our Preliminary Recommendations.

Field Review

A field review of the site was performed by Mike Walsh, P.Eng. of Skmana Creek Consulting Ltd. (Skmana) on April 20-22, 2022. The review comprised of multiple foot traverses of the lower portions of Ratcliffe Creek fan and channel to assess hydraulic conditions and the construction of the proposed creek channel remediation.

Based on the details outlined in the preliminary recommendations and our observations, it was concluded during the initial site review that the magnitude and extent of the remedial measures proposed suitably addressed the required mitigation.

The remedial works were constructed using a 225 sized Volvo tracked excavator with a 750mm wide ripping bucket. All works were completed in dry conditions.

The following is a summary of the completed works:

- The East Channel cutoff was pulled approximately 2-2.5m away from the creek to remediate the eroded subvertical face and better align the channel to minimize deflection of the channel to the west.
- The new face of the East Channel cutoff was sloped at 2H:1V, with an average height of 2m and lined with coarse sub-angular material up to 600mm size to provide increased erosion protection.
- The West Channel berm was extended approximately 25m upstream from the originally proposed termination point to mitigate a point of historic channel avulsion.
- The West Channel berm was constructed along approximately 150m of the historic creek edge and sloped at 2H:1V with an average height of 1.85m.

- A historic channel bifurcation path was re-established on the lower end of the West Channel to provide an alternate creek path and/or a depositional area for gravels as the creek approaches the lower gradient zone at the base of the fan.
- The end of the West Channel was recontoured and widened to better define the flow path to the east culverts and increase the material deposition area available.
- The West Channel berm and channel definition work developed a curvilinear channel approximately 5.5 - 7m wide.
- The completed channel was roughened and intermittent random cobbles were placed in the flow path to slow future creek flow, promote a variable flow path and reduce erosion.

Photos are presented in the Appendix with their locations and orientation referenced in Figure 1.

Observations & Recommendations

Based on observation of the terrain and construction, several issues were observed that influence the effectiveness of the remediation for containing impacts from future creek flooding, erosion and material deposition. The following is a summary of these issues and recommendation:

1) Channel Maintenance

It is evident that the Ratcliffe Creek channel is active and will be subject to continuing channel erosion and material input (sand, gravel & debris) from upstream. To ensure on-going protection from the completed works, it must be understood that seasonal reviews and intermittent maintenance of the constructed channel works will be required. The frequency and magnitude of such maintenance will be primarily driven by the significance of freshet and flood events. It should also be noted that the performance of any maintenance on the channel works may be subject to permitting requirements from the applicable provincial and/or federal agencies.

2) Creek Avulsion

In our review it was recognized that the lower fan of Ratcliffe Creek has been subject to multiple historic avulsion events where the creek has partially or wholly diverted from its established location, causing flooding and erosion on the property to the west. Furthermore, some of the more recent and significant flooding was observed to have originated on the western bank upstream of the east channel cutoff. It is our opinion that a significant portion of the recent flooding that occurred to the western property was natural and unrelated to the east channel cutoff constructed in 2019. Nevertheless, to help mitigate this circumstance, the western berm was extended 25m in a best effort to address the historic point of avulsion.

3) Debris Storage & Conveyance

The function of the completed works in mitigating flooding of the property to the west and the highway will be contingent on available storage within the debris basin and on the continuing capacity of the east culverts. To ensure their continuing service, it is expected that intermittent debris removal and ditching by the highways maintenance contractor will be required.

It was also recognized that the two east culverts that convey Ratcliffe Creek under Highway 20 are presently partially blocked with debris; reducing their capacity by 25% and 50% respectively. This issue will tend to cause a backup of flow in the highway ditch and likely result in the deposition of material that would normally clear if the culverts were fully open. It is recommended that the maintenance contracted be requested to clean the two inlets to re-establish free flowing conditions.

4) Creek Hazard

In extreme flow events there is a recognized potential that the erosion, transportation and/or deposition of debris can occur and may result in the creek losing confinement and establishing a new path on the fan. It must be recognized that the works recommended are intended to mitigate reasonable flood flows estimated to be less than a 1:50 year return period within the zone of the constructed works. No assessment of the upper segment of the creek fan was performed and it must be recognized that there is a potential that erosion and/or loss of channel confinement upstream of the remediation works may still occur.

Conclusions

Based on our review of the site and the constructed works, we believe the works were suitably constructed using appropriate materials and construction technique and will minimize the uncontrolled erosion and flow avulsion occurring on the lower portions of the Ratcliffe Creek fan.

Report Use and Limitations

This report is prepared for the exclusive use of Firvale Wilderness Camp and its designated representatives and may not be used by or assigned to other parties without the written permission of Skmana Creek Consulting Ltd.. The Ministry of Forests, Lands, Natural Resource Operations and Rural Development and the Central Coast Regional District can also utilize this report for reference, zoning and permitting purposes.

It should be noted that the recommendations and conclusions provided in this report are based on a limited review and estimated creek hydraulics. Creek actions may vary from those projected due to subsurface conditions and natural occurrences that could not be anticipated.

The works completed cannot be considered permanent and will require on-going maintenance to maintain their effectiveness.

In cases where our recommendation are not followed, Skmana's responsibility is limited to interpreting accurately the information provided and observed, at the time of their determination or measurement during the preparation of the Report.

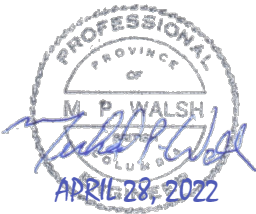
The material in this report reflects Skmana's best judgment and professional opinion in light of the information available to it at the time of preparation. Any use which a third party makes of this report or any reliance on or decision to be made based on it are the responsibility of such third parties. Skmana accepts no responsibility for damages, if any, suffered by any third party as a

result of decision made or action based, or lack thereof, on this report. No other warranty is made, either expressed or implied.

Soil and surface water information presented in the factual data and described in this report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Surface water flow may vary between and beyond reported locations and can be affected by annual, seasonal, and meteorological conditions.

The report and assessment have been carried out in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. The discussion and recommendations presented above are based on limited third party field information and inferences from surficial features. Inherent variability in surface and subsurface conditions may create unforeseen situations.

Prepared by:



Mike Walsh, P.Eng.
Skmana Creek Consulting

Permit to Practice #1003145

Photos



Photo 1 - East Channel cutoff from u/s



Photo 2 - Extension of west berm to cutoff avulsion point



Photo 3 - Upper west channel looking d/s



Photo 4 - West Channel looking u/s from end of East Channel cutoff



Photo 5 - West Channel looking d/s



Photo 6 - West Channel bifurcation looking d/s



Photo 7 - End of West Channel berm and developed debris basin



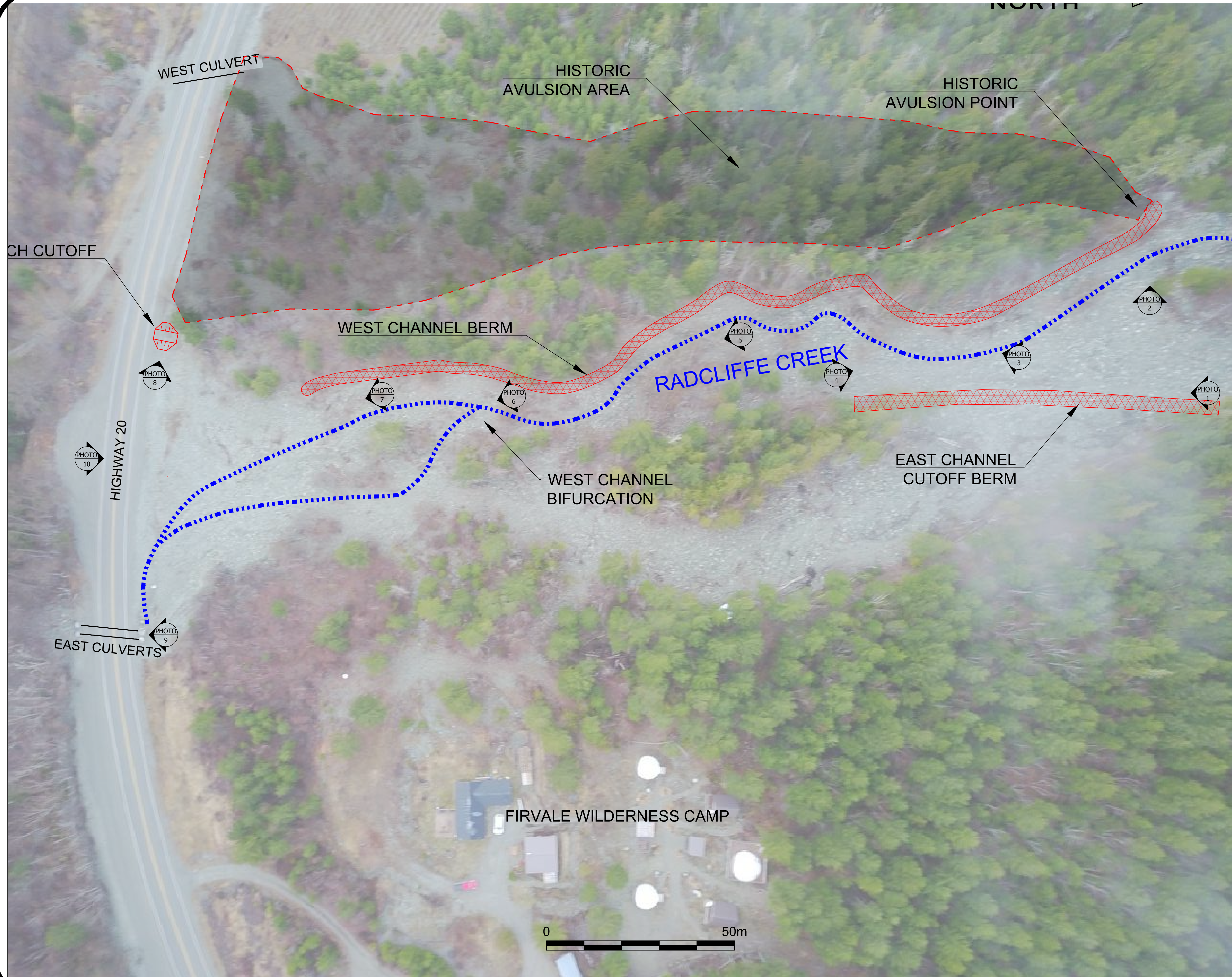
Photo 8 - Existing ditch block



Photo 9 - East culverts inlet blockages



Photo 10 - Ratcliffe Creek lower fan looking u/s



RATCLIFFE CREEK CHANNEL REMEDIATION
FIRVALE WILDERNESS CAMP, FIRVALE, BC
FIGURE 1

General Notes

0	AS BUILT	04/28/22
No.	Revision/Issue	Date

Firm Name and Address
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3038 ALLEGRO MEWS
Kelowna, BC
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Project Name and Address
FIRVALE CREEK
WILDERNESS CAMP
4330 HIGHWAY 20
FIRVALE, BC

Project	2022-009	Sheet
Date	28.04.2022	01
Scale	NOT TO SCALE	