Murphy Creek Rainbow Trout Spawning Channel Maintenance 2016 - 2017

Project (COL-F17-F-1344)

Prepared for: Fish and Wildlife Compensation Program

Prepared by: Trail Wildlife Association, Al Mallette (2017)

Prepared in part with financial support of the Fish and Wildlife Compensation Program on behalf of its program partners: BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and public stakeholders.

Date: March 31, 2017

Executive Summary

Murphy Creek is located approximately 7 km north of Trail, British Columbia and is a tributary to the Columbia River. In 1992, a spawning channel was built on Murphy Creek south of the Birchbank Golf Course (BGC) and east of Highway 22 under the leadership of the Trail Wildlife Association (TWA).

Spawning survey data from 2016 indicated reduced productivity in the Murphy Creek spawning channel likely due to increased sedimentation and debris (Pers. Obs.). Therefore, the TWA proposed to conduct in-stream maintenance to restore spawning channel productivity for Rainbow Trout (*Oncorhynchus mykiss*).

The primary goal of the Murphy Creek spawning channel maintenance project was to enhance Rainbow Trout spawning and rearing habitat by reducing sedimentation of spawning gravels and removing woody debris. Methods for maintaining the spawning channel were based on the advice of Fisheries Biologists Steve Arndt (MFLNRO) and Michael Zimmer (Okanagan Nation Alliance). We removed all dangerous overhead snags prior to working in the channel. We also removed large in stream woody debris that was causing sediment buildup in the channel. The material was placed alongside the channel for wildlife. Some of the larger snag segments were placed astride the pools to provide cover and rearing habitat. Fine sediment was removed via dredging and 1-2 inch round river rock was placed as spawning gravel.

The maintenance of Murphy Creek spawning channel is an important exercise to maintain adequate spawning habitat for Rainbow Trout. Since previous maintenance activities conducted in 2007, sedimentation and input of woody debris lowered the capacity of the channel to provide suitable spawning habitat for Rainbow Trout. The TWA recommends bi-annual maintenance at the Murphy Creek spawning channel and annual spawning surveys to monitor the channels productivity and effectiveness. The largest obstacle of this project was permitting; due to a delayed permit, crews were forced to work in late November and December in freezing and snowy conditions which discouraged potential volunteers.

Acknowledgments

This project is funded by the Fish and Wildlife Compensation Program (FWCP). The FWCP is a partnership between BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations and public stakeholders to conserve and enhance fish and wildlife impacted by the construction of BC Hydro dams.

The Trail Wildlife Association would like to recognize and thank the following volunteers for their hard work on this project:

- Al Mallette and Rob Frew and Gary Nutini– Trail Wildlife Association
- Eleanor Duifhuis – Salmo resident
- Lauri Kakkuri – Selkirk College Student
- Halle and Kaley Sbitney – J.L. Crowe Secondary Students
- Rod Zavaduk and Roger Oliver – West Kootenay Fly Fishing Club

We would like to thank the following organizations and individuals for their contribution of time, financial and logistical resources, and expertise:

- Okanagan Nation Alliance: Michael Zimmer, Fisheries Biologist, for visiting the site and providing valuable advice, Amy Duncan, Biologist, for reporting advice and Evan Smith, Fisheries Technician, for fieldwork and reporting advice;
- Birchbank Golf and Country Club: specifically Mark Lloyd, maintenance supervisor, for dredging the golf course water intake pond which acts as our sedimentation pond, and for granting the TWA to access the site;
- Hi-Tech Contracting Ltd.: for supplying the wheelbarrow and hand tools used in this project;
- Bell Poles: for donating the cedar poles used to increase pool depths in the channel; and
- Teck Metals Ltd.: for permission to access the site on their property.

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Introduction

The Murphy Creek spawning channel, located approximately 7 km north of Trail, British Columbia, on a tributary to the Columbia River, was built in 1992 under the leadership of the Trail Wildlife Association (TWA). The purpose of this spawning channel was to mitigate the effects of a highway culvert which was blocking fish passage beyond an alluvial fan into the upper reaches of the stream (Arndt and Klassen 2004). The side channel was grafted onto an existing water diversion structure used to supply the Birchbank Golf Course (BGC) with irrigation water. When completed, a series of stepped pools containing spawning gravel was fed by an intake off the main stem of Murphy Creek to create a spawning channel.

In recent years, the Fish and Wildlife Compensation Program (FWCP) has funded studies to determine the effectiveness of the artificial spawning channel for the production of Rainbow Trout. They found that the spawning channel produced more Rainbow Trout fry than the main stem of Murphy Creek (Arndt, 2000). The TWA has been working to enhance fish habitat at Murphy Creek since 1990. Since 1992, several improvements have been made to the channel focused on enhancing the culvert to facilitate fish passage, and to the channel intake and settling pond. As the members of the original volunteer crew responsible for the work at Murphy Creek began to retire and pass on, the ongoing upkeep of the spawning channel lapsed. The last instance of in-stream maintenance occurred in fall 2007 (Zimmer Environmental Ltd. 2007). In 2012, a new group of TWA volunteers initiated a major upgrade to the two intakes and sediment settling pond (Adrain and Frew 2014).

Spawning survey data from 2016 indicated reduced Rainbow Trout presence in the Murphy Creek spawning channel. Increased sedimentation reduced visibility and made fish detection during the survey difficult. In addition, it may also have discouraged Rainbow Trout from using the spawning channel. Over the years, spawning gravel had been scoured from many of spawning pools. The ongoing presence of beaver (*Castor canadensis*) in Murphy Creek and the spawning channel led to the deposition of a significant amount of woody debris in spawning channel pools resulting in increased sediment retention. The cumulative impacts of the scouring of spawning gravel and increased retention of fine sediment resulted in a reduction of Rainbow Trout spawning within the channel. Therefore, the TWA proposed to conduct in-stream maintenance to restore spawning channel productivity for Rainbow Trout.

The TWA had two main objectives with associated goals for the Murphy Creek spawning channel maintenance project:

(1) Enhance Rainbow Trout spawning and rearing habitat within the Murphy Creek spawning channel.
    Goal 1: Remove woody debris within the spawning channel to reduce sediment retention;
    Goal 2: Remove fine sediment from the spawning channel by dredging the settling pond (BGC water intake pond);
    Goal 3: Add new spawning gravel to the channel; and

Goal 4: Add new flow control logs to increase pool depth in shallow pools.

(2) Promote environmental awareness, education and outreach within the community and the TWA membership.

Goal 1: Involve local high schools, colleges, clubs, and community members;

Goal 2: Partner with local businesses and agencies; and

Goal 3: Increase skills in spawning channel maintenance within the TWA for future upkeep at Murphy Creek.

The project is aligned with the FWCP Columbia Streams Action Plan which seeks to enhance productivity in 15 priority tributary streams of the Columbia River downstream of the Keenlyside Dam (Rainbow Trout.)

Project Background

Rainbow Trout spawning survey data for the Murphy Creek spawning channel is available from 2013 to 2016. A comparison of Rainbow Trout use in the spawning channel between 2013 and 2016 is available in Figure 1. The temperature profile of the spawning channel for 2013 to 2016 is shown in Figure 2. Each year, water temperatures rose consistently throughout the spawning season with lows of approximately 4°C in early May to highs of 10°C in early June. Spawning surveys in 2013 were conducted before the intake structures were updated. High turbidity in 2013 discouraged Rainbow Trout from using the site and reduced in-stream visibility which may have biased redd counts.

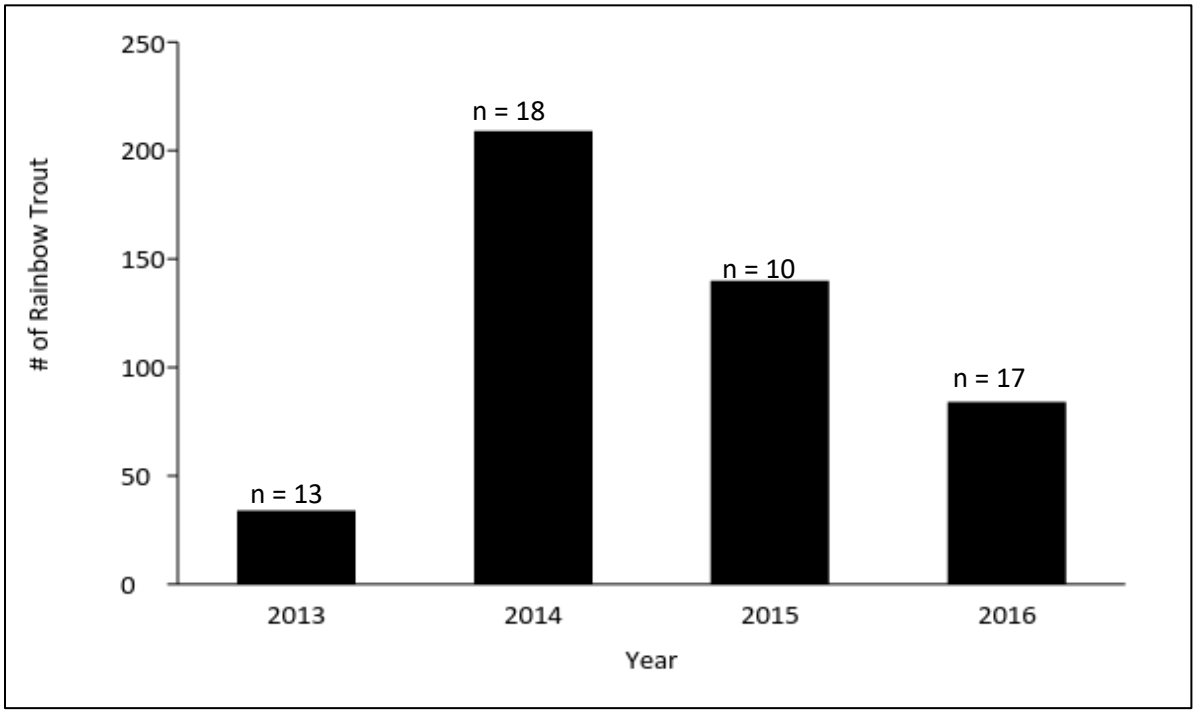


Figure 1. Number of spawning Rainbow Trout (total of all counts) observed in the Murphy Creek spawning channel from 2013-2016 (n=number of survey days)

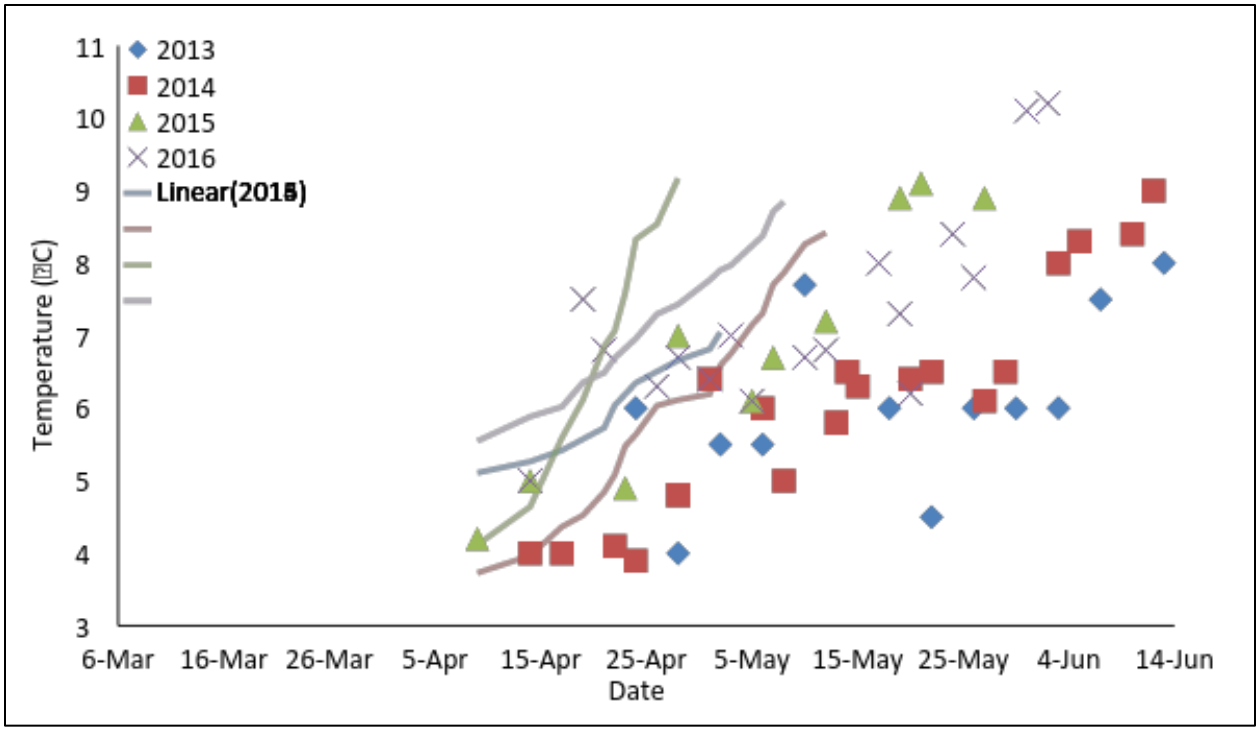


Figure 2. Temperature (°C) profiles and trend lines for the Murphy Creek spawning channel between April 5th and June 14th 2013 – 2016

Rainbow Trout numbers increased in 2014 and 2015, which may have been a result of the new infrastructure which allowed spawning channel water levels to be precisely controlled. In addition, spring freshet had low turbidity during the 2014 and 2015 spawning seasons increasing visibility for surveyors (Figure 3). Cooler water temperatures, coupled with major silting events, resulted in a consistent decrease in Rainbow Trout use in the 2016 survey period. High turbidity during these surveys affected the surveyor's ability to detect Rainbow Trout in the spawning channel (Figure 4).

In fall 2015, a Fisheries Biologist with the Ministry of Forest Lands and Natural Resource Operations (MFLNRO) identified sediment accumulation and the lack of available spawning gravels as focal points for any in stream maintenance project. Michael Zimmer, Fisheries Biologist from the Okanagan Nation Alliance (ONA) supported the 2015 recommendations for maintenance. Site assessments of the channel occurred on November 5th 2015 by Steven Arndt (MFLNRO) and October 17th 2016 by Michael Zimmer. The findings of these site visits are summarized below:

- Spawning gravel in the upper half of the spawning channel had been flushed downstream by high water flows;
- A significant percent of the remaining spawning gravel in these pools were covered by sediment. This was due to normal deposition, acute events at spring freshet in recent years (such as that recorded in April 2016) and the presence of beaver activity resulting in a large volume of small and large woody debris trapping sediment. In stream vegetation and waterlogged plywood cover structures also contributed to sediment loading;

- Several spawning pools were too shallow (less than 6 inches in depth) to attract spawning fish;
- Safety along the channel access path had become compromised by excessive brush, dead trees and garbage; and
- A large snag lying across Murphy Creek, adjacent to the channel exit, was diverting water resulting in erosion to the north stream bank that threatened the entrance/exit to the spawning channel.

Figure 3. Water from Murphy CK flows into the first spawning pool (upper right photo) through two inlet structures. The water then flows into the sediment settling pond (lower right photo). The water flows through the settling pond to the upper entrance of the channel.

Figure 4. Heavy sediment loading in Murphy Creek and the spawning channel occurred between April 21 and April 30, 2016.

Study Area

Murphy Creek is located approximately 7 km north of Trail BC, adjacent to the south end of the Birchbank Golf Course (Figure 5). The spawning channel is located south of the BGC and east of Highway 22 (Figure 6). The 2 intakes are located approximately 15 m and 20 m downstream of the Highway 22 culvert on the north bank of Murphy Creek. The spawning channel is approximately 225 m in length (Figure 7). The site is accessed by Murphy Creek Road via Highway 22 and is owned by Teck Metals Ltd. and the BGC. Permission to enter the site was obtained from Teck and BGC prior to fieldwork.

Figure 5. Location of Murphy Creek (blue line) in relation to Trail, BC and the Birchbank Golf Course

Figure 6. Location of Murphy Creek spawning channel in relation to the Birchbank Golf Course, Highway 22 and the Columbia River

Figure 7. Murphy Creek spawning channel structures on Murphy Creek

Methods

Methods for maintaining the Murphy Creek spawning channel were established with the consultation of Fisheries Biologists from the MFLNRO and ONA who assessed the state of the spawning channel and provided recommendations for habitat restoration. This provided the TWA's project coordinator with a list of action items designed to enhance spawning channel productivity.

To enhance Rainbow Trout spawning and rearing habitat within the Murphy Creek spawning channel, the following methods were recommended:

- Manually remove woody debris from within the channel to reduce sediment retention;
- Dredge the settling pond of accumulated sediments;
- Remove the large tree in Murphy Creek which is contributing to bank erosion;
- Add spawning gravel and logs to increase water retention.

To increase environmental awareness and education within the community, local high schools and Selkirk College were contacted and encouraged to participate in a volunteer capacity for this project. Local clubs such as the West Kootenay Fly Fishing Club were also approached. Organizations in the area were also asked to provide in-kind materials for the project.

Results

Between November 24th and December 5th, 2017 a total of 17 pools in the Murphy Creek spawning channel were cleaned of debris and sediment (Figures 8 and 9). Over 20 snags or large tree limbs either overhanging the channel or within the pools were removed and placed on the banks of the channel. In addition, approximately 25 pieces of waterlogged large woody debris were removed from the bottom of channel pools. Small woody debris and accumulated sediment was removed from the pools with rakes and shovels. In addition, approximately 9 m^3 of clean 1-2 inch round drain spawning gravel was added throughout the spawning channel.

Prior to dredging the settling pond, fish salvage was conducted using a seine net to capture 18 Rainbow Trout fry that were removed from the pond. A single Rainbow Trout mortality was observed at the settling pond outflow, which likely occurred after the settling pond water level was reduced. The settling pond was dredged to increase the settling pond depth by approximately 1.5 to 2 m in the area of the intake used to pump water to the golf course in the summer.

To increase pool depths nine cedar poles were added to a number of shallow pools (Figure 10). In addition 55 to 60 rocks were also strategically added to manage stream flows in the pools and to increase in-stream habitat for juvenile Rainbow Trout (Figure 11).

The large log in the main Murphy Creek was removed with a chainsaw on March 7, 2017 to reduce erosion on the north bank (Figure 12). During peak flows in spring 2017, stream flows against the north bank were reduced to the point where north bank erosion was no longer evident.

The TWA involved J.L Crowe High School and Selkirk College students, members of the West Kootenay Fly Fishing Club, and community members into the volunteer work crew to promote environmental awareness and education. A total of 7 volunteers were involved in this project. The objectives of strengthening and increasing partnerships and increasing capacity within the TWA were also achieved.

Figure 8. : (top) A spawning pool before removal of woody debris and fine sediment (May 2015) and (bottom) the pool after removal of woody debris and fine sediment and gravel addition (Dec 2016)

Figure 9. (top) The pool upstream of the walking bridge at the Murphy Creek spawning channel before removal of woody debris and fine sediment (Nov 2015), and (bottom) the pool after removal of woody debris and fine sediment and gravel addition (Dec 2016)

Figure 10. Peeled cedar logs installed in the Murphy Creek spawning channel were used to increase pool depths in a number of shallow pools (Dec 2016)

Figure 11. TWA member Rob Frew and Selkirk College Student Lauri Kakkuri adding a boulder to the Murphy Creek spawning channel to increase in-stream juvenile rearing habitat (Dec 2016)

Figure 12. (top) Large log in Murphy Creek proper causing erosion of the north stream bank, and (bottom) site following the removal of the log (March 2017)

Discussion and Recommendations

The maintenance of Murphy Creek spawning channel is an important exercise to maintain adequate spawning habitat for Rainbow Trout. The maintenance completed in 2016 was the first active management at Murphy Creek since 2007 (Zimmer Environmental Ltd. 2007). Since the maintenance in 2007, sedimentation and input of woody debris lowered the capacity of the channel to provide suitable spawning habitat to Rainbow Trout. Diverting the intake from the sediment pond directly into the spawning channel reduced the risk of Rainbow Trout mortality while dredging and provided higher velocities which helped flush out fine sediments. Bi-annual maintenance of the channel is required to ensure long-time productivity.

Obtaining the necessary permit to undertake in stream work under the Water Sustainability Act S.11-1 was the most difficult problem faced by the group. A permit request to undertake maintenance at Murphy Creek was completed mid -September 2016. The TWA did not receive the permit that authorizes in-stream work until the mid-November. This created two significant logistical issues for the project coordinator and the volunteer work crew. First, J.L. Crowe was unable to commit the number of students initially agreed upon at the beginning of the 2016 school year. Second, as the in-stream work coincided with the onset of the winter season, we experienced inclement weather conditions during field work (particularly in Dec). This resulted in work being performed during a period marked by snow and unseasonably low temperatures. This situation posed a significant safety hazard to the volunteer crew and discouraged participation by potential volunteers.

The TWA contends that the Front Counter B.C. should provide some help to community groups working to obtain permits. We feel that continuing the present practice, in which groups such as TWA are solely responsible for obtaining permits, may discourage such groups from attempting to receive funding. When discussing maintenance and permitting, the TWA was informed by MFLNRO staff that any in-stream work, would require a Water Sustainability Act S.11-1 permit, and possibly an environmental monitor. We would like to explore the issue of changing the status of the site, so that TWA volunteers could perform basic in-stream maintenance such as raking spawning gravels, without incurring the expense and delays associated with permitting or securing an environmental monitor. Failing that, our organization would like to be granted a Water Sustainability Act S.11-1 permit that would be valid for five years. We would follow all the protocols associated with under such a permit.

Future projects at the Murphy Creek spawning channel are recommended to ensure high quality spawning habitat for years to come. The TWA recommends the following:

1. Continue to monitor Rainbow Trout spawning activity in the channel by:

    a) Designing and executing a study to improve knowledge of Rainbow Trout rearing capabilities within the channel in conjunction with annual spawning surveys. These surveys will be implemented using methodologies established in baseline studies conducted by Arndt (2000) and Arndt and Klassen (2004) to enable comparisons between years.

2. Monitor the Murphy Creek main channel upstream of the Highway 22 culvert to:

    a) Quantify the carrying capacity and current Rainbow Trout population above the culvert in Murphy Creek;
    b) Identify enhancement opportunities above the culvert in Murphy Creek; and,
    c) Determine if the culvert is still a barrier to fish passage.

3. Enhance the Murphy Creek Spawning Channel by:

    a) Adding fabricated cover structures where warranted;
    b) Adding additional willows/native plant species;
    c) Monitoring and actively managing beaver and otter activity;
    d) Conducting in-stream maintenance every 2 years to suspend sediments, remove woody debris, and re-distribute/add spawning gravel.

4. Enhance the Murphy Creek Spawning Channel by:

    a) Investigating the feasibility to facilitate Rainbow Trout access to the reach of Murphy Creek above the Highway 22 Culvert (depending on results of recommendation 2) by:
        i) Actively transporting Rainbow Trout above the culvert;
        ii) Modifying the existing culvert; and
        iii) Replacing the culvert with a more fish-accessible structure.
    b) Investigating the feasibility of constructing a second spawning channel on the right (south) bank of Murphy Creek, below the entrance/exit of the existing spawning channel.

5. Promote stewardship and environmental education by:

    a) Installing an informational interpretive kiosk depicting the history and significance of the site.

References

Arndt, S. 2000. Effect of an artificial side channel on fry production and rearing densities of Rainbow Trout in Murphy Creek, Southeastern British Columbia. Columbia Basin Fish and Wildlife Compensation Program. 25 pages.

Arndt, S. and K. Klassen. 2004. Evaluation of Rainbow trout spawning migrations in Blueberry, China and Murphy Creeks from 1999 to 2003. Columbia Basin Fish and Wildlife Compensation Program. 26 pages.

Adrain, C. and R. Frew. 2014. Murphy Creek Spawning and Rearing Channel Restoration 2013/2014. Trail Wildlife Association submitted to the Fish and Wildlife Compensation Program. 6 pages.

Zimmer Environmental Ltd. 2007. A summary report for works in the Murphy Creek side channel to improve Rainbow Trout spawning habitat in 2007. Submitted to the Fish and Wildlife Compensation Program. 56 pages.

Appendix I: Okanagan Nation Alliance Report

Okanagan Nation Alliance Environmental Monitoring - Turbidity Readings				
Date	**Site**	**Description**	**Turbidity (NTU)**	**Comments**
11/24/2016	1	Intake of settling pond	1.11	Baseline
11/24/2016	2	Approximately 1 m upstream of spawning channel bridge on river right	0.08	Baseline
11/24/2016	3	End of spawning channel at flagging tape indicating last 2015 downstream redd	0.00	Baseline
11/24/2016	4	Main stem of Murphy Creek near bridge on spawning channel for a control site (murphy creek river left)	0.17	Baseline
11/29/2016	1	Intake of settling pond	0.30	Three hours after settling pond dredging
11/29/2016	2	Approximately 1 m upstream of spawning channel bridge on river right	1.53	Three hours after settling pond dredging
11/29/2016	3	End of spawning channel at flagging tape indicating last 2015 downstream redd	1.59	Three hours after settling pond dredging
11/29/2016	4	Main stem of Murphy Creek near bridge on spawning channel for a control site (murphy creek river left)	1.00	Three hours after settling pond dredging

Appendix II: Section 11 Permit

BRITISH COLUMBIA

File: 76910-20/A4-6890

November 15, 2016

Michael Zimmer
Okanagan Nation Alliance
101-3535 Old Okanagan Highway
Westbank BC V4T3L7
Sent via email to: (mzimmer@syilx.org)

Dear Michael Zimmer:

Re: Section 11 Approval – Murphy Creek – Restoration of Stream and Fish Habitat

Approval for the above has been granted, and the approval document verifying this is attached.

This Approval or copy of it should be kept on the work site so that it may be shown to a Ministry official upon request. Not having a copy of this document at the worksite is an offence under Section 106(3)(k) of the *Water Sustainability Act.*

If you have any questions or concerns regarding this Approval, please contact Ben Cross, Water Stewardship Officer, at (Benjamin.Cross@gov.bc.ca). You should contact your local government (local or municipal) to determine if there are any additional requirements.

Yours truly,

Tom Cummings, P. Ag.
Assistant Water Manager

TC:ts

Attachment

cc: Terry Anderson, Habitat Officer, MFLNRO, Resource Management, (Terry.Anderson@gov.bc.ca), (Nelson)
Cynthia Mann, Sergeant, Conservation Officer Service, (Nelson)
Terry Corley, A/C & E Officer, Compliance and Enforcement Branch, MFLNRO, (Terry.Corley@gov.bc.ca), (Nelson)

Ministry of Forests, Lands and Natural Resource Operations | Kootenay-Boundary Water Management | Mailing Address: 401-333 Victoria Street, Nelson BC V1L 4K3 | Telephone: 250 354-6333 | Facsimile: 250 354-6332 | Website: www.env.gov.bc.ca/wsd

BRITISH COLUMBIA

APPROVAL

Changes In and About a Stream

WATER SUSTAINABILITY ACT – Section11 (1)

Okanagan Nation Alliance is hereby authorized to make changes in and about a stream as follows:

A. The stream is Murphy Creek.

B. The changes to be made in and about the stream are the restoration of stream and fish habitat within Murphy Creek as submitted with the application.

C. All works shall be located and constructed in accordance with the plans and specifications contained in the document entitled "Change Approval and Notification (Changes in and About a Stream)" under Section 11 of the *Water Sustainability Act* and Part 3 of the Water Sustainability Regulations submitted by Michael Zimmer, dated September 13, 2016.

D. The works authorized shall be completed on or before December 30, 2016.

E. Care shall be exercised during all phases of the work to minimize siltation.

F. The holder of this approval shall take reasonable care to avoid damaging any land, works, trees or other property, and shall make full compensation to the owners for any damage or loss resulting from the exercise of the rights granted with this approval.

G. This approval does not authorize entry onto privately held land.

H. Vegetation along the bank shall be disturbed as little as possible.

I. All disturbed areas of the bank shall be restored to their original condition and protected from erosion

J. Any machinery operated on site shall be in good repair and be free of hydraulic leaks and excess surface oil and grease.

Ministry of Forests, Lands and Natural Resource Operations | Kootenay-Boundary Water Management | Mailing Address: 401-333 Victoria Street Nelson BC V1L 4K3 | Telephone: 250 354-6333 Facsimile: 250 354-6332 Website: www.env.gov.bc.ca

K. Fuelling and servicing of vehicles and equipment must occur a minimum of 30 metres away from all streams, lakes and waterbodies and any spills must be properly cleaned up and reported as required by the Spill Reporting Regulation (B.C. Reg. 263/90).

L. Upon completion of this project no depressions will be left in the streambed that could trap fish or initiate erosion.

M. This Approval, or a copy of it, must be kept or posted on the work site so that it may be shown to a Ministry official upon request.

Thomas W. Cummings, P.Ag.
Assistant Water Manager
Water Stewardship Division
Ministry of Forests, Lands and Natural Resource Operations

Date: November 15, 2016

Approval: A4-6890

Ministry of Forests, Lands and Natural Resource Operations
Kootenay-Boundary Water Management
Mailing Address: 401-333 Victoria Street Nelson BC V1L 4K3
Telephone: 250 354-6333
Facsimile: 250 354-6332
Website: www.env.gov.bc.ca

Appendix III: Teck Metals Limited Letter of Permission

Dave DeRosa
Superintendent, Ecosystems Projects
David.DeRosa@teck.com

Teck Metals Ltd.
Trail Operations
P.O. Box 1000, 25 Aldridge Avenue
Trail, BC Canada V1R 4L8

+1 250 364 4124 Tel
+1 250 364 4272 Fax
www.teck.com

Teck

July 1, 2014

Trail Wildlife Association
1440 Bay Avenue
Trail, BC, V1R 4L5

Attention: John Harmston

Dear Sir:

Re: **PERMISSION TO USE TECK PROPERTY**

Further to your request, we hereby confirm that Teck Metals Ltd. ("TECK") grants permission for Trail Wildlife Association ("TWA") and its contractors, representatives, and agents (as approved in writing by TECK) to use the TECK Property (as defined in section 3 below) for maintenance and monitoring of the Murphy Creek Spawning Channel and associated infrastructure (the "Authorization"), on the following terms:

1. This Authorization expires June 30, 2017 (the "Term");
2. The parties acknowledge and agree that the maintenance activities are being done at no cost to TECK and TECK will not be contributing financially;
3. TWA agrees to provide reasonable notice to TECK prior to using TECK Property;
4. TECK Property consists of the lands as indicated by a red outline on the attached Schedule "A" to this permission letter, (the "TECK Property");
5. TECK may at any time, by written notice, suspend or terminate the Authorization without cause;
6. The specific authorized site for the access area is limited to the TECK Property (the "Authorized Area");
7. TWA agrees to not use other areas on TECK Property other than the Authorized Area without the prior written consent of TECK;
8. TWA shall use the Authorized Area only during daylight hours;
9. TWA shall not make any written use of or reference to TECK's name or trademarks (or any name under which TECK does business) for any purpose without the prior written consent of TECK, which consent may be withheld or granted in TECK's sole and absolute discretion;
10. TWA shall not erect any permanent improvements on the Authorized Area, except as agreed to by TECK pursuant to TWA's submitted plan;

11. TWA shall not discharge or cause to be discharged any firearms or explosives on the TECK Property;

12. TWA shall provide TECK with a full, unedited copy of the results and any reports or papers that incorporate the results, whether published or not, relating to the cuttings taken from the Teck Property and Authorized Area at no cost to TECK;

13. TWA will not, without TECK's prior written approval, make any statement or publish or release to any other person any photograph, advertisement, testimonial, letter of commendation or approval or any other document or written matter which might imply TECK's approval of the results of the use of the cuttings.

14. TWA acknowledges that TECK is committed to excellence in environmental management. TWA shall ensure that all activities in relation to this Authorization are conducted in such a manner as to have a minimal adverse impact on the environment. TWA shall comply, and shall ensure that all invitees comply, with all relevant federal, provincial and municipal statutes, regulations and bylaws.

15. TWA shall abide by the requirements of the Ministry of Forests, Lands and Natural Resource Operations as set out in their letter of October 2, 2013 including, but not limited to, the requirements of the *Water Act* and the Water Regulation (BC Regulation 204-88).

16. TWA agrees to obtain and maintain in force for the Term:

    a. Commercial General Liability Insurance having a limit of not less than $2,000,000 per occurrence, naming "Teck Metals Ltd., Teck Resources Limited and their respective directors, officers, employees, and agents" as Additional Insureds;

    b. Automobile Liability Insurance having a limit of not less than $2,000,000 per occurrence; and

    c. Workers' Compensation Insurance in compliance with the laws and other statutory and regulatory obligations imposed by the jurisdictions in which the Services are being provided.

    TWA agrees to forward a copy of their insurance certificate and clearance letter to TECK, c/o Director, Risk & Global Insurance, Teck Resources Limited, 3300 – 550 Burrard Street, Vancouver, BC V6C 0B3.

17. TWA shall indemnify and save harmless TECK, its directors, officers, successors, assigns, employees, contractors, representatives, and agents from all claims, demands, losses, costs and expenses (including actual legal costs and disbursements) caused to or incurred by TECK, and from all claims and demands, loss, costs, damages, actions, suits or other proceedings by whomsoever made, brought or prosecuted in any manner and damages based upon, arising out of or connected with the uses of the Authorized Area by TWA or TWA's invitees including, without limitation, environmental damage, or contamination, or damages arising from the building of improvements, or third party claims, or for any action taken or things done or maintained in connection with this Authorization; the intent being that TECK shall be at no expense or loss to which it would not have incurred but for this Authorization;

18. TECK shall not be liable to TWA or to any third party for any direct, indirect, special or consequential damages, arising directly or indirectly out of this Authorization, whether or

not those damages arose in contract, tort or strict liability and whether or not the damages were foreseeable even if TECK was advised of the possibility of them;

19. TWA acknowledges that the Authorized Area may contain inherent hazards, including naturally occurring geographical features; and that TECK shall not incur any liability whatsoever to TWA or to any third party for any claims arising therefrom;

20. TWA agrees to indemnify and hold harmless TECK and its directors, officers, successors, permitted assigns, employees and agents from any liability or claim including but not limited to any direct or indirect monetary loss, or civil or criminal law suit, resulting from:

    a. injury to or the death of any persons;

    b. damage to or loss of any property; and/or

    c. damage to the environment

    arising directly or indirectly from the uses of the Authorized Area;

21. TWA is responsible for removing all of its equipment as well as cleaning up the Authorized Area after it has finished using the Authorized Area to ensure that the Authorized Area is free of garbage or other debris that may have been caused by TWA. If any ground in or around the Authorized Area is disturbed, TWA will reseed the disturbed area as soon as possible with suitable seed to prevent intrusion by undesirable weeds as directed by TECK. TECK may, at its option, clean up the Authorized Area if TWA has not done so by the end of the Term and any costs associated with TECK's clean up of the Authorized Area will be billed to and paid for by TWA. TWA shall be responsible for maintaining the Authorized Area to an appropriate and safe standard for the access and use during the Term of the Authorization.

22. TWA shall not assign this Authorization.

23. Any amendments to this Authorization must be made in writing and signed by both parties.

Please acknowledge TWA's agreement to the terms outlined within by signing this letter where indicated below and a copy to our office as soon as possible.

If you have any questions, please do not hesitate to contact me.

Yours truly,

Dave DeRosa
Superintendent Ecosystems Projects

The undersigned confirms that he/she has read this letter and hereby agrees to the terms set out within.

Date: June ___, 2014

TRAIL WILDLIFE ASSOCIATION
by its authorized signatory:

_____

Print Name:

not those damages arose in contract, tort or strict liability and whether or not the damages were foreseeable even if TECK was advised of the possibility of them;

19. TWA acknowledges that the Authorized Area may contain inherent hazards, including naturally occurring geographical features; and that TECK shall not incur any liability whatsoever to TWA or to any third party for any claims arising therefrom;

20. TWA agrees to indemnify and hold harmless TECK and its directors, officers, successors, permitted assigns, employees and agents from any liability or claim including but not limited to any direct or indirect monetary loss, or civil or criminal law suit, resulting from:

    a. injury to or the death of any persons;

    b. damage to or loss of any property; and/or

    c. damage to the environment

    arising directly or indirectly from the uses of the Authorized Area;

21. TWA is responsible for removing all of its equipment as well as cleaning up the Authorized Area after it has finished using the Authorized Area to ensure that the Authorized Area is free of garbage or other debris that may have been caused by TWA. If any ground in or around the Authorized Area is disturbed, TWA will reseed the disturbed area as soon as possible with suitable seed to prevent intrusion by undesirable weeds as directed by TECK. TECK may, at its option, clean up the Authorized Area if TWA as not done so by the end of the Term and any cos s associated w' h TECK clean up of the Authorized Area will be billed to and paid for by TWA. TWA shall be responsible for maintaining the Authorized Area to an appropriate and safe standard for the access and use during the Term of the Authorization.

22. TWA shall not assign this Authorization.

23. Any amendments to this Authorization must be made in writing and signed by both parties.

Please acknowledge TWA's agreement to the terms outlined within by signing this letter wher indicated below and a copy to our office as soon as possible

If you have any questions, please do not hesitate to contact me.

Yours truly,

Dave DeRosa
Superintendent Ecosystems Projects

The undersigned confirms that he/she has read this letter and hereby agrees to the terms set out w th n

Date: June 4 , 2014

TRAIL WILDLIFE ASSOCIATION
by its authorized signatory:

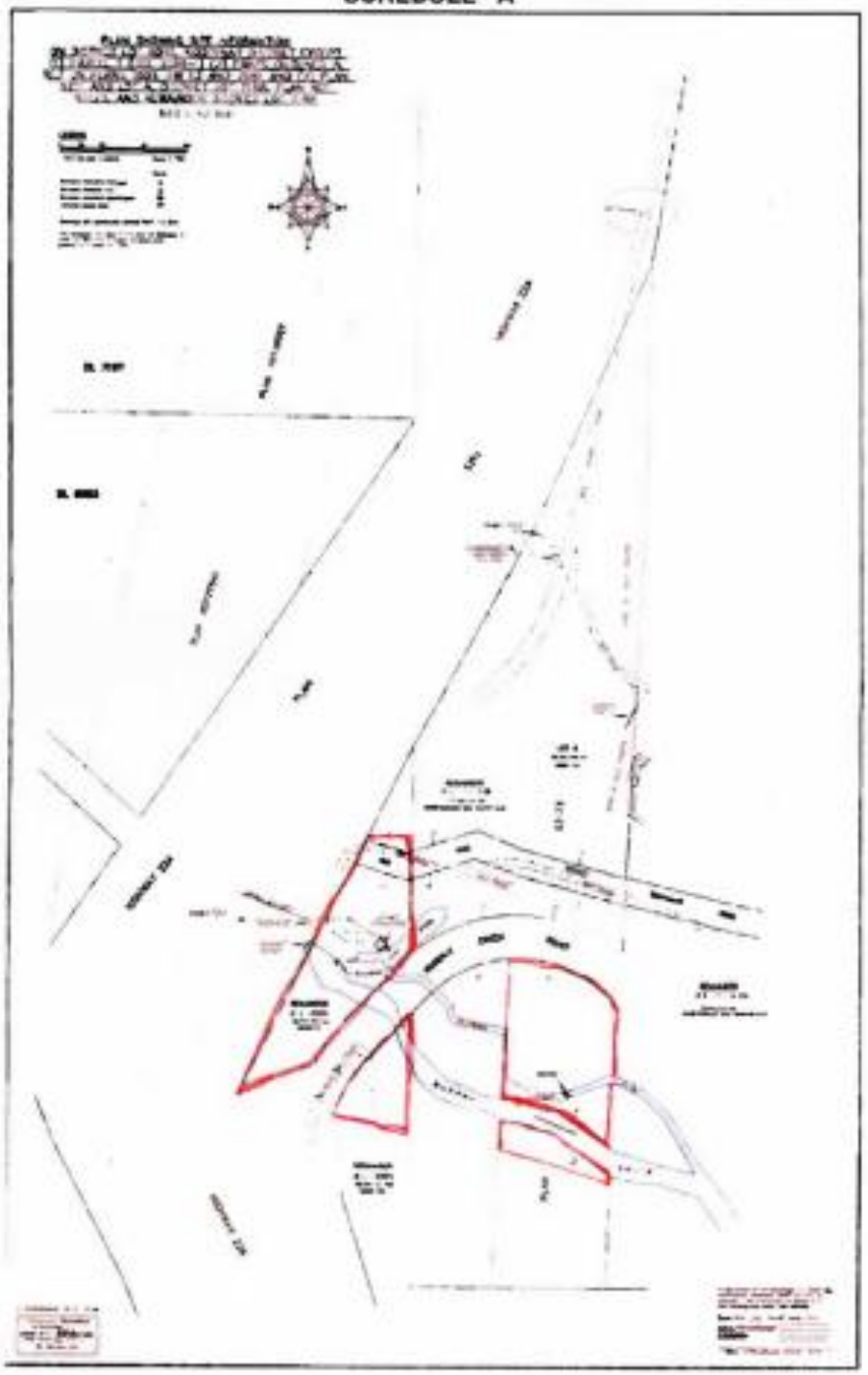
Rob Frew

Print Name:

ROB FREW TWA DIRECTOR

3 A

SCHEDULE "A"



Appendix IV: Performance Measures and Indices

Performance Measures – Target Outcomes - Continued												
Project Type	Primary habitat benefit targeted of project (sq.m.)	Primary Target Species	Estuarine	In-stream Habitat – Mainstream	In-stream Habitat – Tributary	Riparian	Reservoir Shoreline Complexes	Riverine	Lowland Deciduous	Lowland Coniferous	Upland	Wetland	Other
Maintain or Restore Habitat forming process												
Artificial gravel recruitment	Area of stream habitat improved by gravel placement	Spawning Rainbow Trout 400 m2	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	
Artificial wood debris recruitment	Area of stream habitat improved by LWD placement		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Small-scale complexing in existing habitats	Area increase in functional habitat through complexing	Spawning Rainbow Trout 400m2	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	
Prescribed burns or other upland habitat enhancement for wildlife	Functional area of habitat improved		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Habitat Development													
New habitat created	Functional area created		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Other													
			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Appendix V: Confirmation of FWCP Recognition

The Fish and Wildlife Compensation Program was/will be recognized for their role as funders in the Murphy Creek Rainbow Trout Spawning Channel Maintenance 2016 – 2017 project through the following planned presentations/media:

- PowerPoint Presentation – October 14th 2016 – J.L. Crowe Secondary School.
    - Presented in front of thirty potential work experience students who were considering participating in the Murphy Creek Spawning Channel Project, the TWA included all partners in the presentation.

- Wildsite Field School at Murphy Creek Spawning Channel May 3,4,5.
    - J.L. Crowe Secondary students. We discussed the history and significance of the spawning channel and the role that FWCP and other organizations and volunteers played in the creation and development of the site.

- Presentation - May 12, 2017. Trail Wildlife Association Supper Meeting. A presentation on the results of the 2016 channel maintenance project was given to members of the TWA. The FWCP was recognized as the funder for this project.

- Website Article – Spring 2017 – http://www.trailwildlife.com/
    - A summary of the project will be placed on the Trail Wildlife Association website and will recognize the FWCP as funders.

- PowerPoint Presentation – Fall 2017 – J.L. Crowe Students
    - A presentation on the results of the 2016 channel maintenance project will be given to J.L. Crowe students. The FWCP will be recognized as funders for this project.

- PowerPoint Presentation – Fall 2017 – Castlegar Fly Fishing Club
    - A presentation on the results of the 2016 channel maintenance project will be given to members of the Castlegar Fly Fishing Club. The FWCP will be recognized as funders for this project.

- Newspaper Article – Summer 2017 – Trail Daily Times
    - An article about the Murphy Creek spawning channel is planned to be submitted to the Trail Daily Times describing the work completed in 2016. The FWCP will be recognized as funders.

Any other presentations, articles, or other forms of media that have yet to be planned regarding the work conducted on the Murphy Creek spawning channel in 2016 will acknowledge FWCP as the funders for the work.