NECHAKO ENVIRONMENT & WATER STEWARDSHIP SOCIETY

NEWSS

Annual Report September 1, 2014 to March 31, 2015

Submitted to NEEF

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Nechako Environment & Water Stewardship Society

Nechako Environment and Water Stewardship Society – NEWSS

NEWSS – Incorporated into a society January 31, 2012 S-0059345

Board of Directors:

Wayne Salewski – Chair
John Degagne – Secretary/Treasure
Brain Frenkel – Director
Cam Hill – Director
Richard Martens- Director

NEEF Project name: Nechako River Sustainability

Forward:

NEWSS has moved from its original roots of the "Murray Creek Stream Restoration Project" to its new society "NEWSS" to facilitate the larger idea of working on all of the streams within the Nechako Valley agricultural belt and to better facilitate partnerships and relationships that work towards NEWSS's goals as listed:

- Facilitating the rehabilitation of streams that flow through the Nechako Agricultural Belt.
- Facilitating watershed planning that provides a framework to protect, maintain and restore a healthy natural watershed.
- Collaborating to improve the mapping of aquifers that lie beneath the Nechako Plateau and foster an improved understanding of the role healthy streams and riparian areas play in the dynamic interaction of surface and groundwater.
- Assisting government to meet its stated vision for a cleaner and healthier environment.
- Facilitating and participating in environmental stewardship and education opportunities for schools, universities and the community at large, including stream rehabilitation, water quality, Nechako White sturgeon and salmonids.
- Developing a program to administrate a "Gold Label" certification standard for agricultural products produced in the Nechako Valley by identifying opportunity to recognize agriculture producers that have Farm Stewardship Plans in place and apply Best Management Practices on the land and streams with stewardship as an objective and to ensure the legacy of these values.

Project Goals: build towards achieving the six primary goals that meet NEEF objectives and NEEF MC decisions

1. *Facilitate the rehabilitation of streams that flow through the Nechako Valley agricultural belt (NEEF decision 6)*

   NEWSS has prior to and during this reporting period worked on 4 streams within the agricultural belt:

   - Murray Creek: During this reporting period NEWSS has repatriated 600 meters of stream from its current "re-location" from a decade ago back into its original channel which has been rebuilt to include over winter habitat while additionally creating better structure through log and rock placement.
     This not only removed the stream from the field but eliminates a larger source of sediment from continually eroding downstream and into the Nechako River.
     Off channel watering and fencing of this area are included within the project.

   - Stoney Creek: During this reporting period NEWSS has created over wintering habitat in three locations within the lower section, strengthen erosion control and habitat creation above and below the Douglas Street bridge and remove and replaced three large culverts that were incorrectly installed over thirty years ago with a bridge.

   - Chilako River (Mud): Previous to this reporting period, NEWSS had in conjunction with Fraser Basin Council facilitate a public meeting with regional and local governments officials from all levels and members of the upper and low communities that live along the Chilako River. The local residents have been flooded out on a regular bases with the accusations that over harvesting has lead to annual flooding.
     This meeting has during this reporting period lead to NEWSS in partnership with MFLNR installing data loggers within the system and two flights along the system to facilitate the development of a strategy to stabilize the eroding banks, understand where we need to create a better riparian zone and to develop a longer term fencing strategy to remove cattle from the river. We have also requested a response from the two major licensee's to understand how over harvesting of this watershed has been allowed to happen when they

exceed the equivalent clear cut area (ECA) recommendations of 30% by DFO.

- Knight Creek: During this reporting period NEWSS has had a broad overview of the watershed to appreciate its complicates, interviewed numerous farms, ranches and residents to garner local history and applied for funding to start the development of a longer term recovery plan for the water shed. Initial field examinations can attest to a large annual sediment loss that has come from up stream damming on private land through to poorly placed culverts and bad land clearing practices.

2. *Facilitate watershed planning that provides a framework to protect, maintain and restore a healthy natural watershed.*
   (NEEF decision 6 & 7)

   Prior to and during this reporting period NEWSS is a founding member of the Nechako Watershed Roundtable (NWR). The Nechako Watershed Roundtable is a volunteer entity created to direct and advise water stewardship activities in the Nechako River Basin. The Roundtable sets the strategic direction of these activities with the Core Committee serving as the decision-making body to advance this direction.
   The NWR is made up of a variety of stakeholders ranging from cities, municipalities and regional districts along with UNBC, Fraser Basin Council and numerous First Nations and we will be rolling out our vision in October of 2015 at an event at UNBC.

   Prior to and during this reporting period NEWSS has been moving forward with an approach to create collaborative management strategies for two lesser watersheds within the defined area of NEWSS operation, (Stoney Creek and Chilako) and one within the boundaries of the NWR (Necoslie) that are a result of proposed relationships being facilitated by MFLNR, the District of Fort St James, Carrier Sekani Tribal Council (CSTC) and the Upper Fraser Fisheries Conservation Alliance. These are opportunities to facilitate conversations that will ensure a complete vision for those watersheds and ensure that investment being made piece meal can be protected and enhanced by the larger strategy.
   NEWSS has also moved forward a conversation to create two lake management strategies for Nulki and Tachick with water monitoring and development of goals and objectives are now taking place.

3. *Collaborating to improve the mapping of aquifers that lie beneath the Nechako Plateau and foster an improved understanding of the role healthy streams and riparian areas play in the dynamic interaction of surface and groundwater (NEEF decision 6 & 7)*

   Prior to and during this reporting period NEWSS has been actively involved in with staff from the MFLNR in supporting their endeavors to create a relationship with the agricultural community and to collect data from existing wells within the region.
   This is a work in progress with MFLNR now having a staff member signed to this task and they are now in their second summer of collection and NEWSS has take a role in informing the Regional Cattleman's Association with the benefits of cooperating and the beneficial reasons why.
   MFLNR has stated publicly that without NEWSS moving this agenda forward there would be no regional program looking at aquifer health in the Nechako Valley.

4. *NEWSS will proactively work towards a cleaner and healthier environment which is a stated vision of the Ministry of Environment Service Plan 2013/14*

   During this short window within the reporting period NEWSS has not had an opportunity to delve to far into this section.
   We have read the updated Service Plan and must confess some confusion with NEEF MC and this request as a mandated function of NEWSS. Many of the issues identified are not within the core business or objectives of NEWSS and would look forward to clarification of this objective as much of it is more to do with the proactive mandate of moving oil and gas forward.

5. *Facilitate and participating in environmental stewardship and education opportunities for schools, universities and the community at large including stream rehabilitation, water quality, Nechako White Sturgeon and salmonids. (NEEF decision 6)*

   Prior to and during this reporting relationship NEWSS has taken an active role in facilitating educational opportunities in schools, universities and within the community. In this reporting period we have:
   - NEWSS has been invited to judge environmental programs and projects with SD 91 and to suggest next steps with these projects.
   - NEWSS has facilitated several field trips for high school classes from within SD 91 to look at our stream restoration projects.

- NEWSS organized a trip and luncheon with Dr. David Suzuki for the local enviro class at Nechako Valley Senior Secondary to UNBC to introduce them to the Blue Dot campaign of the Suzuki foundation. Blue Dot campaign was presented to and endorsed by The District of Vanderhoof.
- NEWSS provide the guest speaker at the Regional Cattleman's Association AGM to showcase the accomplishments of NEWSS and to layout the future roles and objectives of our Society. NEWSS believes that the regional cattleman believe in the value and role of NEWSS and have stated so at their AGM.
- NEWSS has seen an opportunity to work with the BC Cattleman's Association on their goal of enhancing riparian zones around the Nechako Valley to enhance habitat for the Clark woodpecker. Although this woodpecker is not common within the region, any or all work on riparian zones will be healthy for water quality, salmonids and the Nechako White Sturgeon.
- NEWSS continues to work with the District of Vanderhoof in accounting for the health of the riparian zones within their boundaries and is currently in discussions on next steps to enhance and protect the wetlands, greenbelts and riparian zones.
- NEWSS continues to work with the District of Vanderhoof to facilitate the removal of vehicles placed into the Nechako River decades ago as a buffer to erosion.
- NEWSS is currently working with the administration of SD 91 to facilitate how more out of classroom education can be included in their programs.
- NEWSS has developed a strong relationship with the District of Fort St. James and along with a presentation by MP Nathan Cullen and NEWSS chair Wayne Salewski we have seen a fledgling group emerge that is now examining a stream restoration project on a local stream. In this regard we have also created a working relationship with the Mnt. Milligan group to help facilitate this opportunity.
- NEWSS has worked with several grad students at UNBC to facilitate their variety of studies on sediment movement through the streams we are engaged on and within the Nechako River

6. *Developing a "Gold Label" certification standard for agricultural products produced in the Nechako Valley by identifying opportunities to recognize producers that have Farm Stewardship Plans in place and apply Best Practices on the land and streams with stewardship as an objective and to ensure the legacy of these values.*

We continue to discuss how this will be rolled out but have had conversations in the recent past with individuals from Prince George that are supportive of this idea and from a marketing standpoint they see this as an important opportunity. We have also had interest expressed from funders to participate and support this idea.
It is our feeling that this is still early days but it is on our agenda to continue to move this idea forward.

Workplans

2014/2015 Actions	Tasks	Delivery Partners	Outputs/ Outcomes	Timelines	NEWSS Budget	NEEF Contributions	Funding Partners
Stream Restoration Stoney Creek	*removal of fish barriers removal of sediment buildups by excavation &creation of overwintering habitat including signage*	*Recreational Fisheries Compensation Program No:14-HPAC-00803 2year program*	*creates over winter habitat and backwaters stream…removes poor culvert placement*	*completed March 31,2015*	*$ 200,000.00*	*$ 100,000.00*	*$ 100,000.00*
Stream Restoration Murray Creek	*remove stream from field and puts it back in old and improved channel*	*Recreational Fisheries Compensation Program No: 14-HPAC 00051 ends March 31 2015*	*Creation of overwintering habitat in old channel & removal of stream from farm field* *Educational signage*	*completed March 31,2015*	*$ 200,000.00*	*$ 100,000.00*	*$ 100,000.00*
Stream Restoration Stoney Creek		*District of Vanderhoof (cash)*	*create habitat Stoney Creek*	*completed March 31,2015*	*$ 11,000.00*	*$ -*	*$ 11,000.00*
Stream Restoration Stoney Creek		*L&M Lumber (materials and technical costs)*	*supplied bridge and engineering for Stoney Creek*	*completed March 31,2015*	*$ 30,000.00*	*$ -*	*$ 30,000.00*
Stream Restoration Stoney Creek		*TransCanada Pipeline (cash)*	*watershed planning Stoney Creek*	*completed March 31,2015*	*$ 10,000.00*	*$ -*	*$ 10,000.00*
Total NEEF Contribution 2014/2015						*$ 200,000.00***	
Total Funding for Period					***$ 451,000.00***	***$ 200,000.00***	***$ 251,000.00***

*** NEEF has deposited $100,000for (2014-2015)*
but there is an outstanding $100,000 for works completed

2015/2016 Actions	Tasks	Delivery Partners	Outputs/ Outcomes	Timelines	NEWSS Budget	NEEF Contributions	Funding Partners
Stream Restoration Stoney Creek	*removal of fish barriers removal of sediment buildups by excavation &creation of overwintering habitat including signage*	*Recreational Fisheries Compensation Program No:14-HPAC-00803 Year 2*	*creates over winter habitat and backwaters stream…removes poor culvert placement*	*to be completed March 31, 2016*	*$ 200,000.00*	*$ 100,000.00*	*$ 100,000.00*
replace three culverts under Larson road - Murray Creek	*install one culvert*	*Ministry of Transportation and Infrastructure*	*removes fish passage barriers, moves obstruction that divides the stream into three parts*	*March 31,2016*	*$ 300,000.00*	*$ 100,000.00*	*$ 200,000.00*
Knight Creek	*move stream back into its original channel. Establish riparian zone. Create one over wintering spot. Landowner to fence out stream*	*Recreational Fisheries Compensation Program No:14-HPAC-01214*	*streamed washed out several years ago when a dam broke upstream and channel lost definition, Large interest from area residences for this watershed*	*Sept 1st 2015 - March 31 2016*	*$ 100,000.00*	*$ 50,000.00*	*$ 50,000.00*
Chilako/Mud River	*repair stream bank, create riparian zone. Restrict cattle from river*	*Recreational Fisheries Compensation Program No:14-HPAC-01214*	*remove cattle from river, restrict cattle access to river, creates some level of hope for area residences and the long path to total restoration*	*Sept 1st 2015 - March 31 2016*	*$ 100,000.00*	*$ 50,000.00*	*$ 50,000.00*
Stream Restoration Stoney Creek	*removal of fish barriers removal of sediment buildups by excavation at CN rail crossing of Stoney Creek*	*CN Rail*	*Replace fish blockage by installing culvert in proper manner, backwater weir above and below, repair erosion below current culvert*	*Sept 1st 2015 - March 31 2016*	*$ 350,000.00*	*$ -*	*$ 350,000.00*
Total NEEF Contribution						*$ 300,000*	
Total Funding for Period					***$ 1,050,000***	***$ 300,000***	***$ 750,000***

Murray Creek
Watershed Rehabilitation:

Historic Stream Channel Re-establishment and Culvert Replacement, KP9+500 – KP10+100

Final Report

Prepared By:

Mark Tiley, M.A.Sc., RP Bio., Olin Albertson, B.Sc., RP Bio.,
and Brian Frenkel, Director, Avison Management Services

Prepared for:

The Nechako Environment & Water Stewardship Society (NEWSS)

In Fulfillment of the *Nechako Environment Enhancement Fund* Contribution Agreement Requirements

Executive Summary

In continued effort to restore aquatic and riparian habitats in the Nechako Watershed, Avison Management Services was retained by Nechako Environment and Water Stewardship Society (NEWSS) to: (1) survey fish habitat in Murray Creek; (2) prescribe, design, conduct and oversee restoration projects and (3), on behalf of NEWSS, complete habitat prescription reports, environmental monitoring reports and a final report (Activity 5) detailing the activities completed in the 2014/2015 fiscal year as required under the NEEF Contribution Agreement (Agreement). The four activities completed as per Agreement requirements were: Murray Creek instream fish habitat restoration and fish passage improvement; (Activity 1); Riparian Planting (Activity 2); Reporting and Documentation (Activity 3) and Project Signage (Activity 4).

The Murray Creek historic channel restoration and culvert replacement project (Project) area is located within the District of Vanderhoof (DOV) from the Larson Road crossing at river kilometer (KP) 10+0 to 0.64 kilometers (km) downstream at approximately KP9+500). For approximately the past 20 years, stream flow has been diverted out of the historic Murray Creek channel at the Larson Road crossing into an agricultural field resulting in the loss of approximately 0.64 km of high quality fish habitat. The Project involved (1) locating and marking the historic channel; (2) removing accumulated soil from the historic creek channel to an average depth of approximately 1 meter to allow for sufficient flow volume to improve fish passage and prevent excessive flooding into neighbouring farm fields; (3) the installation of bank erosion control and fish habitat features; (4) the placing salmonid habitat enhancement features, including bank armouring for erosion control, to maximize habitat suitability for resident rainbow trout and, potentially, rearing habitat for juvenile Chinook salmon and (5) removing the earthen diversion dam constructed over 20 years ago; To minimize impact to existing riparian vegetation and prevent the sedimentation of downstream habitats, all instream channel work was completed in the dry during the period from January 29, 2015 to February 25, 2015, a period in which all onsite transportation routes, landings and access points remained frozen.

One sign design, intended to inform the general public on the purpose and intended benefits of the Murray Creek habitat restoration project, and acknowledge funding contributors, was jointly developed by Avison Management Services Ltd and NEWSS with the final signage design being completed in early March 2015. A contractor has agreed to install the sign.

Stream bank at the outside bends and other locations vulnerable to erosion were armoured with boulders and cobbles. LWD (spruce root wads and logs) and alder removed from the stream channel and boulders were strategically placed along the banks and within the channel to (i) provide instream cover and velocity refugia for juvenile Chinook salmon and all life history stages of rainbow trout; (ii) create scour pools and deflect flows towards the thalweg to further increase bank stability and substrate sorting and (iv) increase spawning gravel retention. A layer of cobbles and gravels, approximately 15 to 20cm deep, were placed on top of dredged stream bed for macroinvertebrate production and cover for juvenile salmonids and small fish species. Intermediate diameter gravels of 1.5 to 6.0cm considered optimum for resident rainbow trout spawning success (Raleigh *et al*., 1984) were placed at locations typically used for spawning by

salmonids including pool tail-outs, behind large boulders, amongst coarse woody debris and riffles.

Willow whips collected from local sources were planted over a period of two weeks in early spring 2015 as the ground gradually thawed (March 26, March 30 and March 31) around the banks of the downstream-most overwintering pool that lacked riparian vegetation and in sections of exposed bank observed along the 180m of stream channel between the alder stand to the East and willow thickets located at the downstream (west) end of the project.

Acknowledgements

Funding for the Stoney Creek Rehabilitation Project was generously provided to the Nechako Environment and Water Stewardship Society (NEWSS) through grants from the Fisheries and Oceans Canada Recreational Fisheries Conservation Partnerships Program and the Nechako Environmental Enhancement Fund (NEEF). Avison Management Services Ltd (Avison) biologist Olin Albertson was the primary contributor towards the habitat prescriptions and coordinated and directed the actual instream habitat enhancement activities. Avison Director Brian Frenkel oversaw the budgeting and equipment and material purchases. Avison staff members Scott Klassen, Ian Macleod and Geoffrey D. Mercer assisted with the environmental monitoring, erosion control/sediment isolation and the planting of willow cuttings. Avison biologist Mark Tiley contributed towards environmental monitoring, the planting of willow and report writing.

Many thanks go out to landowners John Andros and Allan Martens for allowing access to the project site through their property. We also wish to thank Richard Martens (President: Sinkut Mountain Cattlemen's Association) for meeting with landowners and facilitating the partnership between landowners and NEWSS. Also we must acknowledge the work performed by M4 Contracting Ltd for their excellent services in completing this project.

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1.0 Introduction

For approximately the past 20 years, an earthen berm (dam) has diverted stream flow out of a 640m section of Murray Creek channel which historically flowed through a dense wooded stand primarily consisting of alder (*Alnus spp.*) that provided high quality fish rearing habitat. Due to the berm, Murray Creek has cut a new channel of low fish habitat value through a neighbouring farm field to the North resulting in a loss of crop production. A diversion ditch was then constructed along the southern boundary of the farm field in an effort to divert flows out of the farm field to reduce erosion and loss of topsoil and lost crop production due to flooding. In 2014 the Nechako Environment and Water Stewardship Society (NEWSS) retained Avison Management Services (AMS) to: (1) locate the historic Murray Creek channel that travelled approximately 460m through the dense alder stand; (2) prescribe, design, implement and oversee restoration activities that would restore juvenile salmonid rearing habitat, create additional juvenile salmonid and adult rainbow trout overwintering habitat and create additional rainbow trout, and potentially Chinook and coho salmon, spawning habitat; (3), on behalf of NEWSS, complete habitat prescription reports, environmental monitoring reports and a final report detailing the activities completed in Murray Creek as required under the NEEF contribution Agreement (Agreement) for the 2014 -2015 fiscal year. The four activities completed as per Agreement requirements were as follows: (1) design and implement improvements to fish passage and salmonid habitat within the section of historic Murray Creek into which water would be re-diverted; (2) plant willow whips in areas devoid of or lacking in riparian vegetation; (3) complete a final report detailing habitat prescriptions, work completed, techniques used and project expenses; and (4) design and erect signs explaining the purpose and benefits of the project to the general public and to acknowledge the DFO and NEEF for funding this Project).

1.1 Background

Aquatic ecosystems within the Nechako River watershed have been impacted by forestry and agricultural land use practices (Government of B.C., 2015a) and more recently the loss of extensive pine forest to pine beetle (*Dendroctonus ponderosae*) outbreaks. These cumulative impacts have altered watershed hydrology, removed or reduced riparian vegetation and increased the rate of erosion and sediment transport into surface waters resulting in a substantial loss in rainbow trout (*Oncorhynchus mykiss*) Chinook salmon (*O. tshawytscha*) and the endangered and *Species At Risk Act* (SARA) protected white sturgeon (*Acipenser transmontanus*) habitat.

The Nechako Environment and Water Stewardship Society (NEWSS), established in 2006 initially to implement riparian habitat restoration within the Nechako Plateau, serves in an advisory capacity in order to achieve high quality land and water stewardship within the Nechako River watershed. The NEWSS purpose statement (NEWSS, 2015) is as follows:

> "...corroboratively improve damaged stream ecosystems within the Nechako Watershed by restoring riparian function in the flood plain of streams, enhancing the regions collective awareness of surface and groundwater as a single resource

and creating an atmosphere where the residents, land owners and various industries can voluntarily improve land and water stewardship practices"

Rehabilitation projects, including one culvert assessment report, one fish passage report, and this project report (14-03), are listed in (**Table 1**). The reports for each project are available at http://newssociety.org /newss_reports.html. The sites were selected for rehabilitation based on (1) qualitative fish habitat assessment; (2) quantitative culvert assessments; (3) the amount of potential rainbow trout and Chinook habitat gained or protected and (4) the granting of access to site by private land owners or the District of Vanderhoof.

Table 1. Completed Murray Creek Rehabilitation Projects.

Project Title	Year Completed
14-01: Murray Creek fish passage report	2014
14-02: Murray Creek historic channel restoration and culvert replacement	2015
11-01: North Side Rd culvert replacement/livestock crossing structure installation	2011
11-02: Dale Marten/Loop Rd culvert replacement	2011
11-03: Gaylon Mckee property culvert replacement	2011
11-04: Sylvia Price property culvert replacement	2011
11-05: Kevin Bailey property hardened cobble-gravel livestock crossing	2011
11-06: John Bailey property hardened cobble-gravel livestock watering site	2011
11-07: Murray Creek culvert assessment report (revised in 2014)	2011
10-01: Allan Marten property culvert replacement	2010
10-02: HCTF demonstration site/riparian planting	2010
10-03: Tom Silvers property channel realignment and habitat enhancement	2010
10-04: Vern Reimer property bank stabilization and habitat enhancement	2010
10-05: L & M Lumber Ltd Streigler Pit Rd silt management	2010
10-06: Mcleod Rd Martens & Sons cattle exclosure/riparian protection fencing	2010
09-01: Galyon Mckee bridge foundation replacement	2009

1.2 Murray Creek

Murray Creek is classified as a 2nd order, S3 stream at the Nechako confluence according to Habitat Wizard with a magnitude of about 2. An S3 stream as defined by the Province of B.C. (1995) in the Riparian Management and Area Guidebook is a fish bearing channel with a bankfull width of 1.5 to 5.0m. Based on Provincial Terrain Resource Information Management (TRIM) maps, Murray Creek, the origin of which is located at approximately kilometer post (KP)17+800 (17.8) kilometers upstream from the Murray Creek/Nechako River confluence (**Figure 1**), travels southward from an elevation of 2844ft (866.8m) above mean sea level (AMSL) (10U 430536. 43E, 5996552.41N) initially through approximately 4 km of mix forest within a hilly ridge. Murray Creek then flows across approximately 13.9km of relatively flat agricultural lands until reaching the Nechako/Murray Creek confluence within the town of Vanderhoof at an elevation of 2084ft (635.2m). The majority of the Murray Creek headwaters, including the East Murray Creek catchment area, originate from small lakes (*e.g.* Waterlily Lake, Janzé Lake) wetlands and drainages located to the East within forested sections of the ridge

which flow in Westerly direction, eventually draining into Murray Creek. It should be noted that TRIM maps do not account for all channel meanders thus, for short distances, the Google Earth measuring tool "Path" was used to measure short distances, indicated as river kilometers (rkm) within the project area. East Murray Creek, the most significant tributary, confluences with Murray Creek, 0.41rkm downstream of the Snell Road culvert crossing at KP6 + 350 (**Figure 1**). The topography affecting the project site varies from nearly level in the agricultural belt to strongly sloping and hilly 1.5km to the north of the Larson Rd culvert crossing.

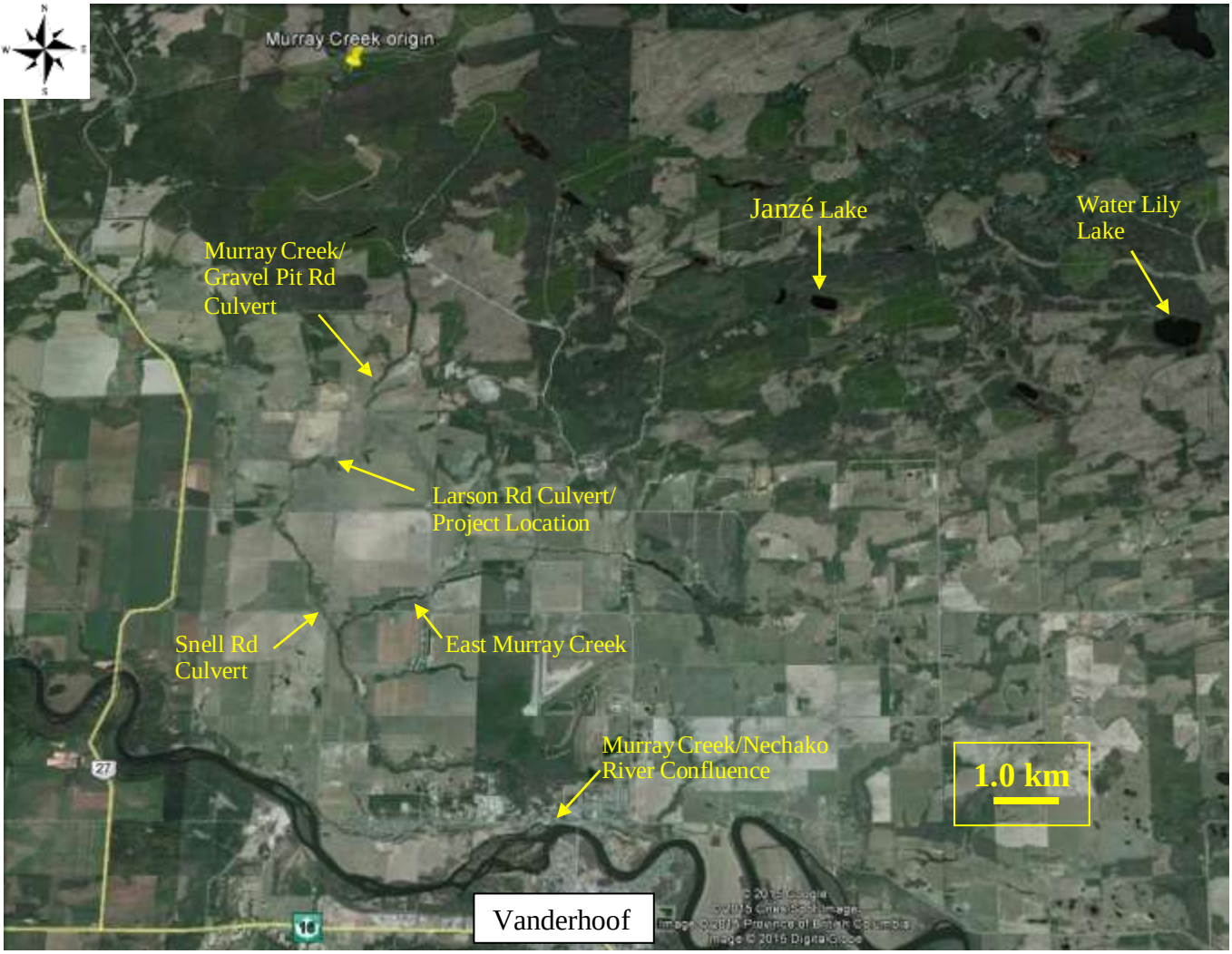

Figure 1. The Murray Creek historic channel project location, drainage area from the headwaters to the Murray Creek/Nechako River confluence and the juvenile Chinook salmon capture locations at the Snell Road and Gravel Pit Road culvert crossings.

1.2.1 Site Geology

A review of a provincial soil map indicates that the subject property is located within a glacial lacustrine region. The prevailing soil type for this classification is typically sandy material atop silt and clay. Surficial soils are described as orthic gray luvisol in an area characterized by thick,

compact, clay and glaciolacustrine deposits with surfaces modified to silty clay loam (Dept. of Agriculture 1974).

1.2.2 Murray Creek Discharge

The water survey of Canada (WSC) operated 08JC008, located near the Snell Road crossing, continuously from April 27, 1967 to November 23, 1974 (**Figure 2**) and 08JC006 located near the Murray Creek/Nechako River confluence (**Figure 3**), continuously from April 30, 1962 to October 31, 1974. Both hydrographs indicate rapidly increasing flows following the onset of freshet (snowmelt) in March or April followed by a similarly rapid decline in flows after peak freshet, until the start of base flow conditions in July or August suggesting that Murray Creek flows are predominantly derived snow melt and surface water runoff following rain events. Very low base flows (< 0.1 m^3/s) persisted until fall precipitation which increased flows slightly from October through to December until winter low flow conditions. To what extent the discharge patterns illustrated in the hydrographs below were influenced by changes in hydrology as a result of forestry and agricultural land use is unknown.

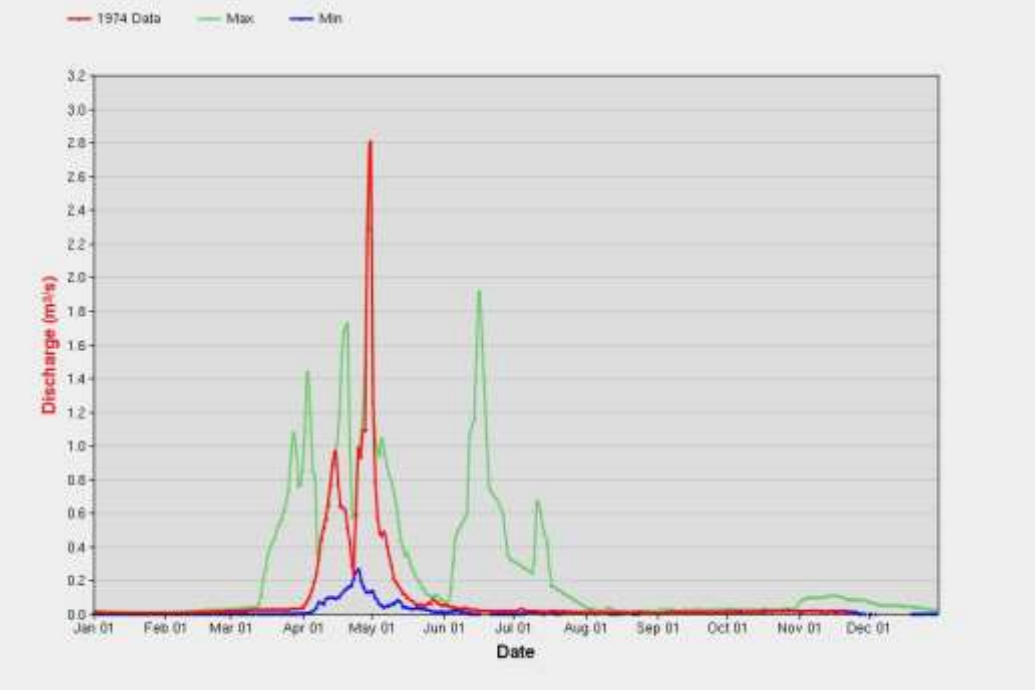

Figure 2. Murray Creek minimum (blue) and maximum (green) discharge collected by WSC gauging station 08JC008 from April 27, 1967 to November 23, 1974 near the Snell Road crossing. *Graph courtesy of the Water Survey of Canada.*

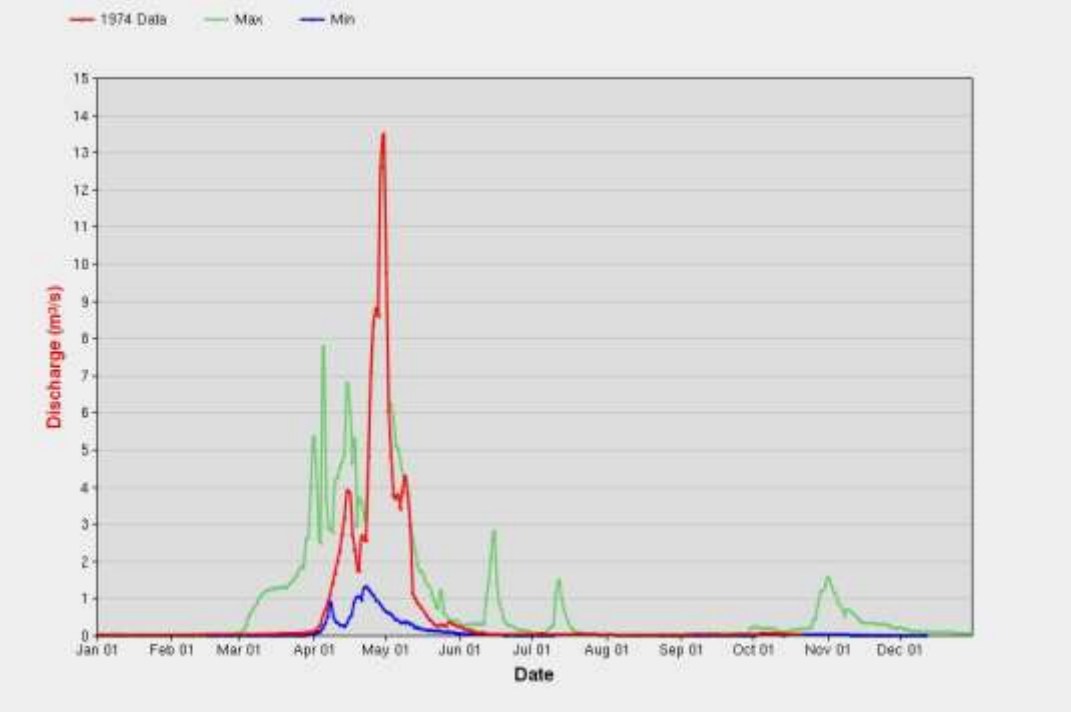

Figure 3. Murray Creek minimum (blue) and maximum (green) discharge collected WSC gauging station 08JC006 from April 30, 1962 to October 31,1974 at the Nechako River Confluence. *Graph courtesy of the Water Survey of Canada.*

1.2.3 Vegetation

The riparian vegetation that exists around the diverted channel coursing through the agricultural field immediately to the north of the historic channel consists of mainly grasses and sedges (*Carex spp.*) with a few sporadically occurring willows (*Salix spp.*). Semi-aquatic emergent cattail (*Typha spp.*), probably *T. latifolia,* was the dominant macrophyte observed within the diversion ditch. Periphyton algae were also observed.

Starting from the Larson Rd crossing travelling downstream, 460m of the 640m of restored historic channel (KP10+0 to KP9+540) travels through a dense 0.02km^2 wooded stand consisting primarily of alder (*Alnus spp.*) (**Photo 1, Photo 2**) providing a high quality riparian habitat with a dense canopy that would help to maintain stream temperatures. Note, there is a difference of approximately 100m of restored channel is using the TRIM map scale compared to the more accurate Google Earth "Path" tool. Willow, spruce (*Picea spp.*), red osier dogwood (*Cornus sericea*) and cottonwood (*Populus spp.*) are also present within the alder stand. Small groves of mature trembling aspen (*Populus tremuloides*) occurred in adjacent higher elevation areas adjacent to Larson Road. During the excavation of the channel, alder roots were observed growing to depths of greater than 1.0 meters within the organically rich topsoil that had accumulated within the historic channel.

The historic Murray Creek channel flows through open farm fields immediately downstream of the dense alder stand for 180m along which the riparian vegetation plant community is similar that occurring along the diverted channel described above, though with fewer cattails (**Photo 3**,

Photo 4). Immediately downstream of the fence line, which marks the downstream end of the Project area, Murray Creek flows into an area that floods during spring freshet where a dense thicket of willows has established. The channel then flows into a mature trembling aspen stand at which point the single channel divides to form one or more side channels.

Photo 1. Representative stem density of the alder grove**.**

Photo 2. Alders growing adjacent to the historic stream channel**.**

Photo 3. Representative riparian vegetation along the drainage ditch. Note the willow thicket, aspen stand and livestock fence at the downstream end of the project.

Photo 4. The new Murray Creek mainstem channel coursing through the North farm field during freeze-up illustrating the lack of overstory riparian vegetation.

1.2.4 Fish Species Observed In Murray Creek

Other than the fish culvert and fish passage surveys indicated in **Table 1**, no extensive fish or fish habitat surveys are known to have been conducted in Murray Creek. Sampling for juvenile white sturgeon was conducted from the Nechako River KP0 to 142m upstream on August 22, 2008 during which no salmonids or gamefish species were captured according to Province of B.C. Habitat Wizard (Government of B.C., 2015b) and FISS (Government of B. C., 2015c) websites (

Table 2). During late fall 2010, Avison Management Services (AMS) captured two juvenile rainbow trout and one Chinook salmon at the downstream end of the gravel pit road culvert at KP11+0 during a fish salvage operation (AMS, 2010). After AMS notified the DFO of the juvenile Chinook capture, the DFO conducted a fish survey of their own in spring 2011 and captured a number of juvenile Chinook salmon downstream of the Snell Road and Loop road culverts KP6+350 (Mark Potyrala, DFO biologist, personal communication) despite several downstream culverts having been assessed as barriers or potential barriers to upstream fish passage under base flow conditions (AMS, 2010; DWB, 2014).

Table 2. Documented fish species observations for Murray Creek dating back to 2008. *Data courtesy of AMS, DFO and the Province of B. C. Habitat Wizard website*.

Common Name	Scientific Name	Location Observed
Rainbow trout	*Oncorhynchus mykiss*	Downstream of the Gravel Pit Rd culvert (KP11+0)
Chinook Salmon	*Oncorhynchus tshawytscha*	Downstream of Snell Rd culvert (KP6+350) and the Gravel Pit Rd culvert (KP11+450)
Sculpin (general)	*Cottus spp.*	Upstream of Nechako River to 142m
Redside shiner	*Richardsonius balteatus*	Upstream of Nechako River to 142m
Suckers (general)	*Catostomidae*	Upstream of Nechako River to 142m

Suitable salmonid spawning habitat has been observed approximately 0.7rkm upstream of the project area and other areas of high quality rearing and overwintering habitat exists elsewhere within the Murray Creek watershed, including a habitat restoration demonstration site located approximately 1.0km (KP 11) upstream of the Larson Road culvert crossing and several wetlands or small lakes that drain into Murray Creek (AMS biologist Olin Alberston (R.P.Bio), personal observation). DWB Consulting Services Ltd (DWB) observed "many juvenile rainbow trout" within the restored demonstration habitat during their Larson Road culvert assessment on August 15, 2012 (DWB, 2014). Given the presence of juvenile rainbow trout approximately 11 km upstream of the Nechako River and the availability of suitable habitat for all life history stages, it is highly probable that the Murray Creek watershed supports a self-sustaining resident rainbow trout population.

Due to a number culverts that are preventing or inhibiting upstream fish passage during base flow conditions (AMS, 2011; DWB, 2014), it is unlikely that anadromous Chinook or sockeye (*O. nerka*) adult salmon are spawning in Murray Creek given that timing of their migration into spawning tributaries corresponds with the late summer and early fall low period. There is a slight possibility of coho salmon (*O. kisutch*) accessing Murray Creek if their run timing in the Nechako watershed coincides with late fall/early winter rains though low flow conditions can also occur at this time. The juvenile chinook salmon that have been observed in Murray Creek likely hatched within the Nechako River mainstem or from other tributaries and later migrated upstream into Murray Creek during high flow periods. Chinook fry were captured or observed in Stoney Creek from the Douglas Street Bridge to approximately 0.7km upstream from the Nechako River on April 21, 2015 suggesting that some Chinook fry will enter tributaries during spring high flows. Chinook salmon adults spawn in the Nechako River in the vicinity of Burrard

Avenue Bridge within the developed center of the District of Vanderhoof (DOV). Both Chinook and coho salmon also spawn in the Nechako River watershed upstream of Vanderhoof to Cheslatta Falls (DFO, 2001; Government of B.C., 2003; Triton, 2010). It is currently unknown whether salmon historically spawned in Murray Creek. Given the availability of suitable spawning habitat, anadromous salmon may establish a spawning population in Murray Creek if the remaining barriers to fish passage, particularly culverts, are removed and existing flows and depths are sufficient to allow embryos/alevins and juveniles to successfully overwinter.

Based on 2010 rotary screw trap data, the vast majority of juvenile Chinook salmon rearing in the Nechako main stem from Kenney Dam to Fort Fraser outmigrate as age 0+ juveniles in May and June with very little outmigration occurring in early July (Triton, 2010). Of the 32,456 juvenile Chinook salmon captured by backpack electrofishing in the Nechako River main stem between Cheslatta Falls (9.0rkm downstream of Keeney Dam) and Fraser Lake in 2010, 32,232 were age 0+ juveniles whereas only 224 were identified as age 1+ juveniles (Triton, 2010). In 2010 the majority of age 1+ Chinook juveniles outmigrated in April and May with little to no outmigration being observed after the end of June (Triton, 2010). Backpack electrofishing between Fraser Lake and Keeney Dam also observed an upstream movement of 0+ Chinook salmon from May to July (Triton, 2010) which may also explain the absence of chinook juveniles in Stoney Creek during the warmer months. Due to a lack of data, the significance of many Nechako River tributaries in terms of rearing habitat for juvenile Chinook salmon (and coho salmon) is unknown. Investigations into habitat use in Stoney Creek (and other tributaries), including sampling during the colder months, is needed to determine Chinook (and coho) presence/absence, distribution and relative abundance.

2.0 Murray Creek Habitat/Environmental Issues

The most significant impact to Murray Creek in the Project area is the loss of approximately 640m of quality rearing habitat (
Figure 4) for juvenile salmonids, adult rainbow trout and potentially other cool water species such as mountain whitefish (*Prosopium williamsoni*) and burbot (*Lota lota*) that are otherwise common to the region. Adult and juvenile rearing habitat is available in the newly cut channels and diversion ditch under high flow conditions; however, there is a potential for fish stranding to occur in these habitats during base flow conditions. Furthermore, due to a lack of riparian vegetation, temperatures within the newly formed channels and diversion ditch may become unsuitable or unfavourable to cool water species from late spring to early fall. Any overwintering or spawning habitat that was available within the dewatered section of historical channel was lost following the diversion. The diversion has resulted in the flooding and cutting of new channels through the neighbouring farm field to the north resulting in lost productivity to the farm owners.

Lacking in overstory riparian vegetation, the newly cut channels exposes stream water to direct sunlight and unprotected banks, potentially increasing stream temperatures and the rate of sediment transport and pollutants (*e.g.* fertilizers, pesticides) to downstream habitats. The channel braiding within the farm field, evident in

Figure 4, suggests that active channel erosion is continuing which could potentially inhibit fish passage downstream as a result of channel aggradation. The later construction of a diversion ditch to prevent further flooding and erosion of the farm field may have further contributed to downstream sedimentation, elevated stream temperatures and reduced fish passage.

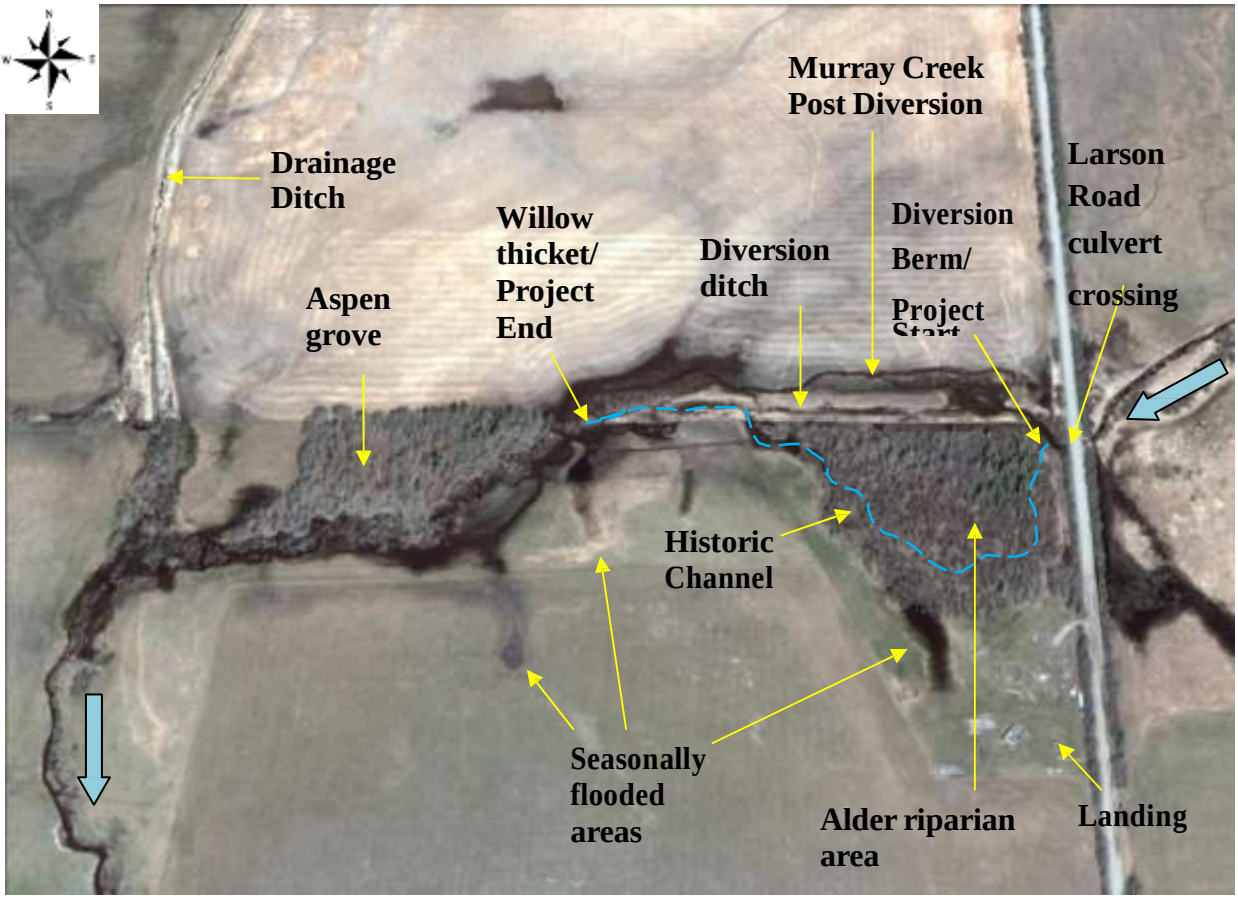

Figure 4. The 640 meters of Historic Murray Creek Channel (dashed line) prior to restoration and surrounding active farm fields on May 05, 2013. The blue arrows indicate direction of flow.

Photo 5. The earthen berm, photographed on March 02, 2015, that caused the channel

Photo 6. The diverted channel coursing towards the North farm field and diversion

diversion over 20 years ago.	ditch, June 07, 2011.

A culvert assessment completed by AMS on June 07, 2011 using the protocol described in B.C. MOE (2011) determined that the three culverts at the Larson Road were found to be a potential fish barrier (**Table 3., Photo 7**, **Photo 8**). Note, the April 15, 2011 date indicated in the table is an error. DWB re-assessed the Larson Road culverts under low flow conditions on August 15, 2012 and found the two 1200mm diameter overflow culverts perched above the water level (complete fish barriers) and the 1000mm diameter culvert to be a fish barrier with a score of 21 (DWB, 2014) due to a lack of embedment and the culvert being undersized which presumably creates a velocity barrier to upstream fish passage under high flow conditions.

Table 3. The culvert assessment at Larson Rd completed on June 07, 2011.

Date (mm/dd/yy)	4/15/2011		
Crossing ID #	CMP (06-07)		
Crew Name	OA/BF		
Stream Name	Murray Creek		
UTM	Easting	Northing	
10U	429935	5992715	
Road Name	Larson Rd		
Crossing Type	Round Culvert	Outlet Residual Pool (m)	0.67
Embedded	None	Inlet Drop	No
Outlet Drop (cm)	0	Fill Depth (m)	0.75
Culvert Width (m)	1.05	Valley Fill	Deep Fill
Channel Width (m)	1.27	Habitat Value	Low
Stream Width Ratio (m)	1.21	Beaver Activity	No
Culvert Slope %	2.6	Backwatered	0
Stream Slope %	1.5	Fish Sighted?	No
Culvert Length (m)	12.2		
Fish Barrier Result			
Score	18	Result	Potential Barrier
Stream Priority Rank	1		
Recommendation			
Potential Barrier. Rank 1 stream priority, low habitat value, however, upstream has high habitat value. **Medium to high replacement priority.**			
Comments			
Directly above and below this culvert, have been influenced by past and current occasional cattle use. The stream has moved from its original course downstream which may have been influenced by the positioning of the culverts. Not only should the culverts be replaced, but a prescription to rehabilitate the creek itself is in order.			
Photos	5		

DWB (2014) suggested that the backwatering effect of the undersized culvert may allow some fish passage during moderate to low flows, an effect which is not considered the B.C. MOE (2011) methodology. DWB (2012) concluded that the three culverts were seasonal barriers suggesting that the perched culverts, when fully connected to main stem flows, may allow fish passage during moderate to high flow periods.

Photo 7. Inlet of main culvert at the Larson Rd crossing, June 07, 2011

Photo 8. Outlet of main culvert at the Larson Rd Crossing, June 07, 2011.

2.1 Prescription

2.1.1 Stream Channel Restoration

The existing fish habitat within the newly formed channel and diversion ditch was qualitatively described in Section 3.1.4 of the Site Assessment Prescription and Proposed Works document (AMS, 2015). In short, the newly formed channel and ditch provided juvenile habitat during the spring freshet period but was completely devoid of spawning habitat and lacked deep pools and sufficient flow volume to provide sufficient overwintering habitat. Due to a lack of overstory riparian vegetation or instream cover, low flows (< 0.1 m^3/s) and potentially high temperatures as a result of direct sunlight exposure, juvenile rearing habitat suitability during the base flow summer and early fall period is likely low.

The details of the habitat restoration prescriptions are provided in AMS (2015). In summary, the primary objective of the stream restoration was to provide high quality spawning, rearing and overwintering habitat for rainbow trout and rearing habitat for Chinook salmon. Prescriptions therefore included (1) the construction of riffle and pool habitat at approximately a 1:1 ratio; (2) the construction four deep overwintering pools, (3) incorporating substrates ranging from small gravels to large boulders and coarse woody debris structures throughout the section of channel to be restored; (4) construct six rock weirs (**Figure 5**) or wooden weirs to (i) create additional riffle and pool habitat; (ii) create turbulence to oxygenate stream water during summer low flow

conditions, (iii) create scour to sort and maintain clean gravels and cobbles and (iv) capture and retain spawning gravels.

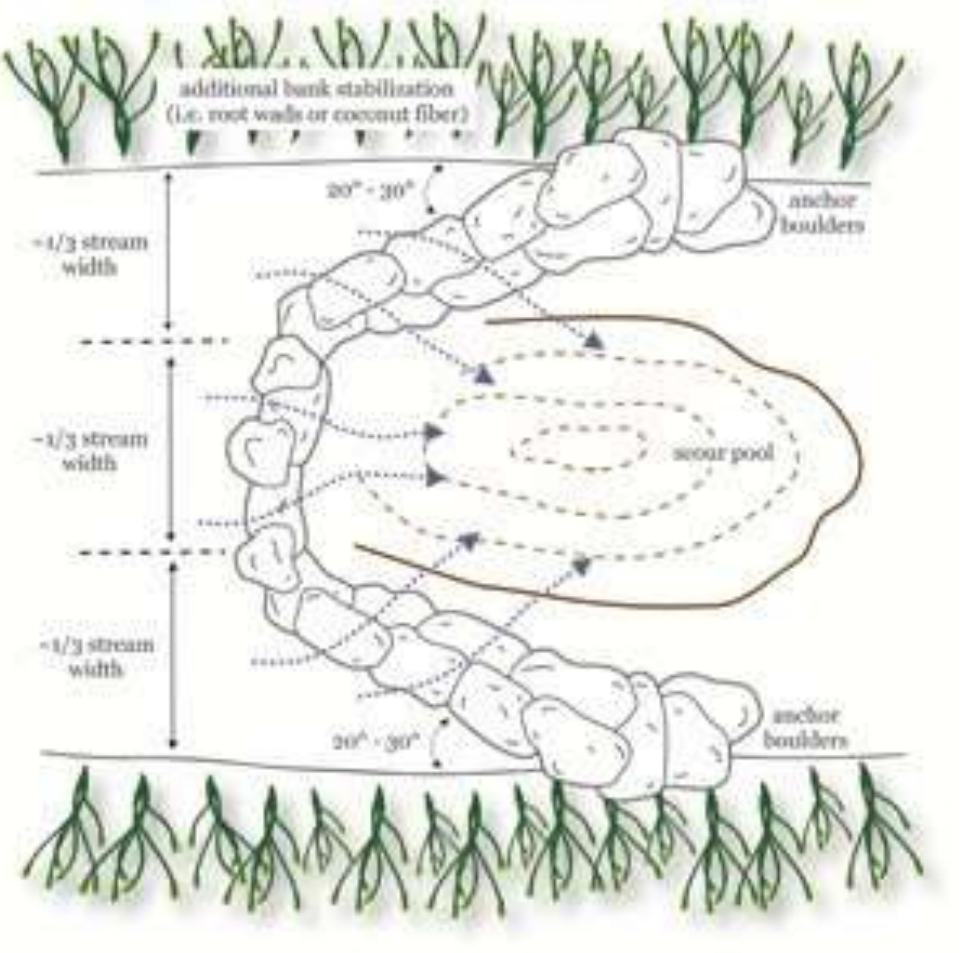

Figure 5. Schematic Diagram of a rock V- weir.

A second objective was to reduce sedimentation during the construction process and after the historic channel had been restored. Natural rock and boulders were to be placed along sections of bank that would receive high energy flows such as outside bends to prevent excessive bank erosion and sloughing. The boulders and cobbles used for bank armouring would also provide juvenile salmonid overwintering habitat (Raleigh *et al*. 1984).

An instream livestock watering site with design features such as fencing and a narrow U-shape access point to limit the number of livestock entering the stream at a given time to protect riparian vegetation and stream bed was recommended. These watering sites were also hardened with geo-cell filled gravel to further reduce sediment resuspension and downstream transport (**Figure 6**).

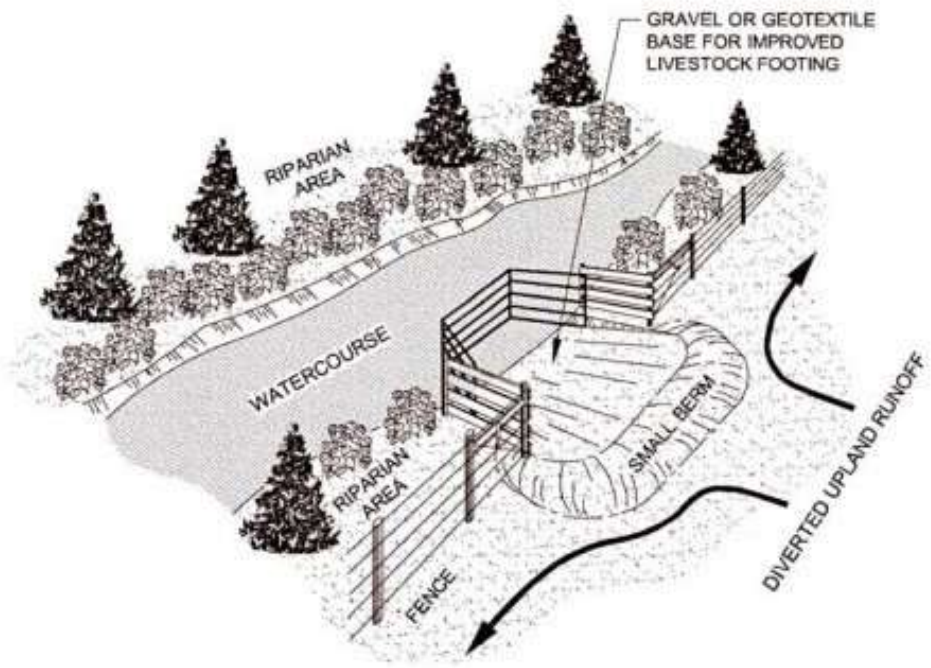

Figure 6. Illustration of the type of livestock watering sites planned for this project, "BC Livestock Watering Factsheet" (2006).

2.1.2 Culvert Replacement

It was originally recommended that all three existing culverts be removed and replaced with one large open bottom arching culvert (AMS, 2015) spanning a width greater than bankfull to provide unrestricted fish passage under all flow conditions and, as much as possible, enable natural channel processes. An assessment conducted for the BC Ministry of Transportation (MOT) indicated that a closed bottom concrete box culvert would be needed in order to take the weight of the overlaying road and traffic. At the time of the writing of this report, the MOT was still in the process of developing specific work plans for a culvert removal project. As a result, it is anticipated that culvert replacement will occur sometime between July 15, 2015 and March 31, 2016.

3.0 Murray Creek Historical Channel Restoration and Fish Passage Improvement

3.1 Project Timing

The locating of the historic channel was completed during the fall and early winter, 2014 prior to snow fall. After meeting on January 25, 2015 held to discuss established safety, spill response

and erosion control protocols with AMS field crew and the contracted heavy machine operators, all work involving the restoration of the historic channel was completed between January 26, 2015 and February 25, 2015. Work did not commence until the registered professional biologist (RP Bio) and/or the environmental monitor was satisfied that all required equipment and materials were stockpiled onsite. Areas to be planted with willow whips to restore or enhance areas lacking in riparian vegetation were identified during the second week of March 2015. Willow planting was conducted on March 26, March 30 and March 31, 2015. The west bank of overwintering pool 3 was the only area where the ground had thawed by March 26. After the ground downstream of the alder stand had thawed, all remaining banks devoid of vegetation and outside bends that were at risk of erosion were planted on March 30 and March 31, 2015. Cuttings were planted to a depth of approximately 0.5m (approximately 2ft) in efforts to ensure that cuttings reached the water table during the summer low flow period. At the time of the writing of this report, flows from Murray Creek had not been re-diverted into the historic channel pending approval from the B.C. Ministry of Transportation and their completion of the closed bottom concrete box culvert installation. The channel restoration and riparian planting activities were therefore completed within the July 15 to April 15 timing window specified by the Government of B.C. for conducting instream works within Omineca Region surface waters supporting rainbow trout. Without compromising worker safety, work activities were completed as quickly as possible to avoid the potential negative environmental impacts (*e.g.* sediment transport) associated with working under spring thaw and freshet conditions.

3.2 Worksite Isolation and Sediment and Erosion Control Practices

All habitat rehabilitation-related activities followed the guidelines described in the Forest Practices Code (FPC) *Stream Crossing Guidebook* (*e.g.* sediment control, drainage, precautions for deleterious materials) (MOF, 2002). As all activities were completed in the dry, no isolation procedures were required. The excavator and dump truck were operated from January 26, 2015 to February 25, 2015 either on frozen ground covered by a protective cover of ice and snow (**Photo 9**) or within the historic channel footprint (**Photo 10**).

Other benefits of completing instream works during winter freeze-up in the dry were: (1) avoidance of damage and sloughing of newly created stream banks; (2) negligible disturbance or damage to existing vegetation and soils along transportation routes between stream access points, the landing and temporary storage areas; (3) minimal resuspension of instream sediments in the event of backwatering episodes; (3) elimination of fish stranding risk; and (4) reduced financial costs associated with (i) additional federal and provincial permitting applications required in order to work within wetted streams; (ii) planning, preparation, equipment purchase and implementation of instream worksite isolation procedures required to minimize sediment re-suspension and (iii) the increased number and frequency of fish salvage operations.

Photo 9. The excavator operating from a protective layer of snow and ice atop frozen ground downstream of the alder grove.

Photo 10. Reconstructing the historic channel within the alder grove.

Two routes through the dense alder stand used to access the Murray Creek historic channel footprint enabled the excavator and dump truck operate along the historic without requiring the falling of trees and shrubs growing along the stream banks or within the flood plain. Branches of standing trees hovering over the historic channel path were removed to prevent significant damage to both the trees and the excavator (**Photo 11, Photo 12**).

Photo 11. Alder branches overhanging the historic channel carefully being removed to create a path for the excavator.

Photo 12. The excavator removing snow and topsoil from the historic channel.

Alder that were removed from the middle of the historic stream channel were later used to build coarse woody debris structures (**Photo 13)**. Nearly all of the Alder trees growing along the banks of the historic channel were left in place. In a few cases where alder trees growing along the historic channel route had to be removed to create room for the excavator, as much of the stump and root mass was left as was possible to provide bank stability and fish habitat (**Photo 14**). It is anticipated that the retained stumps and root masses of the cut alder trees will produce

new shoots through vegetative reproduction (suckering) and allow for the formation of undercut banks which provides excellent cover for all life stages of salmonids.

Photo 13. Felled alder trees anchored into stream channel to provide coarse woody debris habitat.

Photo 14. Alder tree stumps and roots left to provide bank stability, create undercut bank refugia and sprout new shoots.

The placement of boulders and coarse woody debris within the wetted channel was conducted slowly and carefully to minimize sediment resuspension within the downstream section of the project and to prevent damage to adjacent trees growing along the stream banks. The excavator used was appropriately sized for the stream width and had a thumb attached to the bucket to enable careful placement of boulders, cobbles, gravels and coarse woody debris.

Precautions were taken to ensure that sediments could not be transported into surface waters during the project during non-working hours by transporting the topsoil and underlying clay soils excavated from the historic channel as quickly as possible, usually within hours, to a temporary storage site on a flat grade landing located approximately 80 to 100m from any surface waters (**Figure** 4). Topsoil high in organic content considered suitable for agriculture was transported from the landing site as soon as possible to the farm field immediately to the North to be used for crop production. Similarly the relatively infertile clay soil was taken as soon as possible from the landing site to a dump site.

Best efforts were made to minimize disturbance to existing vegetation within the worksite area by utilizing existing vehicle transport routes and by operating heavy machinery within the foot print of the historic channel via two designated access points or on frozen ground protected by a protective layer of ice and snow. Vanderhoof Roadside Mix® (**Table 4**) was applied to a small area where the earthen berm was removed and on top of the armoured section of channel near the culverts approximately 20m West of Larson Road to prevent the establishment and spread of noxious weeds.

Table 4. Composition of Vanderhoof Roadside Mix® manufactured by Premier Pacific Seeds used to re-seed exposed soils at the Dean Toll and Douglas Street Bridge sites.

Seed	Scientific Name	Component of seed mix (%)
Creeping red fescue	*Festuca Rubra var. rubra*	25
Tall fescue	*Festuca arundinacea*	22
Orchard grass	*Dactylis glomerata L*	22
Timothy-grass	*Phleum pretense*	20
Alfalfa	*Medicago sativa*	5
Sainfoin	*Onobrychis spp.*	5
Single cut clover	*Trifolium pretense*	1

3.3 Equipment and Fuels Management

It was required that all equipment be inspected prior to and during work to ensure that all equipment was clean and free of leaks. Any equipment developing a leak would be immediately removed from the worksite until the necessary repairs were completed. Spill kits, a requirement for all heavy machinery and work vehicles, were kept on site at all times. Refueling of heavy machinery (excavators and dump trucks) was conducted at least 30m from the instream work.

3.4 Monitoring

NEWSS will monitor the historic channel for at least one year following completion to evaluate the effectiveness of the project in improving stream habitat function and fish habitat. Monitoring will include photo documentation and a qualitative assessment of project effectiveness relative to project objectives. Monitoring will also include an assessment of the structural integrity of the works to determine the condition of the site and whether the LWD/rootwads, riprap and the gravel/cobble substrate have been displaced or alterned as a result of freshet or stormwater events. The results of the monitoring assessment will be documented in a short report.

3.5 Activity 1: Murray Creek Instream Fish Habitat Restoration and Fish Passage Improvement

The historic channel within the alder grove had been located during the late fall and early winter prior to snow fall based on visible signs of fluvial activity such as soil and debris deposits, riparian vegetation characteristics, evidence of fluvial erosion and discontinuous sections of what were interpreted to be stream banks. The water stains on trees described above was used to roughly estimate bankfull width assuming an average channel depth of approximately 1.0 – 1.25m. There was a definable channel within the farm fields west of the alder grove which was assumed to be the historic channel given that there was no evidence of an older channel within the area. The historical channel banks were flagged and mapped to assist with habitat prescription development, planning and to mark the stream boundary the excavator operator. To minimize impact to existing riparian vegetation and prevent the sedimentation of downstream

habitats, all instream channel work was completed in the dry during the period from January 29, 2015 to February 25, 2015, a period in which all onsite transportation routes, landings and access points remained frozen beneath a cover of ice and snow.

Starting downstream of the earthen berm approximately 20m from the Larson Road culvert crossing at KP10 the historic stream channel was excavated and contoured using a 135 sized zero tail-swing excavator to 0.64km downstream to approximately KP9+500. The stream channel was constructed to approximately 6m wide, narrowing at times to save intact living tree root systems as key features and to promote habitat complexity in the restoration design, to accommodate flows exceeding bank full. It is hoped that the new channel will contain the majority of high flows to provide neighbouring farm fields some flood protection while allowing some overbank flooding to occur in order to maintain the existing riparian vegetation and, in the 180m section downstream of the alder grove, promote the establishment of natural riparian vegetation and planted willow cuttings.

The bed was sloped such that depth gradually increased towards the bank at outside bends with shallow water habitats along the inside bends as typically occurs under natural conditions (**Photo 15**). Stream bank at the outside bends and other locations vulnerable to erosion were armoured with boulders and cobbles. A 15 to 20cm layer of cobbles and gravels were placed over nearly the entire channel bed to maximize macroinvertebrate production and provide cover for juvenile salmonids and small fish species (*e.g.* **Photo 16**). Gravels with an intermediate diameter of 1.5 - 6.0cm, considered optimum for resident rainbow trout spawning success (Raleigh *et al.*, 1984), were placed at typical rainbow trout spawning locations such as pool tail-outs, behind boulders, behind and in front of weirs, amongst coarse woody debris structures and in riffle habitats (*e.g.* **Photo 13, Photo 16**). Stream gradient from the Larson Road crossing to the end of the restored channel ranged from <1 to 2%. The restored historic channel should contain all moderate to low flows thereby improving fish passage.

Photo 15. Sloping channel bed to simulate natural stream morphology. Note the dump truck in the background transporting soil removed from the historic channel.

Photo 16. Spawning gravel, cobble and boulder substrate with armoured banks.

A total of 16 pools and 11 riffle/glide habitats of varying morphology and depth were constructed. Four pools were constructed to depths of 1.5 to 2.5m to provide high quality adult rainbow trout rearing and overwintering habitat as recommended in Raleigh *et al*. (1984) (**Photo 17**). Boulders and coarse woody debris structures were placed into deep pools to provide habitat complexity overhead cover and velocity refugia. All 16 pools can provide high quality overwintering habitat for juvenile salmonid species including rainbow trout, mountain whitefish, Chinook salmon and potentially coho salmon. Pool habitat area, slightly less than riffle/glide habitat area, is expected to increase in response to freshet flows scouring new pool habitats or enlarging existing pools downstream of the weirs, beneath coarse woody debris structures and downstream of large boulders and boulder clusters. A total of 30 pieces of functional coarse woody debris including spruce logs, spruce root wads and alder trees were added to the restored historic channel in pool and riffle/glide habitats. All pieces of coarse woody debris were anchored to instream boulders with ¼ inch (0.64cm) steel cable and anchoring adhesive (Photo 18). Five rock weirs (**Photo 19, Photo 20**) and one wooden weir were constructed at the locations indicated in AMS (2015).

Photo 17. One of four deep pools providing both rearing and overwintering habitat.

Photo 18. Coarse woody debris anchored to boulders drilled to fit steel cable and adhesive.

Photo 19. Rock weir nearing completion.

Photo 20. **S**pawning gravels upstream and downstream of a completed rock weir.

The existing livestock watering site located on the South bank immediately downstream from the alder grove at KP9+540 was upgraded to reduce erosion and sedimentation by placing boulders along adjacent banks and placing an 8ft (2.45m) wide geocell mat filled with gravel over the stream bed to reduce sediment re-suspension. The watering site entrance was constructed to 2.45m wide to limit the number of livestock that can access Murray Creek from the South farm field at a given time (**Photo 21**, **Photo 22**). A second proposed livestock watering site was not constructed on the North bank due to a change of opinion by the land owner.

Photo 21. Livestock watering access being constructed using Geocell to contain gravels

Photo 22. Livestock watering access completed.

New fencing, intended to protect and enable the expansion of naturally occurring stream riparian vegetation increase the survival of planted willow cuttings, was purchased by the property owner and invoiced to NEWSS. The fencing will be installed once the ground has become sufficiently dry enough at the land owner's discretion in spring or summer 2015 following spring freshet and spring rains.

3.6 Activity 2: Riparian Planting

To prevent the establishment of noxious weeds Vanderhoof Roadside Seed Mix® was dispersed on February 25, 2015 over exposed soils on top of the berm and the end of the tractor route located approximately 10 to 50 meters downstream of the Larson Road culvert (**Photo 23**, **Photo 24**).

Willow cuttings (whips) were planted along sections of historic channel that lacked riparian vegetation or live root masses and that were susceptible to bank erosion. Willow cuttings were also planted adjacent to the 180m of channel downstream of the alder grove that is seasonally flooded to provide overstory shade and habitat diversity.

The collection, storage and planting of willow cuttings (whips) followed the recommendations and procedures described in Hoag (2007). Willow whips were collected from a local source on March 13, 2015, approximately 20 of which were planted on that date in exposed bank about 20 to 50m downstream of the Larson Road culvert crossing. All other sites were still frozen on this date requiring any further willow planting to be postponed. Cuttings not used on March 13 were

bundled and stored in a freezer or outside on a snow bank in darkness at approximately 0°C. Approximately forty cuttings were planted on March 26, 2015 in saturated soils that had thawed to at least 0.5m deep at a spacing of approximately 3 to 5ft primarily along the banks of the overwintering pool (**Photo 25**) located approximately 80m upstream of the livestock watering area. Approximately 10 cuttings were placed along a 5m section of bank that lacked riparian vegetation 10m downstream from the overwintering pool. No other planting was possible on March 26 as all other sites were still frozen a few centimeters below the ground surface. The remainder of the cuttings transported to the site on March 26, 2015 were placed within the channel to soak as recommended by Hoag (2007) to ensure that the cuttings were completely hydrated by the time of the next planting.

Additional willow cuttings were planted along any remaining gaps along the bank of overwintering pool 3 on March 30 and March 31, 2015. Willow cuttings were also planted along exposed banks within the 180m of channel between the alder stand and the end of the project (**Photo 26**)

Where possible, cuttings were planted to a depth > 0.9m (3ft), the minimum depth recommended by Hoag (2007), to ensure that roots have sufficient contact with the mid-summer water table. As cuttings were placed along the wetted margins of the stream bank to within 3m of the historic channel in predominantly saturated soils, it is anticipated that newly developed roots will have access to a sufficient supply of subsurface water to ensure high survival and sufficient growth. Cuttings were inserted by making an initial hole with a 1/4" rebar, inserting the cutting diameter rebar in such a manner, then hammering the cutting as deep into the hole as possible. Back cutting was sometimes used to ensure good soil contact with the cutting to promote root development.

Photo 23. Top of the north (left) and south banks (end of tractor route on right) seeded with Vanderhoof Roadside Mix® (arrows). Larson Road is in the background.

Photo 24. Top of the north bank and transportation route seeded with Vanderhoof Roadside Mix® looking downstream.

	
Photo 25. Willow cuttings planted on March 26, March 30 and March 31, 2015 along the banks of overwintering pool 3.	**Photo 26.** Exposed South bank devoid of riparian vegetation planted with willow cuttings on March 31, 2015

3.7 Activity 3: Reporting and Documentation

The prescription report (AMS 2015) has already been submitted. An environmental monitoring report has been submitted along with this final report.

3.8 Project Signage

One sign design (**Figure 7**), intended to inform the general public on the purpose and intended benefits of the Murray Creek habitat restoration project, and acknowledge funding contributors, was jointly developed by Avison Management Services Ltd and NEWWS with the final signage design being completed in early March 2015. A contractor has agreed to install the sign.

Figure 7. The final sign design for the Murray Creek Historic Channel Re-establishment and Culvert Replacement Project intended for public education and to acknowledge funding contributors.

3.9 Expenses

3.9.1.1 Stream Restoration (Activity 1) Expenditures

3.9.1.2 Riparian Planting Expenditures (Activity 2)

3.9.1.3 Reporting Expenditures (Activity 3)

3.9.1.4 Project Signage Expenditures (Activity 4)

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Stoney Creek Rehabilitation Project

Final Report

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Prepared for:

The Nechako Environment & Water Stewardship Society (NEWSS)

In Fulfillment of the Nechako Environmental Enhancement Fund Contribution Agreement Requirements

Executive Summary

In continued effort to restore aquatic and riparian habitats in the Nechako Watershed, Avison Management Services was retained by Nechako Environment and Water Stewardship Society (NEWSS) to: (1) conduct a reconnaissance survey to determine opportunities for habitat restoration in the lower reaches of Stoney Creek; (2) prescribe, design and oversee restoration projects and (3), on behalf of NEWSS, complete habitat prescription reports, environmental monitoring reports and a final report (Activity 5) detailing the four activities completed in the 2014 -2015 fiscal year as required under the NEEF Contribution Agreement (Agreement). A survey to determine fish presence or relative fish species abundance was not conducted The four activities completed as per Agreement requirements were: Project Signage (Activity 1); Culvert Removal and Bioengineering (Activity 2); Stream Restoration (Activity 3) and Riparian Planting (Activity 4).

Four projects were completed in the lower portion of Stoney Creek within the District of Vanderhoof (DOV): (1) L&M Culvert Removal/Beam Bridge Installation and Habitat Restoration (Kilometer Post 2+900 meters); (2) Douglas Street Bridge Bank Stabilization and Habitat Restoration at the Stoney Creek/Nechako River confluence (0 kilometers); (3) Fish Habitat Restoration and Bank Stabilization at Kilometer Post 2 (KP2)+175 meters; (4) and Fish Habitat Restoration and Bank Stabilization at Kilometer Post 2 (KP2)+450 meters. The distances indicated represent the distance of the downstream end of each project from the Nechako River. The total length of Stoney Creek restored in linear meters (m) combining all four projects, 90m+135m+120m+100m respectively, was 445m, 125m greater than the approximately 320m of stream to be restored specified in the Agreement.

Signage, designed to inform the general public on the purpose and intended benefits of the Stoney Creek habitat restoration projects, was jointly developed by Avison Management Services Ltd and NEWWS with the final signage design being completed in February and early March 2015. The signs were manufactured in late March 2015 by Streamline Signs.

A beam bridge was installed at the L&M Culvert Removal/Beam Bridge Installation site on March 24, 2015, the only project that involved culvert removal and replacement with a bridge to improve fish passage. A V-weir was constructed at the L&M site to create a riffle upstream and a scour pool downstream of the weir. Bank stabilization for erosion control was achieved at each of the four sites by armouring banks with boulders. Root wads (large woody debris) and boulders were strategically placed along the banks and within the channel of each project to (i) provide instream cover and velocity refugia for juvenile Chinook salmon and all life history stages of rainbow trout; (ii) create scour pools and deflect flows towards the thalweg to further increase bank stability and substrate sorting and (iv) increase spawning gravel retention. A layer of cobbles and gravels, approximately 15 to 20cm deep, as well as spawning gravels, were placed on top of dredged stream bed or in strategic locations (*e. g.* pool tail-outs and riffle habitats) at all sites except KP2+175 to improve aquatic macroinvertebrate production. At the culvert removal/ L&M beam bridge installation and the KP2+450 sites, a 30-50 cm layer of gravels of a size range suitable for salmonid spawning was exposed while dredging. A substantial amount of ground water appeared to be upwelling through these gravels which appeared to contribute a substantial amount of water to Stoney Creek.

Willow whips (cuttings) were planted at the Douglas Street bridge in late fall and at the other three sites on March 30, 2015. Willow whip planting was primarily conducted adjacent to and within areas where boulders had been placed to provide bank stability as the naturally occurring conifer stands and willow thickets provided sufficient riparian habitat and bank stability at all four sites.

Acknowledgements

Funding for the Stoney Creek Rehabilitation Project was generously provided to the Nechako Environment and Water Stewardship Society (NEWSS) through grants from the Fisheries and Oceans Canada, Recreational Fisheries Conservation Partnerships Program, and the Nechako Environmental Enhancement Fund (NEEF) .

Avison Management Services Ltd (Avison) biologist Olin Albertson was the primary contributor towards the habitat prescriptions and coordinated and directed the actual instream habitat enhancement activities. Avison Director Brian Frenkel oversaw the budgeting, equipment and material purchases and the L&M Bridge construction. Avison staff members Scott Klassen, Ian Macleod and Geoffrey D. Mercer assisted with the environmental monitoring, erosion control/sediment isolation and the planting of willow cuttings. Environmental Scientist Geoffrey D. Mercer and NEWSS staff member designed the signs posted at the restoration sites for public education. Avison biologist Mark Tiley contributed towards the planting of willow and report writing.

Many thanks to the District of Vanderhoof (DOV), Paul Blattner, Dr. Walter Wigmore, Dean Toll, Dave Fehr and the Brad Kelly on East side of Stoney Creek at the Douglas Street Bridge for allowing access through and work from their property. Also we must acknowledge the work performed by M4 Contracting Ltd., VanCon Enterprises Ltd, L&M Lumber, (Ray Devauld), for there excellent services in completing these projects.

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1.0 Introduction

Aquatic ecosystems within the Nechako River watershed have been impacted by forestry and agricultural land uses (Government of B.C., 2015a). These land use activities, combined more recently with pine beetle (*Dendroctonus ponderosae*) outbreaks, have altered watershed hydrology, removed or reduced riparian vegetation and increased the rate of erosion and sediment transport into surface waters. The cumulative impacts of these stressors have resulted in a substantial loss in habitat suitability for rainbow trout (*Oncorhynchus mykiss*) and Chinook salmon (*O. tshawytscha*) in Stoney Creek. Other fish species inhabiting Stoney Creek that require cool water temperatures, coarse substrates and a complexity of instream cover and stream depths for all or part of their life history requirements including burbot (*lota lota*), mountain whitefish (*Prosopium williamsoni*), pygmy whitefish (*Prosopium coulterii*) and sculpins (Cottidae), may have also been negatively impacted.

The Nechako Environment and Water Stewardship Society (NEWSS) retained Avison Management Services (AMS) to: (1) survey fish habitat in the lower reaches of Stoney Creek; (2) prescribe and oversee restoration projects and (3), on behalf of NEWSS, complete habitat prescription reports, environmental monitoring reports and a final report (Activity 5) detailing the four activities completed in Stoney Creek as required under the NEEF Contribution Agreement (Agreement) for the 2014 -2015 fiscal year. The four activities completed as per Agreement requirements were as follows: Project Signage (Activity 1); Culvert Removal and Bioengineering (Activity 2); Stream Restoration (Activity 3) and Riparian Planting (Activity 4).

1.1 Background

The Nechako Environment and Water Stewardship Society (NEWSS), established in 2006 initially to implement riparian habitat restoration within the Nechako Plateau, serves in an advisory capacity in order to achieve high quality land and water stewardship within the Nechako River watershed. The NEWSS purpose statement (NEWSS, 2015) is as follows:

> "...corroboratively improve damaged stream ecosystems within the Nechako Watershed by restoring riparian function in the flood plain of streams, enhancing the regions' collective awareness of surface and groundwater as a single resource and creating an atmosphere where the residents, land owners and various industries can voluntarily improve land and water stewardship practices"

Four rehabilitation projects were completed in Stoney Creek in 2015/2015 (**Table 1)** within close proximity to Vanderhoof (**Figure 1**). The four sites were selected for rehabilitation given (1) the cultural and biological significance of Stoney Creek to the surrounding region; (2) qualitative fish habitat assessments indicated that a substantial reduction in stream bank erosion and an increase in habitat suitability for rainbow trout and chinook salmon could be achieved; (3) private land owners and the District of Vanderhoof granted access to these sites which were located within private property.

Table 1. Stoney Creek Rehabilitation Projects completed in 2014/2015.

Project Title
L&M Culvert Removal/Beam Bridge Installation and Habitat Restoration
Douglas Street Bridge Bank Stabilization and Habitat Restoration
Kilometer Post 2 (KP2)+175 meters Fish Habitat Restoration and Bank Stabilization
Kilometer Post 2 (KP2)+450 meters Fish Habitat Restoration and Bank Stabilization

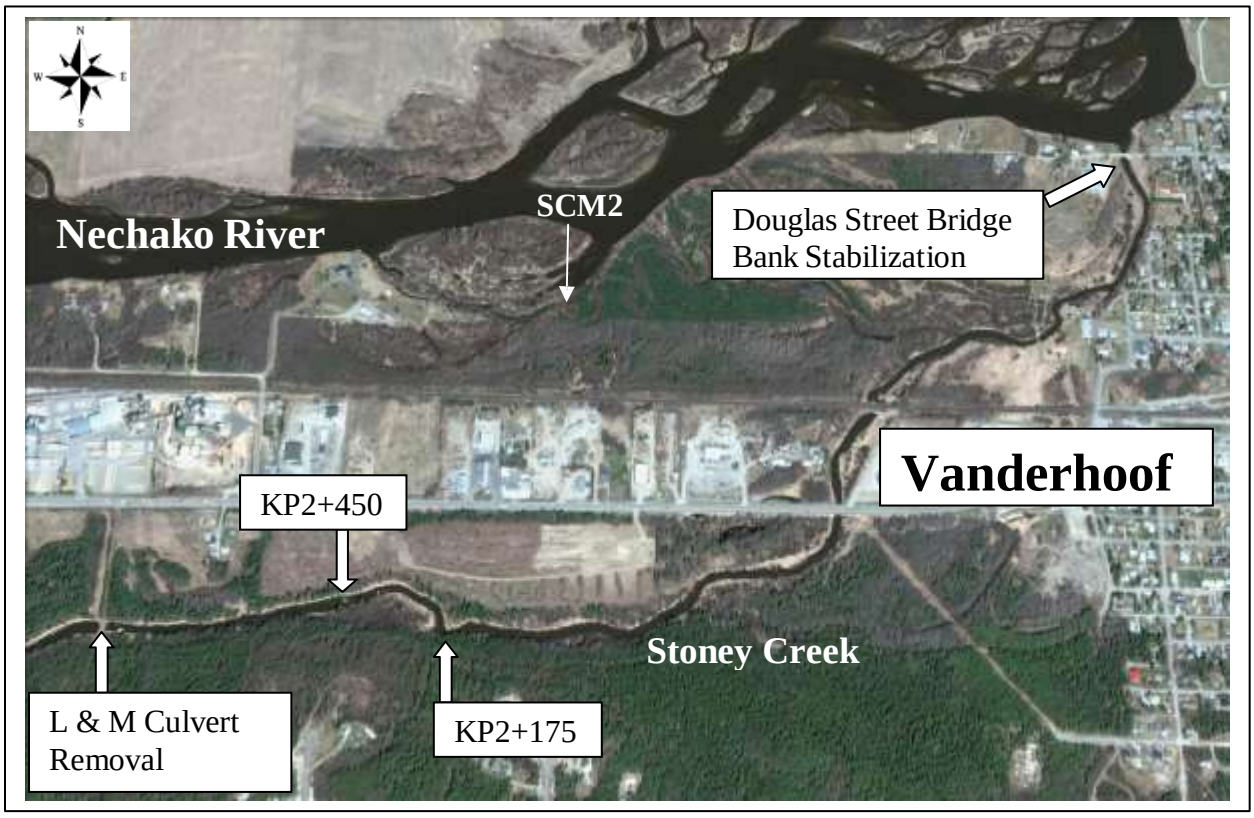

Figure 1. Stoney Creek Rehabilitation Project locations in completed in 2014/2015. SCM2, described below, is incorrectly indicated as the mouth of Stoney Creek in the Province of B.C. Habitat Wizard website.

1.2 Stoney Creek

Stoney Creek (gazetted name: Stony Creek) begins at the North West Nulki Lake outflow from which Stoney Creek travels north-northeast for approximately 6.5 river kilometers (rkm) where it flows through the Stoney Creek First Nations Reserve and into Tachik Lake. From the outlet located at the northeast corner of Tachik Lake, Stoney Creek travels northeasterly until within close proximity to HWY 16 at which point Stoney Creek flows in an easterly direction before flowing northeast along the edge of Vanderhoof until it's confluence with the Nechako River (SC/NR) (**Figure 2**).

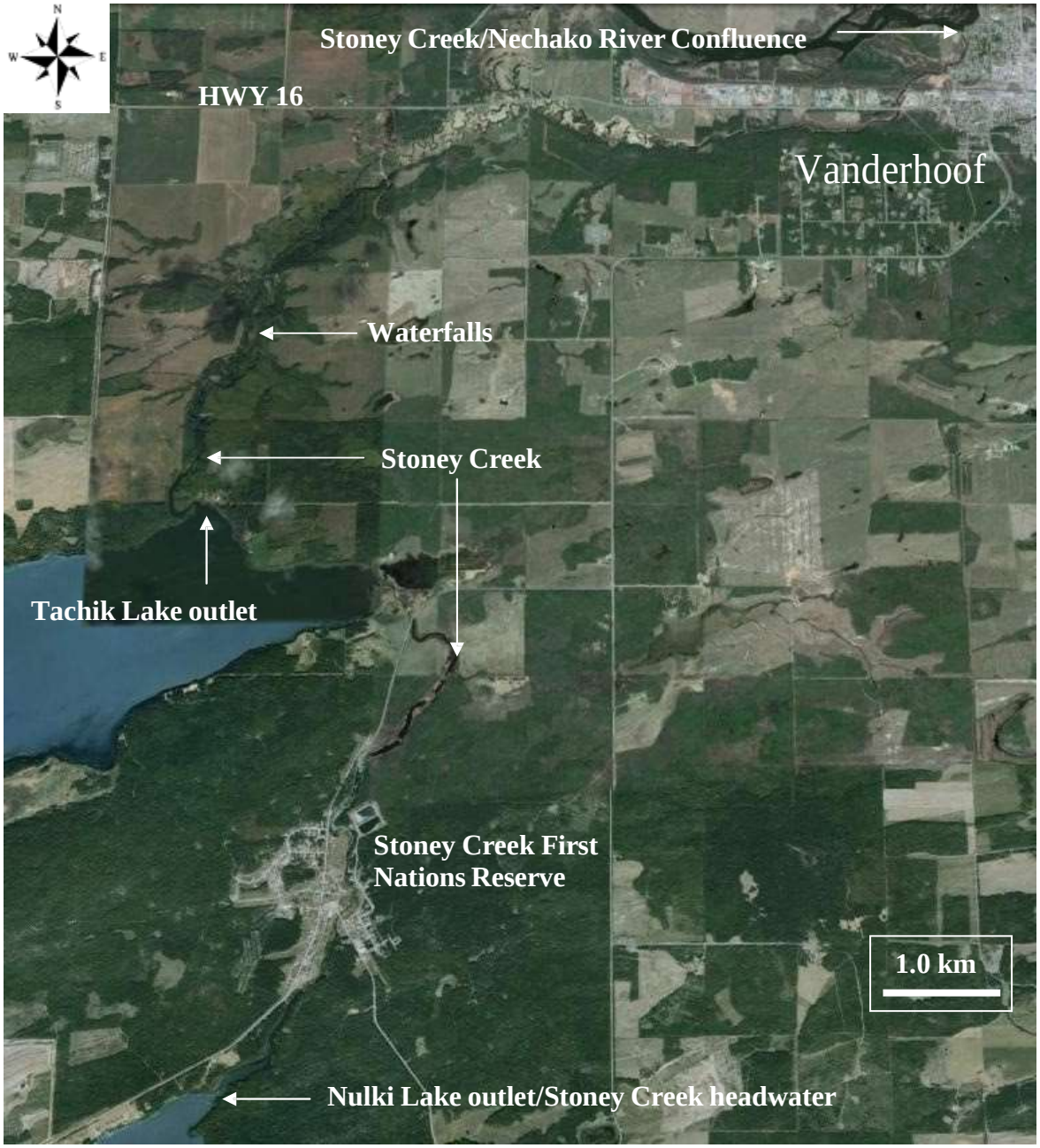

Figure 2. Map of Stoney Creek including the headwater at the Nulki Lake outlet, the waterfalls, a natural barrier to upstream fish migration, and the Stoney Creek/Nechako River confluence.

The BC MOE Habitat Wizard website indicates two locations for the mouth of Stoney Creek. The correct location is indicated approximately 50 meters from the west end of Douglas Street as is evident in **Figure 1** and **Figure 2**. The second indicated location for the Stoney Creek/Nechako River confluence (hence forth SCM2, **Figure 1**) in Habitat Wizard is located approximatrely1.4 rkm further west along the south bank of the Nechako River where one fish survey was conducted. SCM2 branches off of Stoney Creek 0.78 rkm upstream from the Stoney Creek/Nechako River confluence and flows West north-west for 1.46 rkm. The majority of the

SCM2 channel is dewatered during the dry season. Sampling at SCM2 appears to have been conducted at its' confluence with the Nechako River; thus, fish species observations at this site may represent either fish captured within SCM2, fish captured within the Nechako River main stem, or both. SCM2 may indicate a former location for Stoney Creek, or it may represent an unnamed tributary that has erroneously been referred to as Stoney Creek. Presently, it appears to be largely an ephemeral channel that receives flow from Stoney Creek during freshet or high flow stormwater events. A water falls, classified as a natural barrier to upstream fish migration (UTM: 10U 426,364E, 5,983, 288N, **Figure 2**), is located approximately 2.25 rkm downstream from Tachik Lake and approximately 12.4 rkm upstream from the Stoney Creek/Nechako River confluence.

1.2.1 Stoney Creek Discharge

The water survey of Canada (WSC) operated two gauging stations on Stoney Creek: 08JC013 located within the Stoney Creek First Nations Reserve, from 1981 to 1984 below Tachik Lake (**Figure 3**) and 08JC010 from 1977 to 1979 below the water falls (**Figure 4**). Both stations were operated seasonally: 08JC010 from April - October; 08JC013 from March – September, April - December or January - August depending on the year. Both hydrographs indicate rapidly increasing flows following the onset of freshet in March or April followed by a similarly rapid decline in flows from June through to October. Very low flows (< 0.2 m^3/s) were observed during the late summer and fall at both sites. To what extent the discharge patterns illustrated in the hydrographs below were influenced by changes in hydrology as a result of forestry and agricultural land use is unknown.

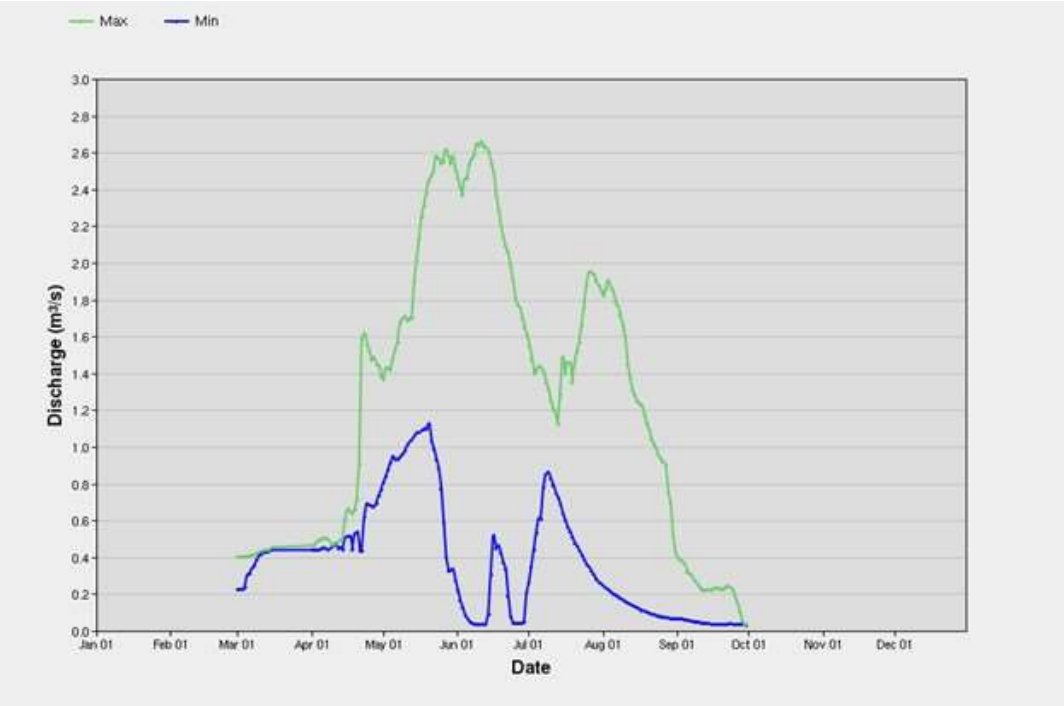

Figure 3. Stoney Creek minimum (blue) and maximum (green) discharge collected from 1981 to 1984, between Nulki Lake and Tachik Lake. *Graph courtesy of the Water Survey of Canada.*

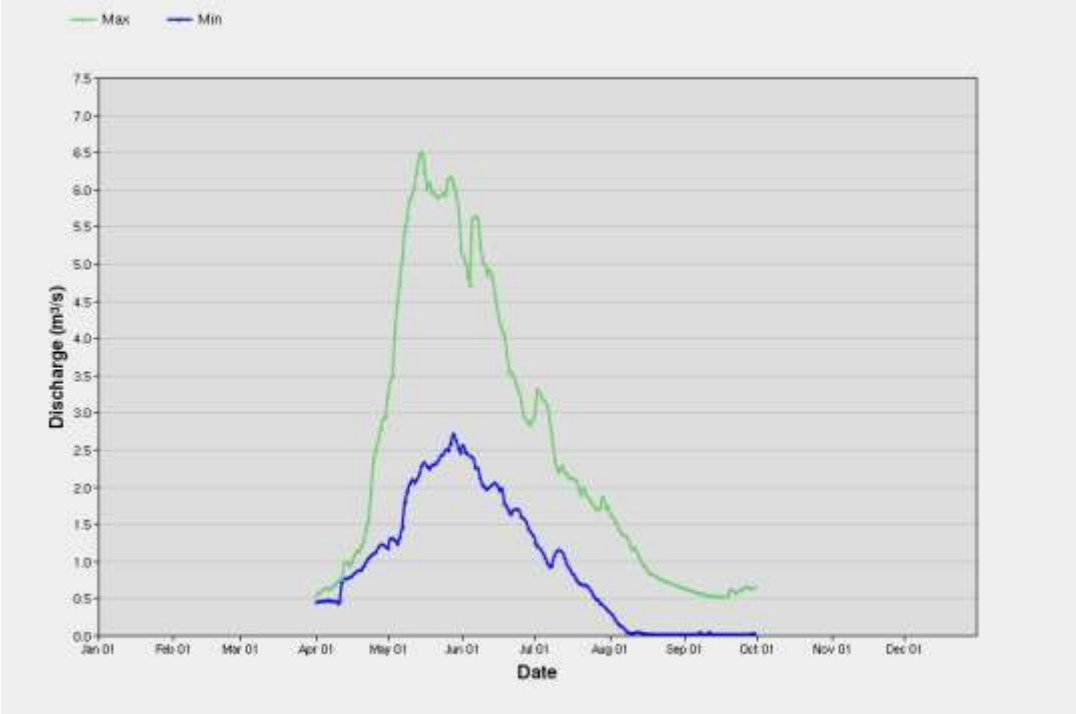

Figure 4. Stoney Creek minimum (blue) and maximum (green) discharge collected from 1977 to 1979, downstream of the waterfalls. *Graph courtesy of the Water Survey of Canada.*

1.2.2 Fish Species Observed In Stoney Creek

Three resident game fish species, rainbow trout (*O. mykiss*), mountain whitefish (*Prosopium williamsoni*) and burbot (*Lota lota*), have been observed at the SCM2/Nechako River confluence, in the upper reach between Nulki Lake and Tachik Lake and within and a short distance downstream the Tachik Lake outlet. Kokanee salmon (*O. nerka*), which generally rear as juveniles and adults in lake habitats, were observed at the outlet of Nulki Lake suggesting that this sampling location was either conducted in lentic habitat or captured young-of-year kokanee that had recently emerged from spawning areas within upper Stoney Creek. There have been anecdotal reports of white sturgeon (*Acipenser transmontanus*) historically occurring in Stoney Creek as far upstream as the water falls. Documented fish species observations in Stoney Creek from the Nulki Lake outlet to the Nechako River confluence dating back to 1997 are provided in **Table 2**.

Chinook salmon adults spawn in the Nechako River in the vicinity of Burrard Avenue Bridge within the developed center of the District of Vanderhoof (DOV) and both Chinook and coho salmon (*O. kisutch*) spawn in the Nechako River watershed upstream of Vanderhoof to Chesslata Falls (DFO, 2001; Government of B.C., 2003; Triton, 2010). There has been no official documentation of anadromous salmonid species occurring in Stoney Creek from fish surveys dating back to 1997 according to the Province of B.C. Habitat Wizard website (Government of B.C., 2015b). There are anecdotal reports of coho salmon and/or Chinook salmon historically being observed as far upstream as the falls. One juvenile Chinook salmon was captured within Murray Creek, a tributary located on the North bank of the Nechako opposite to Stoney Creek by Avison Management Services in fall 2010 (AMS, 2010) which prompted the DFO to conduct

further investigations into the use of Murray Creek by Chinook salmon the following spring. The DFO captured juvenile Chinook salmon in spring 2011 in Murray Creek at the Loop Road/Snell Road crossing, approximately 7.6 rkm upstream from the Nechako River (Mark Potyrala, DFO biologist, personal communication). Both the Chinook salmon spawning area and the mouth of Murray Creek are located approximately 0.75km from the mouth Stoney Creek which suggested that juvenile Chinook salmon could utilize Stoney Creek as seasonal rearing habitat, particularly during the colder months as an overwintering habitat or as refuge habitat during flood events.

Table 2. Documented fish species observations for Stoney Creek dating back to 1997. *Data, except for Chinook salmon, courtesy of the Province of B. C. Habitat Wizard website*.

Common Name	Scientific Name	Reach Observed
Rainbow trout	*Oncorhynchus mykiss*	NL-TL; TL/SC; SCM2/NR
Chinook salmon	*Oncorhynchus tshawytscha)*	SC/NR (Observed by AMS, April 2015)
Kokanee salmon	*Oncorhynchus nerka*	NL-TL
Mountain whitefish	*Prosopium williamsoni*	NL-TL; TL/SC
Pygmy whitefish	*Prosopium coulterii*	TL/SC
Burbot (ling cod)	*Lota lota*	NL-TL;TL/SC, SCM2/NR
Prickly sculpin	*Cottus asper*	NL-TL; TL/SC; SC/NR; SCM2/NR
Slimy sculpin	*Cottus cognatus*	NL-TL; SCM2/NR
Redside shiner	*Richardsonius balteatus*	NL-TL; TL/SC; SC/NR; SCM2/NR
Longnose dace	*Rhinichthys cataractae*	SCM2/NR
Peamouth chub	*Mylocheilus caurinus*	NL-TL; TL/SC; SCM2/NR
Northern pikeminnow	*Ptychocheilus oregonensis*	NL-TL; TL/SC; SC/NR; SCM2/NR
Longnose sucker	*Catostomus catostomus*	NL-TL; SCM2/NR
Coarsescale sucker	*Catostomus macrocheilus*	NL-TL, TL/SC; SCM2/NR
Bridgelip sucker	*Catostomus columbianus*	NL-TL; TL/SC

NL – TL = Nulki Lake to Tachik Lake which may include some lentic habitat at the Nulki Lake outlet explaining the kokanee salmon observations; **TL/SC** = the Tachik Lake outlet/upper Stoney Creek and may include some lentic habitat; **SC/NR** = the Stoney/Nechako River confluence to 0.7km upstream within Stoney Creek; **SCM2/NR** = Stoney Creek Channel 2 at the Nechako River confluence ~ 1.4km West of the SC/NR confluence (**Figure 1**), a probable ephemeral Stoney Creek side channel incorrectly indicated as the Stoney Creek main stem in Habitat Wizard.

Following the completion of all Stoney Creek instream and riparian habitat restoration works, AMS biologist Mark Tiley observed 30 – 40 mm TL salmonid fry, believed to be Chinook salmon, from the mouth of Stoney Creek to approximately 0.5km upstream on April 20, 2015 during post-project monitoring. Two juvenile Chinook salmon, 35mm and 37mm fork length (FL), were captured by minnow trap and dip net at the Douglas Street Bridge Bank Stabilization/Habitat Restoration site on April 21, 2015 confirming Chinook salmon presence in Stoney Creek (**Photo 1**, **Photo 2**). Water temperature in Stoney Creek at the capture site to 0.5km upstream was 10 to 11^{o}C which was considerably warmer than the 5-6^{o}C temperatures

observed in the Nechako River mainstem over the same period. The warmer temperatures and presumably lower predator abundance occurring in Stoney Creek during the spring may enable faster growth and reduced predation risk. Further assessment of Stoney Creek and other tributaries is recommended to determine the significance of tributaries as spring rearing habitat for Chinook salmon and other salmonid species.

Photo 1. Juvenile Chinook salmon, 35mm FL, captured in Stoney Creek at the Douglas Street Bridge Bank Stabilization/Habitat Restoration site on April 21, 2015.

Photo 2. Douglas Street Bridge, Stoney Creek, where two juvenile Chinook salmon were captured and numbers of others were observed swimming upstream in April 2015.

Previous fish inventory assessments in Stoney Creek were not conducted during the colder seasons between October and July 15 and all previous surveys were conducted within < 0.5km of the Nechako River confluence. Juvenile Chinook salmon abundances in the lower reaches of Stoney Creek may be very low or absent owing to habitat degradation. The previous absence of juvenile chinook observations in Stoney Creek may also be explained by juvenile and smolt outmigration. Based on 2010 rotary screw trap data, the vast majority of juvenile Chinook salmon rearing in the Nechako main stem from Kenney Dam to Fort Fraser outmigrate as age 0+ juveniles in May and June with very little outmigration occurring in early July (Triton, 2010). Of the 32,456 juvenile Chinook salmon captured by backpack electrofishing in the Nechako main stem between Cheslatta Falls (9.0rkm downstream of Keeney Dam) and Fraser Lake in 2010, 32,232 were age 0+ juveniles whereas only 224 were identified as age 1+ juveniles (Triton, 2010). Previous fisheries surveys, which were presumably conducted after the July 15 window for instream work in streams supporting rainbow trout, would have likely been conducted after the large majority of juvenile Chinook salmon had out-migrated as smolts. In 2010 the majority of age 1+ Chinook juveniles out-migrated in April and May with little to no outmigration occurring after the end of June (Triton, 2010). Backpack electrofishing between Fraser Lake and Keeney Dam also observed an upstream movement of 0+ Chinook salmon from May to July (Triton, 2010) which may also explain the absence of chinook juveniles in Stoney Creek during the warmer months. Due to a lack of data, the significance of many Nechako River tributaries in terms of rearing habitat for juvenile Chinook salmon (and coho salmon) is unknown. Investigations into habitat use in Stoney Creek (and other tributaries), including sampling during the colder months, is needed to determine Chinook (and coho) presence/absence, distribution and relative abundance.

The fish inventory sampling in Stoney Creek documented in FISS and Habitat Wizard has been limited to within approximately 0.5km of the Stoney Creek/Nechako River confluence, approximately 0.4 km of stream habitat immediately downstream of Tachik Lake, and the approximately 5.5 km of stream habitat between Nulki Lake and Tachik Lake (Government of B.C., 2015b). Given that rainbow trout presence has been confirmed near the Stoney Creek/Nechako River confluence and immediately downstream of Nulki Lake, it is assumed that rainbow trout can utilize all of Stoney Creek, though in some areas use may be seasonal or abundances low.

1.3 Project Timing

All instream works were completed within the July 15 to April 15 timing window specified by the Government of B.C. for conducting instream works in Omineca Region surface waters supporting rainbow trout. Without compromising worker safety, the amount of time the work site was in a disturbed state was minimized by completing each project as quickly as possible to minimize the risk of negative environmental impact. Work did not commence until the registered professional biologist (RP Bio) and/or the environmental monitor was satisfied that all required equipment and materials were onsite or accessible to the worksite. Prior to construction commencing, the worksite boundaries were flagged, the specified materials stockpiled and the equipment staged at the site. The planting or willow cuttings was conducted at the Douglas Street Bridge stabilization site in late fall 2014. Due to frozen ground conditions, willow planting at the L&M Culvert Removal/Beam Bridge Installation and Habitat Restoration site, the KP 2 + 175 site and the KP + 450 site had to be delayed until March 30, 2015 on which date each of the aforementioned sites were planted.

1.4 Worksite Isolation and Sediment and Erosion Control Practices

All habitat rehabilitation-related activities followed the guidelines described in the Forest Practices Code (FPC) *Stream Crossing Guidebook* (MOF, 2002), and the BC MOE Guide to Working Around Water (MOE, 2005) (*e.g.* sediment control, drainage, precautions for deleterious materials). Details of site isolation procedures were provided in the original Prescription documents. No stream isolation or diversion was required for KP2 + 175 as Stoney Creek was at a low flow condition and planned works, including heavy equipment operation, were conducted outside the wetted area.

Best efforts were taken to prevent or minimize as much as possible the disturbance or removal of existing vegetation. Some vegetation was removed where banks were sloped and rip-rapped and in areas where heavy equipment was operated. An appropriately sized excavator with a thumb attached to cover the bucket was used to place riprap and large woody debris (LWD). LWD is defined in BC Fisheries Information Services Branch (2001) as root wads and all relatively stable pieces of wood ≥ 10 cm in diameter.

The excavator was operated when Stoney Creek was at a low flow condition and outside of the wetted area to prevent the following: (1) disturbance to the stream bank; (2) the resuspension of stream sediments and (3) the disruption of stream flow to the project site. The placement of boulders and LWD within the wetted channel area, which will be required to create functional

fish habitat during low flow periods, (mid-summer through to spring freshet) will be conducted slowly and carefully to minimize sediment resuspension.

Sediment fences were erected where necessary to ensure that sediments did not enter the stream where disturbance occurred. Work was postponed if weather conditions increased the probability of sediments entering the stream. Precautions were taken to ensure that sediments were contained during the project during non-working hours to reduce the likelihood of sediments entering the stream. Any removed overburden was stored in a low grade area isolated from the stream and covered with polyurethane sheeting to prevent sediment transport until it could be re-vegetated.

The majority of areas within the project sites that were experiencing bank erosion were sloped and planted with willow whips and/or stakes. If previous erosion was severe, banks were also armoured with rock and LWD. For each of the four Stoney Creek rehabilitation projects, all root wads and LWD were anchored to boulders with ¼ inch cable to maintain position. Best efforts were made to minimize disturbance to existing vegetation within the worksite area to ensure that stream banks remain stable. Vanderhoof Roadside Mix ® (**Table 3**) was used At the L&M site and at the Douglas Street Bridge site to re-vegetate and prevent the establishment of noxious weeks in exposed soil as the final task prior to project completion.

Table 3. Composition of Vanderhoof Roadside Mix® manufactured by Premier Pacific Seeds used to re-seed exposed soils at the L&M and Douglas Street Bridge sites.

Seed	Scientific Name	Component of seed mix (%)
Creeping red fescue	*Festuca Rubra var. rubra*	25
Tall fescue	*Festuca arundinacea*	22
Orchard grass	*Dactylis glomerata L*	22
Timothy-grass	*Phleum pretense*	20
Alfalfa	*Medicago sativa*	5
Sainfoin	*Onobrychis spp.*	5
Single cut clover	*Trifolium pretense*	1

1.5 Equipment and Fuels Management

It was required that all equipment be inspected prior to and during work to ensure that all equipment is clean and free of leaks. Any equipment developing a leak would be immediately removed from the worksite until the necessary repairs are completed. A spill kit was required and on site for all equipment. Refueling was conducted at least 30 m from the instream work.

1.6 Monitoring

NEWSS will monitor each of the four sites for at least one year following completion to evaluate the effectiveness of the project in improving stream habitat function and fish habitat. Monitoring will include photo documentation and a qualitative assessment of project effectiveness relative to

project objectives. Monitoring will also include an assessment of the structural integrity of the works to determine the condition of the beam bridge installed at the L&M site and whether the LWD/rootwads, riprap and the gravel/cobble substrate have been displaced or alterned as a result of freshet or stormwater events. The results of the monitoring assessment will be documented in a short report.

2.0 L&M Culvert Removal/Beam Bridge Installation and Habitat Restoration

2.1 Habitat/Environmental Issues

Preliminary observation found that backwatering caused by the three culverts (**Figure** 5) reduced stream velocity which appears to have caused the observed accumulation of sediments and resulting shallow water conditions (depths of 30-40 cm) immediately upstream of the crossing. At the time of the site visit, stream depths immediately upstream of the culverts were sufficiently high enough to provide unimpeded fish passage. However, observers from the previous year's reconnaissance fly-over reported that the creek was virtually dry downstream of the culvert crossing.

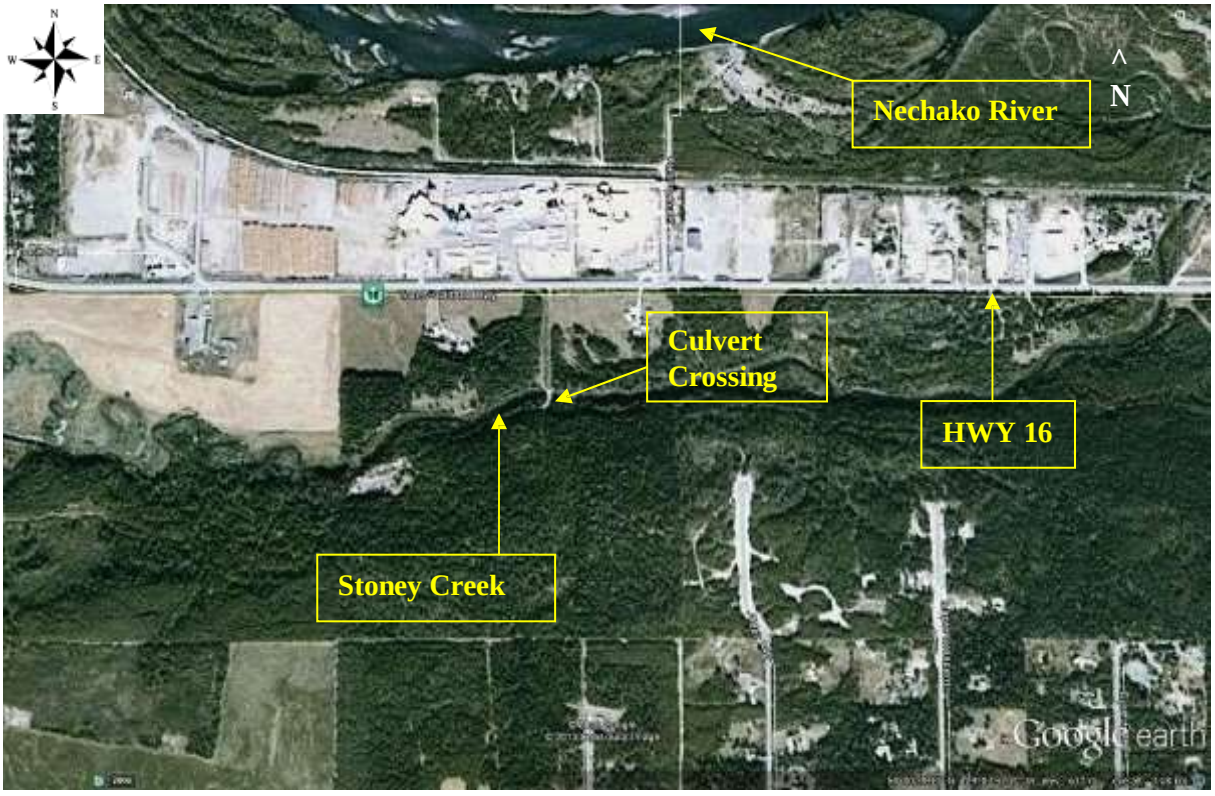

Figure 5. The culvert crossing location on Stoney Creek where the replacement of three culverts with a beam bridge was completed in order to provide fish passage under all flow conditions and to allow natural stream processes to occur.

It appeared that sediment upstream of the culverts had formed a low flow dam which maintained wetted channel conditions upstream but resulted in a dry channel downstream. There was no evidence of washouts occurring in past years indicating that the hydraulic capacity of the three-culvert crossing is sufficient to handle the high flow events that had occurred previously. An accumulation of logs and woody debris from upstream sources created a partial blockage in the middle and southern-most culverts. These culverts are likely large enough to handle high flow; however, based on the culvert assessment protocol described in B.C. MOE (2011) the culverts scored as a barrier to fish passage.

2.2 Prescription

It was recommended that all three existing culverts be removed and replaced with a beam bridge (**Figure** 5**, Figure 6**) spanning the width of the channel to enable fish passage under all flow conditions and enable natural channel processes to occur as much as possible. Prior culvert removal it was also recommended that the upstream section east of the culverts be dredged for 50-100 metres to prevent potentially contaminated sediments from being flushed downstream. After dredging and the removal of fine sediments, it was further recommended that a minimum 15 cm layer of gravels and cobbles be placed on the stream bed to provide potential spawning and rearing habitat for rainbow trout and Chinook salmon. The existing gravel fill that was placed over the culverts provided a source of suitably sized gravels

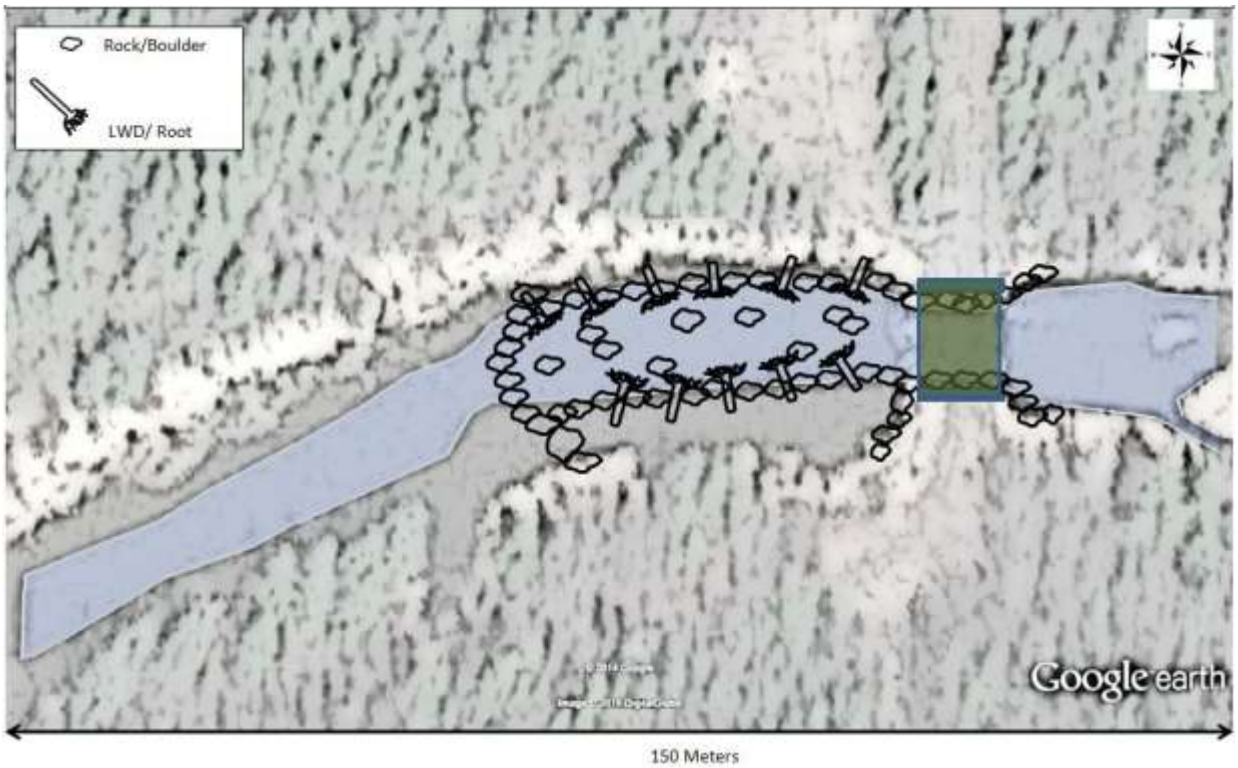

Figure 6. Schematic diagram of the L&M site illustrating proposed culvert replacement with a beam bridge installation, LWD and boulder locations and bank armouring.

Spawning gravels were sorted and cleaned to remove fines and particulates prior to placement within Stoney Creek. Additionally, it was recommended that an upstream V-weir (**Figure 7**) be

placed at the site of the removed culverts to create a riffle effect that would oxygenate water and scour and clean downstream gravels. The final recommendation for this site was the placement of large woody debris (LWD) structures and boulders within the newly dredged area of stream to provide cover for fish and improve spawning gravel retention during freshet and stormwater runoff events.

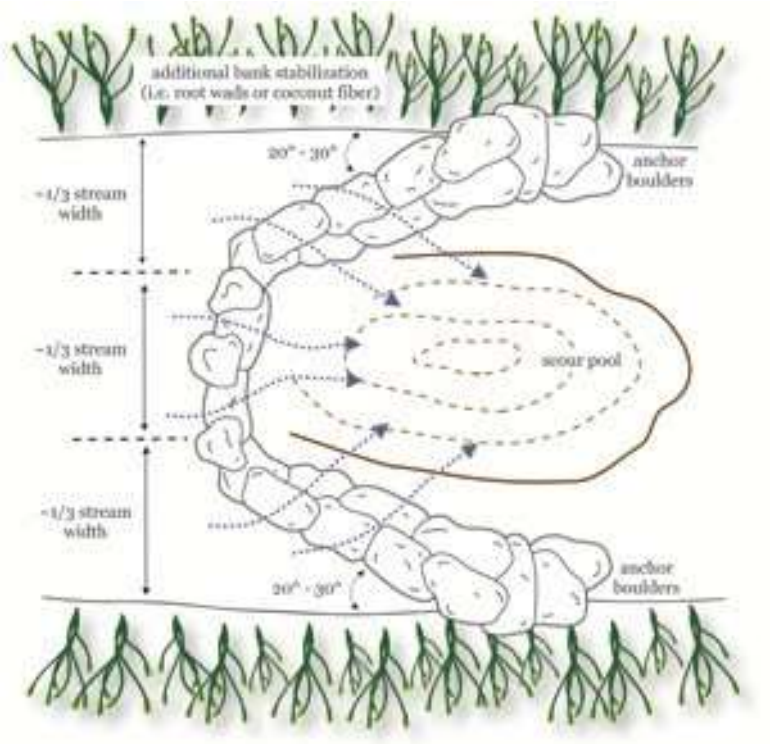

Figure 7. Schematic Diagram of an Upstream V- weir used to create riffle and pool habitat.

2.3 Activity 1: Project Signage

Signs were developed jointly by NEWSS and Avison over early winter, 2015. Three designs were selected by NEWSS and were manufactured locally by Streamline Signs in Vanderhoof in late March 2015. One design, two of which were manufactured, provided images from each of the four Stoney Creek restoration sites (**Figure 11**) and will be installed at the Douglas Street Bridge bank stabilization and habitat restoration project at the mouth of Stoney Creek and at the bank stabilization and habitat restoration site at KP2 + 175. The second and third sign designs provided illustrations of bank stabilization and fish habitat enhancement features installed at KP2 + 900 (**Figure 8**Error! Reference source not found.) and KP2 + 450 (**Figure 15**). Each of the signs included the logos of the various funding contributors and sponsors. An arrangement has been made with a contractor to install the sign at KP2+900 adjacent to the L&M Bridge.

Figure 8. The sign to be installed adjacent to the L&M Bridge at the KP2+900 culvert removal/bridge installation and habitat restoration site.

2.4 Activity 2: Culvert Removal, Beam Bridge Installation and Bioengineering

Culvert removal and bridge abutment installation was completed from November 24 to 26, 2014 after the stream habitat restoration phase had been completed. **Photo 3** and **Photo 4** illustrate how debris accumulations at the upstream end of each of the three culverts were obstructing fish passage prior to their removal under both high and low flow conditions respectively. Photographs illustrating the beam bridge abutment installation conducted in November 2014 with the installation of the beam and bridge on March 24, 2015 are provided in **Photos 3** to **Photo 11**. **Photo 7** and **Photo 8** illustrate the unobstructed fish passage at the L&M crossing even under winter low flow conditions. The beam bridge will enable natural stream processes such as sediment sorting and woody debris transport to occur facilitating recovery from impacts caused by previous land use practices and pine beetle-related impacts.

Photo 3. Upstream view of L&M culverts during looking Northeast prior to removal (summer).

Photo 4. Upstream view of L&M culverts looking Northeast during the fall prior to removal.

Photo 5. Excavation of the east bridge abutment site, November 24, 2014 after the installation of the habitat enhancement structures.

Photo 6. Removal of the first culvert following the installation of the east bank bridge abutment.

Photo 7. Post culvert removal and early stage of beam bridge installation**.**

Photo 8. Stoney Creek discharge following culvert removal.

Photo 9. West beam bridge abutment.

Photo 10. Beam Bridge abutments installed.

Photo 11. Beam bridge being installed on March 24, 2015 looking downstream**.**

Photo 12. Latter stage of the beam bridge installation process, March 24, 2015, looking downstream.

Photo 13. The L& M Bridge photographed on April 14, 2015, looking downstream.

2.5 Activity 3: Stream Restoration

Habitat rehabilitation at the L&M crossing was conducted from November 12 to 20, 2014. A total of 90 linear meters of stream was rehabilitated which included the addition of erosion control measures, the dredging of accumulated sediments to form pool habitat and the installation of LWD (root wad) structures. The following photographs document the before-during-after stages and illustrate the best management practices and bank stabilization activities at the L&M crossing. The major stages of the stream restoration activities are illustrated from **Photo 14** through **Photo 27**. A diversion channel and a silt fence was used to isolate the work site area before any enhancement work began to prevent sedimentation of downstream habitats during the dredging, habitat feature installation and culvert removal phases of the project (*e. g.* **Photo 14**). The pump fitted with a fish-friendly intake screen was used to pump sediment-ladened water into the riparian zone (**Photo 19**). Vanderhoof roadside mix was used to re-seed exposed areas of soil created by project operations.

Photo 14. Isolation of area to be dredged and enhanced with fish habitat structures**.** Note the diversion channel to the right of the photo.

Photo 15. Beginning of dredging along the North bank with area fully isolated with flow diverted along the South bank

Photo 16. Installation of root wads (LWD) that will provide cover, create scour to maintain pool depth, and capture debris.

Photo 17. Armouring of the channel. All root wads were anchored to boulders with ¼ inch cable.

Photo 18. Installation of the V weir and channel armouring.

Photo 19. Pumping of turbid water into the riparian habitat with a fish-friendly intake.

Photo 20. View of the V-weir and fish habitat structures looking downstream.

Photo 21. Cobble and gravel substrate placed at the downstream side of the V-weir (foreground) and within the deep pool.

Photo 22. The area of stream habitat enhancement nearing completion looking upstream.

Photo 23. The L&M rehabilitation site looking upstream during winter low flow conditions following the removal of the diversion channel.

2.6 Activity 4: Riparian Planting

Willow whips were planted on March 30, 2015, at locations within the L&M project site where a sufficient depth of soft, moist substrate was available within the bank zone just below bankfull elevation up to the transition zone (riparian vegetation grading into upland vegetation) (*see* Hoag, 2007) including adjacent to the bridge abutments, between rip rap where suitable substrate permitted and adjacent to a road access at and below bank full elevation (**Photo 26, Photo 27, Photo 28)**. Cuttings were inserted in moist to wet soil to approximately 0.61m (2ft) deep below the soil surface to ensure good contact with soil to maximize, as much as possible, root development. At times in very wet soil or in clay soils, back-cutting was performed to ensure good contact between the soil and the cutting. Vanderhoof roadside seed mix® was dispersed over exposed soils created by project operations. It should be noted that, as for all sites within Stoney Creek, there was an established belt of willow and other riparian species along both

banks of Stoney Creek at each of the four project sites at elevations slightly above and below bank full height (**Photo 24**, **Photo 25**). It is anticipated that the roots/rhizomes of the few willows that were removed in order for the heavy machinery to gain access to the Stoney Creek channel will likely grow new shoots. Willow cuttings were therefore spaced off of naturally occurring willows and evident willow stumps and preferably planted amongst boulders placed along the shoreline for bank stabilization and erosion control.

Photo 24. A belt of willow (red branches) naturally occurring along the North and South banks of Stoney Creek at KP 2+450.

Photo 25. A belt of willow naturally occurring upstream of the L&M beam bridge installation site.

Photo 26. Willow cuttings being planted immediately upstream of the recently installed L&M Bridge.

Photo 27. Willow cuttings planted adjacent to an access point immediately downstream of the V-weir.

Photo 28. Willow cuttings planted within and adjacent to the V-weir upstream of the L&M Bridge, March 30, 2015. Note the extensive reed canarygrass and cattails (*Typha* spp.) growing along the flood-prone channel banks - a condition characteristic of the riparian vegetation throughout lower Stoney Creek.

3.0 Douglas Street Bridge Bank Stabilization and Habitat Restoration

3.1 Habitat/Environmental Issues

The Douglas Street Bridge, located at the confluence of Stoney Creek and the Nechako River (**Figure 9**), periodically experiences high energy flows from Stoney Creek during freshet and storm events. High water level fluctuations influenced by regulated discharges from Kenny Dam into the Nechako River also occurs at this site. The compounding effects of high flow events and the artificially high water level fluctuations have contributed to bank erosion at the Douglas Street Bridge approaches and immediately upstream and downstream of the bridge.

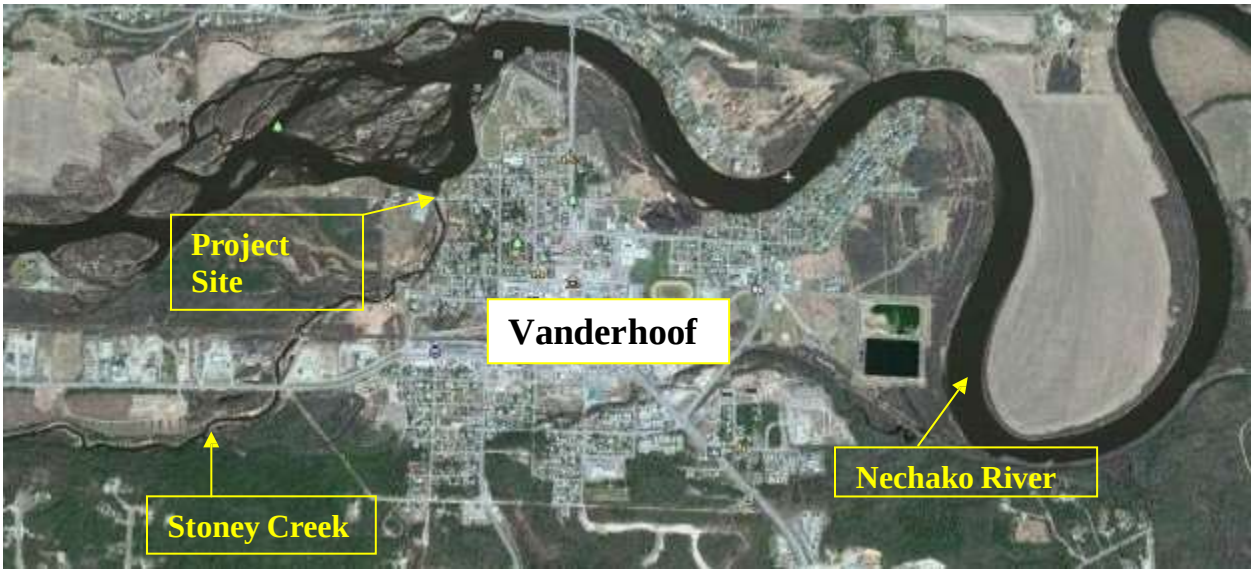

Figure 9. The location of the Douglas Street Bridge project at the Stoney Creek/Nechako River confluence.

3.2 Prescription

It was recommended that the west bank of Stoney Creek at the Douglas Street Bridge receive erosion protection 15m upstream and at minimum 25m downstream of the bridge. Similarly, it was recommended that the east stream bank receive 20m and 60m of erosion protection upstream and downstream of the bridge respectively (120m of bank protection in total) (**Figure 10**). It was further recommended that large woody debris (LWD) be placed at appropriate locations in order to help stabilize the banks and to enhance fish habitat. Where needed, eroding banks were sloped at a 2:1 ratio (3:1 if feasible) and armoured with riprap to prevent further undercutting and erosion. Every attempt was made to conduct works above the current water level to minimize the amount of sediment entering the stream. However, if necessary, some riprap would be toed at the base of the stream bank within the wetted area to ensure that the riprap armouring would not be undermined. Toeing in riprap in the wetted area was conducted slowly and carefully to minimize substrate disturbance sediment resuspension. Willow whips and/or stakes would be placed at appropriate locations to assist in bank stabilization (*i.e.* natural banks, not bridge approaches). Vanderhoof Roadside Mix® seed mix would be dispersed on top off exposed soils that had been disturbed by project activities. Environmental Best Management Practices (BMP's) were employed during all field-related tasks.

Figure 10. Proposed riprap locations for erosion control.

3.3 Activity 1: Project Signage

Signs were developed jointly by NEWSS and Avison over early winter, 2015. Three designs were selected and were manufactured locally by Streamline Signs in Vanderhoof in late March 2015. The design that will be installed at the Douglas Street Bridge bank stabilization and habitat restoration project site (**Figure 11**) provides and illustrations of before and after the installation of the bank stabilization and fish habitat enhancement features. Logos of the the various funding contributors and sponsors were also incorporated into the sign design. An arrangement has been made with a contractor to install the sign at the mouth of Stoney Creek.

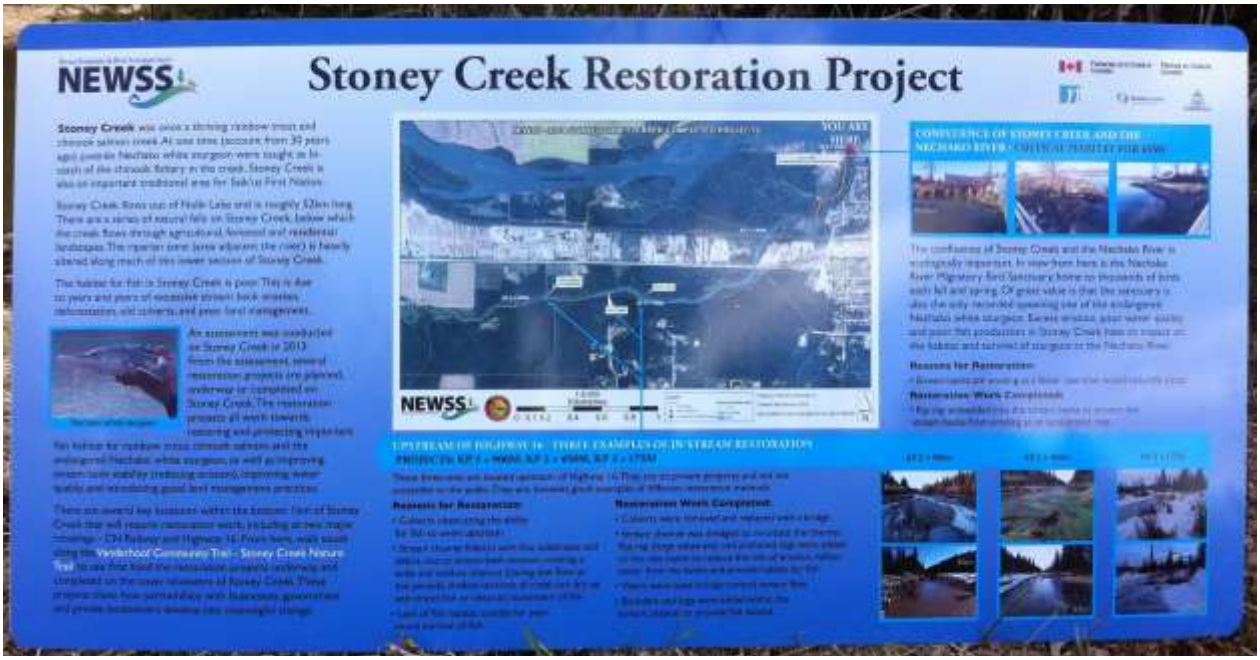

Figure 11. The sign to be installed at the Douglas Street Bridge bank stabilization and habitat restoration project providing before and after photos for each restoration project and major funding organizations, two of which were manufactured.

3.4 Activity 3: Stream Restoration

The armouring of stream bank at the Douglas Street bridge where Stoney Creek confluences with the Nechako River for erosion control and the installation of root wads was conducted from November 04 to November 07, 2014. A total of 135m of stream habitat was restored upstream and downstream of the Douglas Street Bridge. **Photo 29** through **Photo 38** below illustrate the bank armouring installed for erosion control and the LWD installed to improve fish habitat. **Photo 31**, **Photo 33**, **Photo 35** and **Photo 37** also illustrate some of the best management practices used to minimize sediment mobilization and disturbance to existing vegetation during project activities.

Photo 29. Stoney Creek at the Douglas Street bridge/Nechako River confluence illustrating the bank erosion occurring upstream of the bridge.

Photo 30. Stoney Creek at the Douglas Street bridge/Nechako River confluence illustrating the bank erosion occurring downstream of the bridge.

Photo 31. Re-sloping of the West bank of the mouth of Stoney Creek.

Photo 32. Re-sloped west bank of Stoney Creek prior to bank armouring and root wad placement.

Photo 33. Armouring and installation of LWD at the west bank of Stoney Creek at the Nechako River confluence.	**Photo 34.** Armouring and LWD additions completed at the mouth of Stoney Creek at the Nechako River confluence.
	
Photo 35. Re-sloping of the Stoney Creek West bank upstream of the bridge.	**Photo 36.** Armouring and LWD installed on the West bank upstream of Douglas St bridge.
	
Photo 37. Excavator using wooden platforms to protect vegetation and prevent soil compaction.	**Photo 38.** Stoney Creek immediately upstream of the Douglas Street bridge illustrating the bank armouring in the foreground and root wads installed on both the East and West banks.

3.5 Activity 4: Riparian Planting

It is estimated that approximately 150 willow whips were planted in late fall following bank re-sloping, bank armouring and LWD placement. Willow whips were planted in locations where a sufficient depth of soft, wet substrate within the bank zone (just below and immediately above the bankfull elevation) was available. Cuttings were inserted in such a manner as to ensure good soil contact with the cutting to promote root development. Vanderhoof roadside seed mix was dispersed over exposed soils created by project operations.

4.0 Stoney Creek Kilometer Post 2+175 meters Fish Habitat Restoration and Bank Stabilization

4.1 Habitat/Environmental Issues

Bank erosion and a lack of instream fish habitat complexity in Stoney Creek was noted at KP2 + 175 (
Figure 12). In addition, a lack of riparian overstory cover was also noted.

Figure 12. The Stoney Creek habitat rehabilitation site KP2+175.

4.2 Prescription

It was recommended that (1) LWD/root wads and boulders be placed strategically along both stream banks extending into the high water mark; (2) the steeply cut south bank be re-graded to reduce erosion and promote riparian vegetation establishment and (3) where appropriate, re-plant the North bank with willow whips and stakes to increase bank stability and provide riparian overstory cover (**Figure 13, Figure 14**).

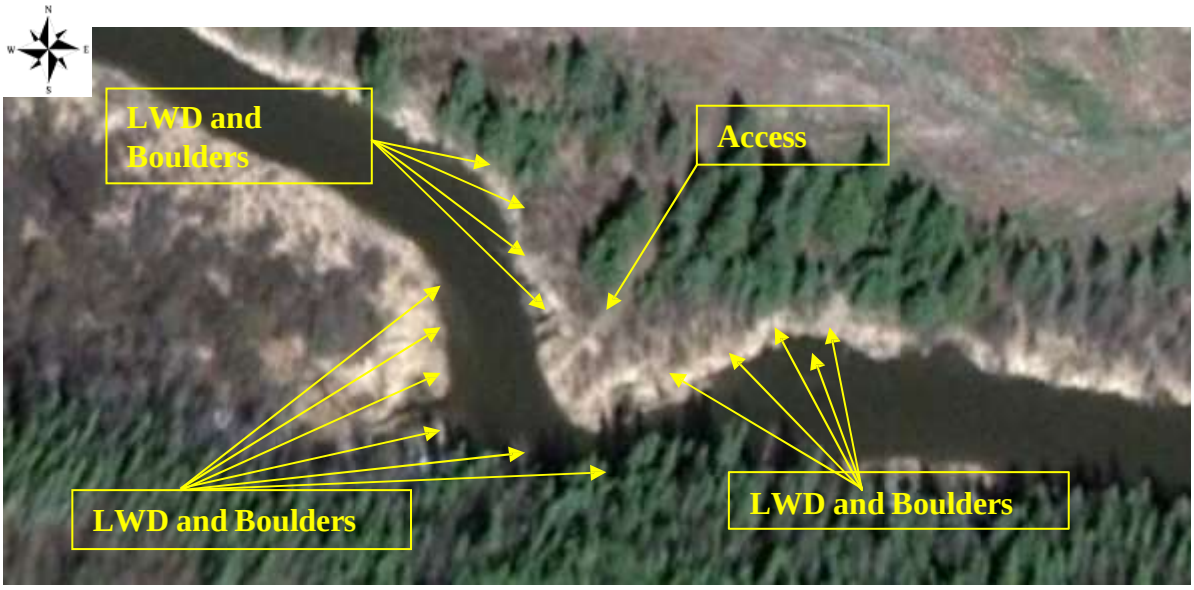

Figure 13. Proposed Stoney Creek fish habitat enhancement and erosion control at KP2 + 175.

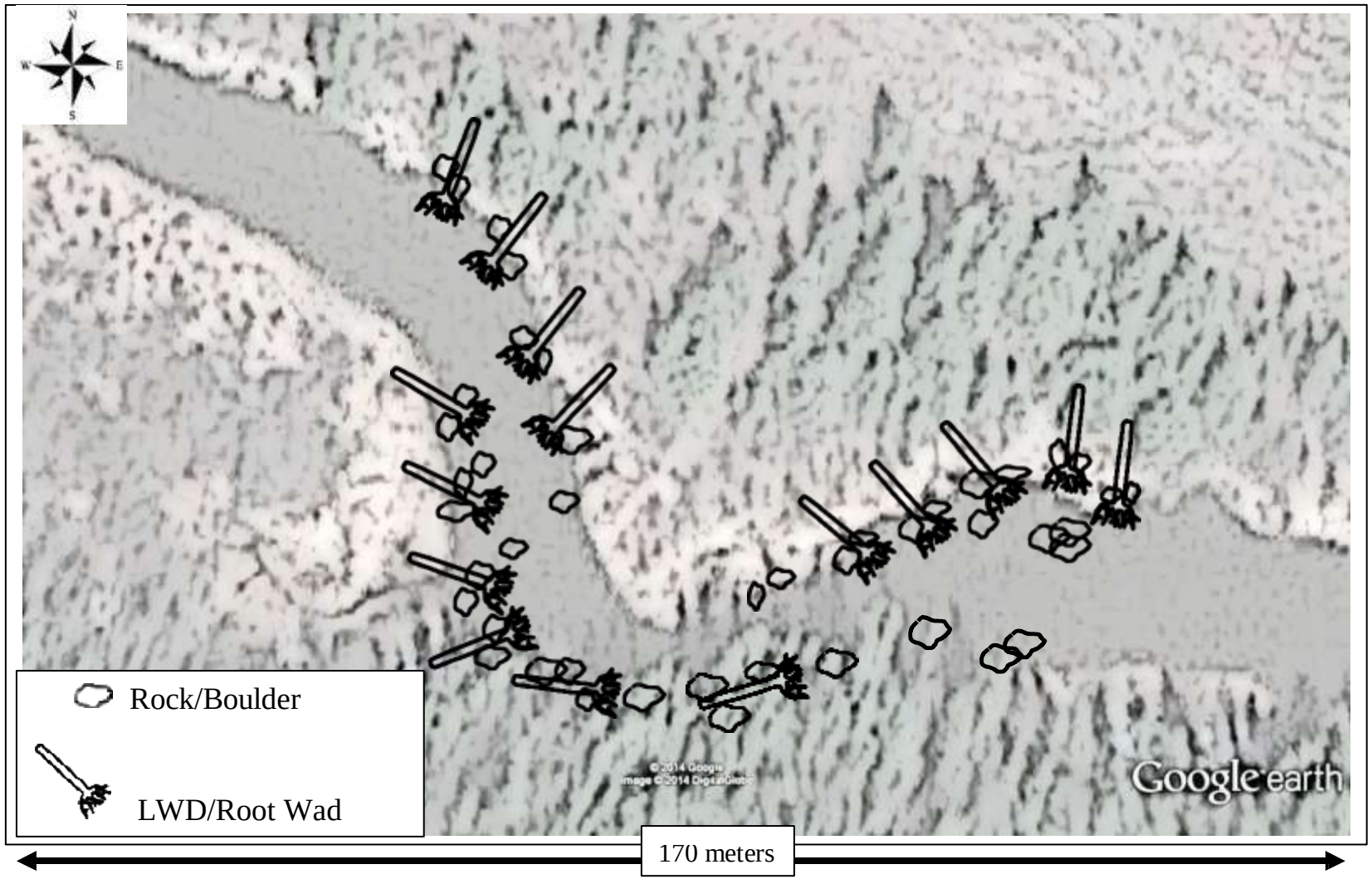

Figure 14. Schematic diagram of the proposed root wad and boulder placement locations at KP2+175m.

4.3 Activity 1: Project Signage

The same sign that will be installed adjacent to the mouth of Stoney Creek at the Douglas Street Bridge bank stabilization and habitat restoration will be installed at KP2+175 (**Figure 15**). An arrangement has been made with a contractor to install the sign at the mouth of Stoney Creek.

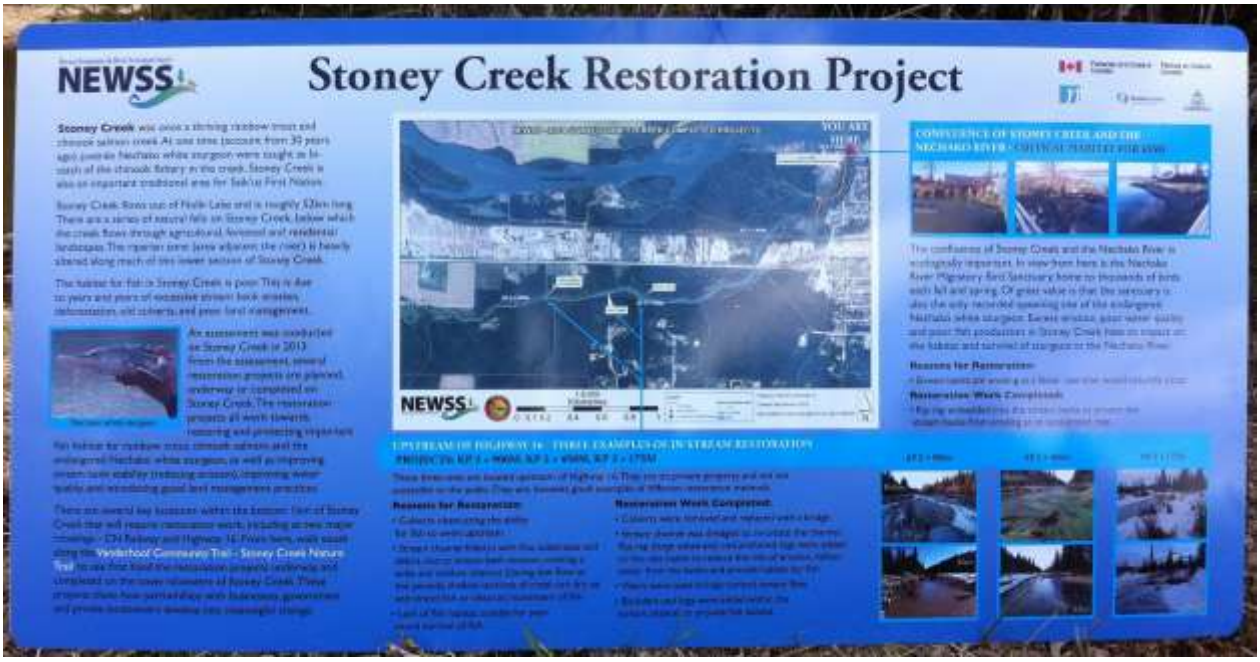

Figure 15. The sign that will be installed at the KP2+175 fish habitat restoration and bank stabilization project.

4.4 Activity 3: Stream Restoration

A total of 120m of stream habitat was restored at KP2+175 on December 10, 2014. All photos of the Stoney Creek at the KP2+175 site were taken on December 10, 2014. All activities were conducted in the dry (above the water line) to minimize re-suspension of stream bed sediments. Ice cover was broken only at the specific locations where root wads (LWD) and boulder clusters were placed. Enhancement was restricted to the North bank where 8 root wads and boulder clusters were placed. Enhancement of the South bank, including re-grading of the South bank, as originally proposed, was not implemented as it was felt that enhancement of the North bank provided sufficient salmonid habitat given that all LWD structures were placed below bank full elevation and extended very close to or within the channel thalweg. Furthermore, natural sources of LWD from the maturing stand of conifer trees along the South bank would eventually provide a natural source of LWD to the channel.

Photo 39. Stoney Creek at KP2+175 prior to habitat restoration activities**.**

Photo 40. Stoney Creek at KP2+175 prior to habitat restoration activities**.**

Photo 41. Root wads and boulder clusters being installed on the North bank looking upstream to the West.

Photo 42. Root wads and boulder clusters being installed on the North bank looking upstream to the North.

Photo 43. Boulder clusters and root wads installed on the North bank looking downstream

Photo 44. Boulder Clusters and root wads being placed from atop of the North bank.

to the East.	
	
Photo 45. Installed boulder clusters to which the root wads were anchored with cable.	**Photo 46.** KP2+175 at project completion.

4.5 Activity 4: Riparian Planting

The noted lack of overstory vegetation identified during the preliminary assessment likely referred specifically to the area of channel within bankfull which is frequently flooded and possibly unsuitable for woody riparian shrubs and trees which roots are intolerant of the hypoxic to anoxic conditions that occur in continually saturated soils. As is the case for all four sites and throughout most of lower Stoney Creek, reed canary grass (*Phalaris arundinacea*), a wetland plant capable of achieving heights of up to 2.7m (9ft) and tolerant of anoxic wetland sediments, has established dense stands within the continuously to frequently flooded sections of channel. Although reed canary grass may offer some erosion protection and nutrient removal services (Stannard and Crowder, 2003) it is likely reducing biological diversity by inhibiting the establishment of other herbaceous species such as sedges and rushes and possibly willows. The planting of willow cuttings, conducted on March 30, 2015, was mainly restricted to the few areas slightly below bank full elevation that lacked naturally occurring willow. Willow occurred in a near continuous belt slightly below and above bank full height at all sites below which a dense, near continuous belt of reed canarygrass had established. Cuttings were also placed at intermediate elevations to determine whether willow can establish in the wetter substrates and possibly outcompete reed canary grass. The planting of willow stakes was shown to be experimentally effective in controlling reed canary grass under some conditions by Kim *et al*. (2006).

Photo 47. Representative vegetation observed on the North and South banks of Stoney Creek at KP2+175, early winter, 2014.

5.0 Stoney Creek Kilometer Post 2+450 meters Bank Stabilization and Fish Habitat Restoration

5.1 Habitat/Environmental Issues

The back watering effect of a non-active beaver dam, located immediately downstream of KP2+450 (
Figure 16) has, for many years, reduced upstream velocities that resulted in a significant accumulation of sediments and a reduction fish habitat quality and quantity upstream of the beaver dam.

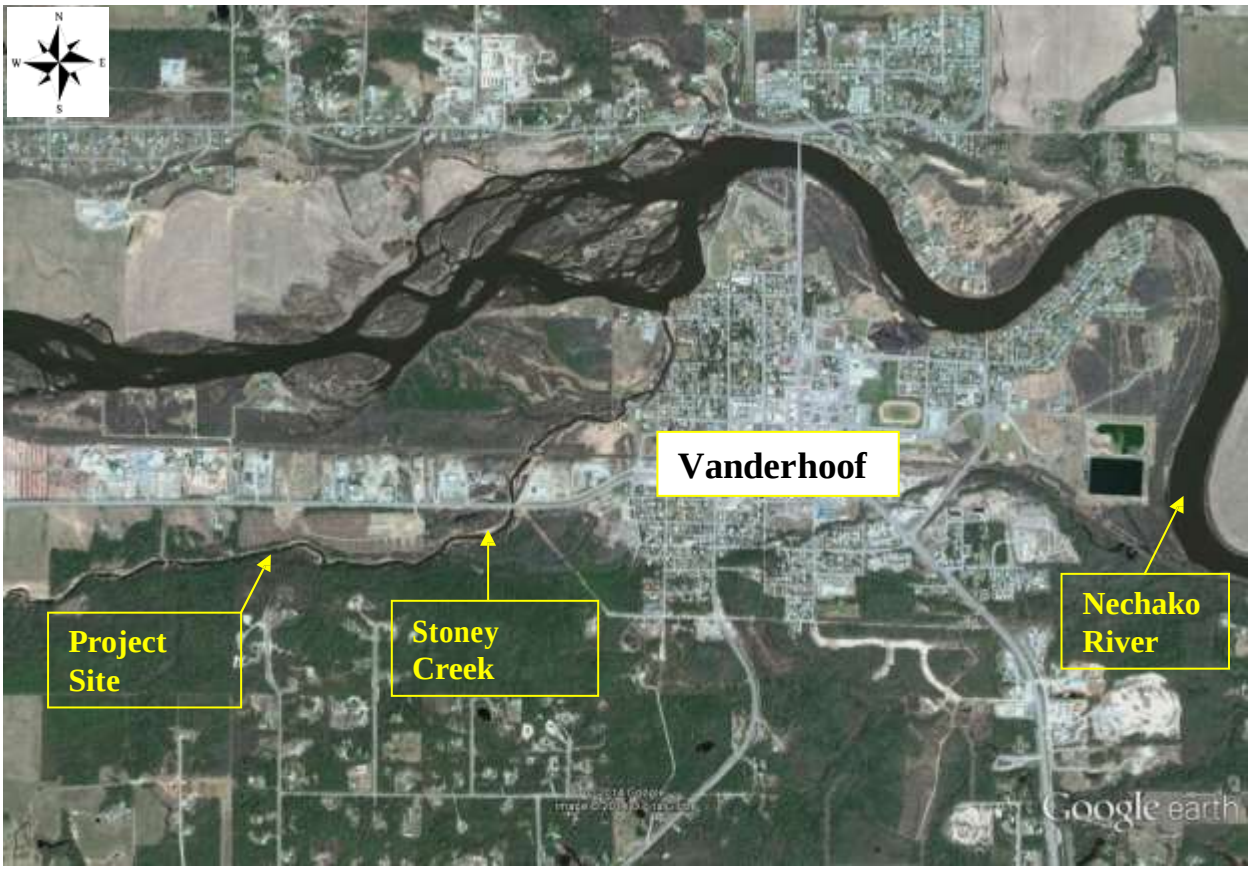

Figure 16. The location of KP 2 + 450 meters where a beaver dam had caused upstream sedimentation.

5.2 Prescription

It was recommended that the accumulated sediment deposits upstream of the beaver dam on the north stream bank be dredged to provide deep pool habitat. As the beaver dam had not been active for several years and no longer creates a dam effect, it would remain in place to serve as fish habitat. Approximately 1050 square meters (m^2) of stream bed at an average depth of 1 meter would be dredged. The dredging would be contoured with depth increasing towards the middle of the stream channel. After the dredging has been completed, it is recommended that a 20-40 cm layer of cobbles and gravels be placed on top of the dredged area to provide spawning, rearing and overwintering fish habitat. To further improve the habitat quality and complexity at this site it was recommended that LWD and boulders be placed along the north and south banks extending into the stream, including the deeper channel areas, to protect banks from erosion, provide instream cover for fish, increase gravel retention and promote scour in the dredged area to reduce sedimentation rate, maintain pool depth and facilitate riffle formation (**Figure 17, Figure 18**).

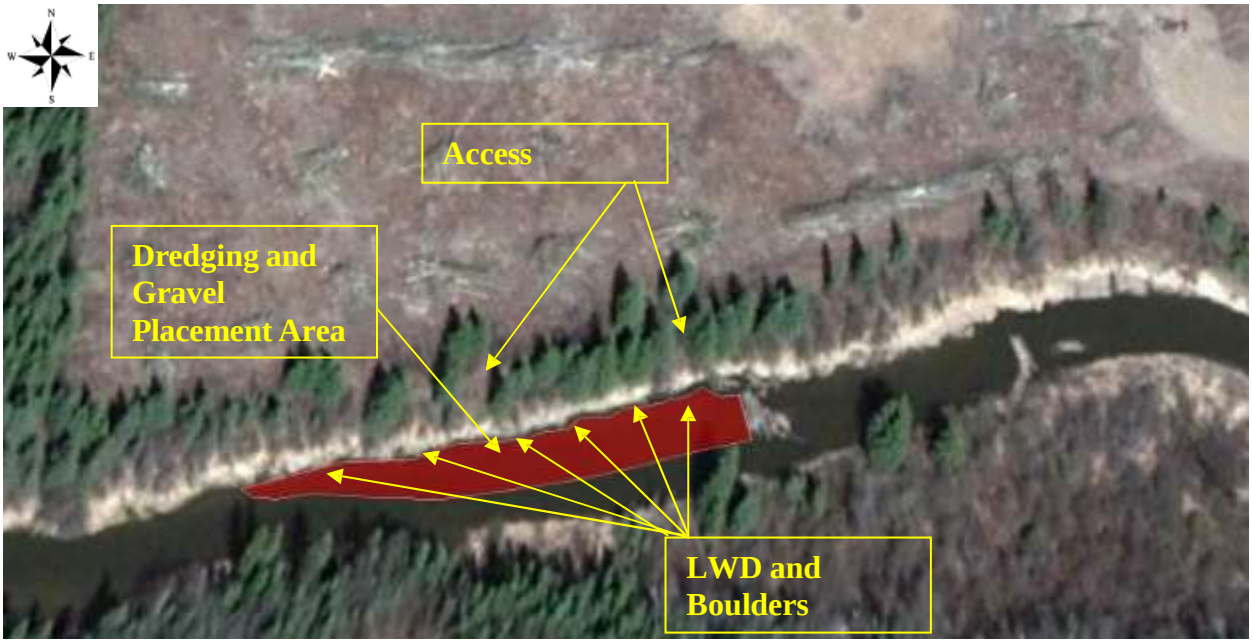

Figure 17. The proposed habitat enhancement site located immediately upstream of a non-active beaver dam illustrating the area to be dredged and enhanced with coarse substrate, LWD and a large, deep pool.

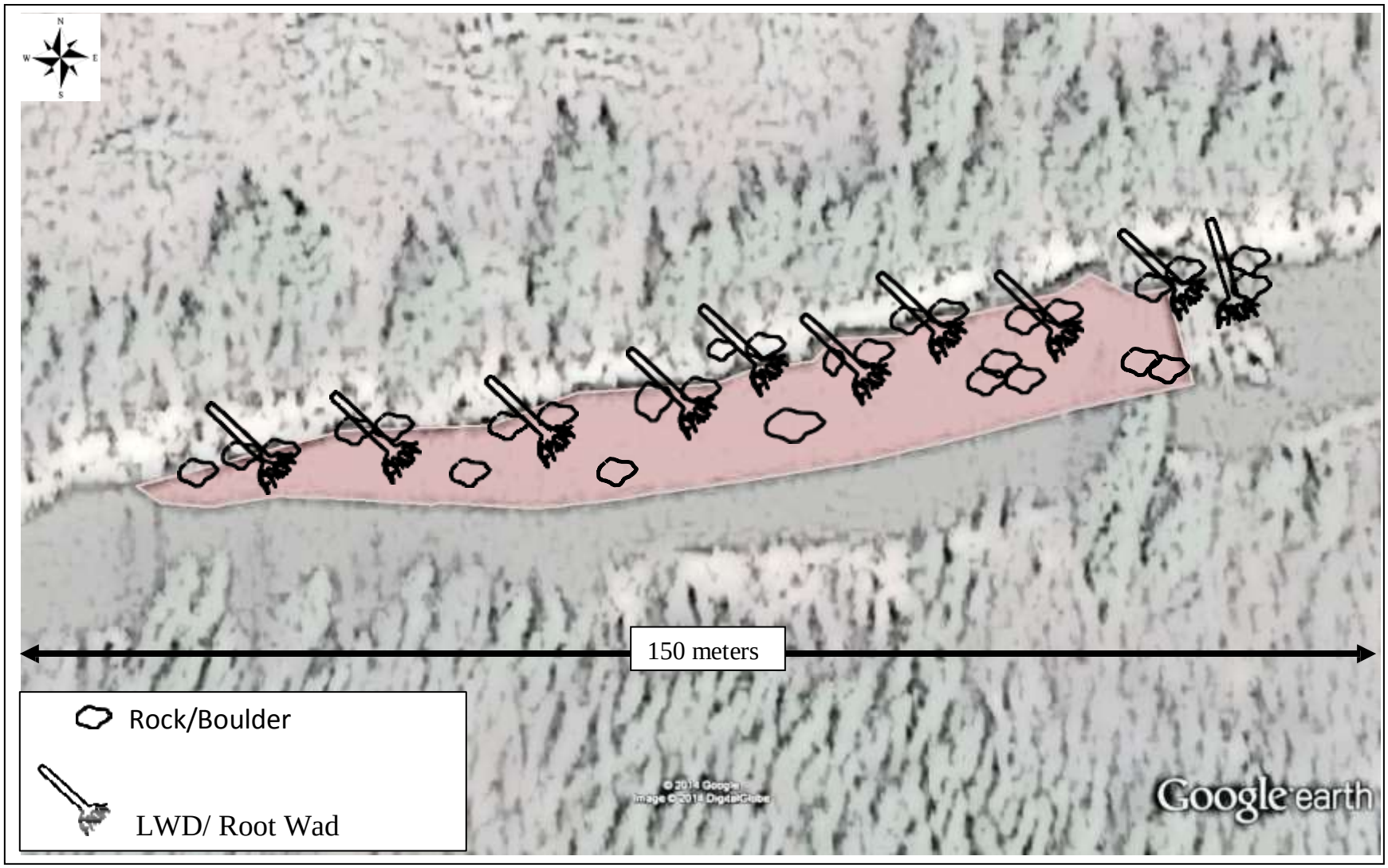

Figure 18. Schematic diagram of the proposed LWD and boulder locations and the area to be dredged at KP2+450.

5.3 Activity 1: Project Signage

The sign below, which will be installed and KP2+450, provides a before and after illustration of the erosion control and fish habitat enhancement structures and recognition for the funding sources and sponsors. A contractor has agreed to install the sign.

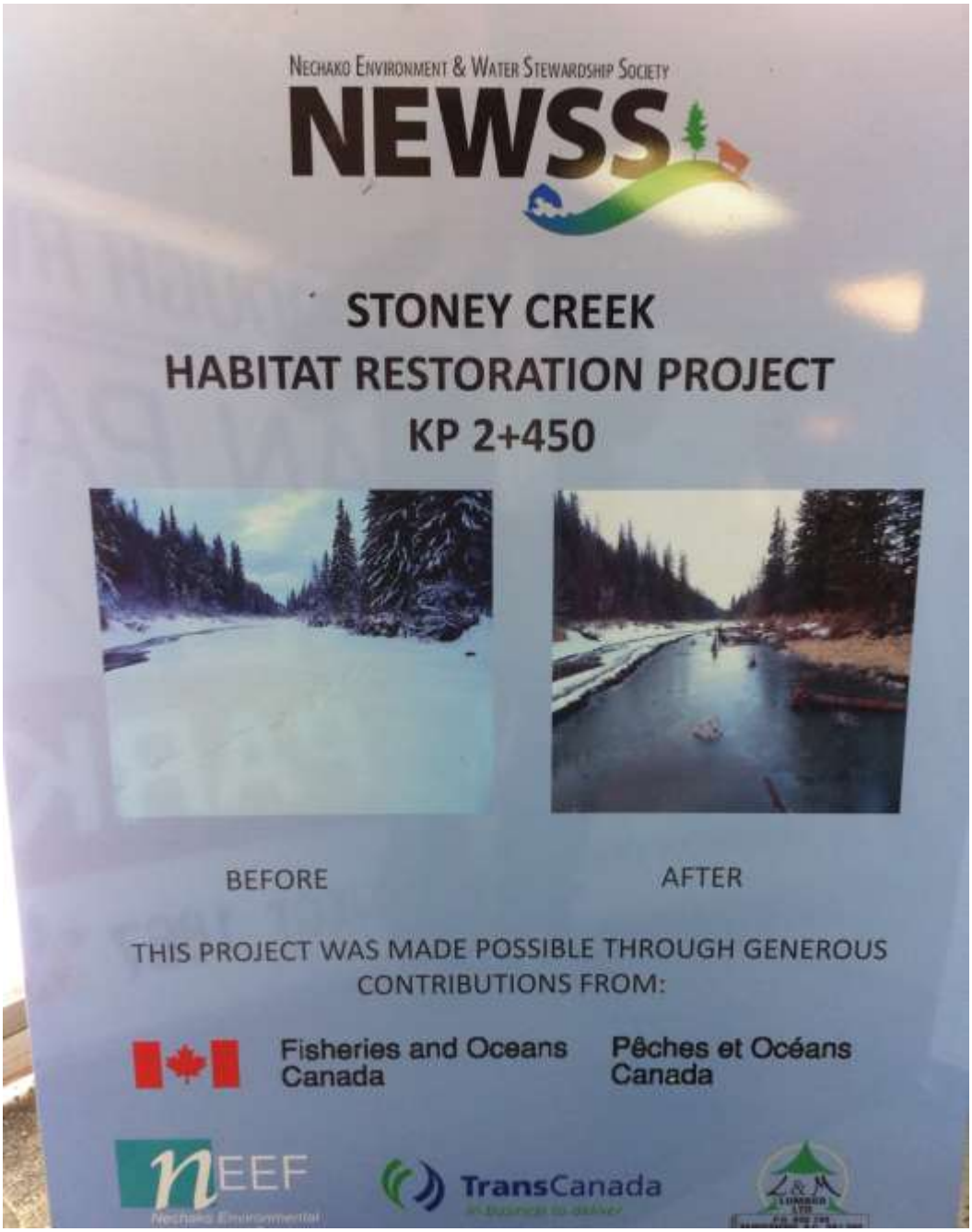

Figure 19. The sign designed and manufactured for the Stoney Creek KP2 +450 bank stabilization and fish habitat enhancement site.

5.4 Activity 3: Stream Restoration

Habitat restoration upstream of the non-active beaver dam was conducted from December 08 and December 11, 2014. All work was done in the dry to avoid re-suspension of stream sediments. No less than 100 meters of stream habitat was restored at this site.

Photo 48. Area immediately upstream of the beaver dam being dredged. Note the earthen platform from which the excavator is being operated and away from the wetted channel.

Photo 49. Root wad (LWD) and boulder clusters being added to provide fish habitat.

Photo 50. Completed habitat restoration upstream of the non-active beaver dam looking upstream.

Photo 51. Completed restoration upstream of the non-active beaver dam looking downstream.

5.5 Activity 4: Riparian Planting

Willow cuttings were planted on March 30, 2015. Planting was limited to below and within the one section of bank that was armoured with boulders (**Photo 52**, **Photo 53**), visible to the right in **Photo 50,** as the existing riparian vegetation at this site, including willows and conifers of mixed ages, was so extensive that some vegetation had to be cut back to provide access to the site. Cuttings were inserted into any available soft, wet substrate at the foot of and within the boulders to a depth of approximately 0. 5m.

Photo 52. Willow cuttings planted below and between boulders within soft sediment at KP2+450.

Photo 53. Willow cuttings planted at KP2+450. Note the recently fallen conifer tree.

6.0 Expenses

6.1 Culvert Removal and Bioengineering (Activity 2) Expenditures

See schedule 7 and Paid Invoices summary

6.2 Stream Restoration (Activity 3) Expenditures

See schedule 7 and Paid Invoices summary

6.3 Riparian Planting (Activity 4) Expenditures

See schedule 7 and Paid Invoices summary

6.4 RFCPP Budget 2014/2015 (Schedule 7, Activity 5).

See attached Schedule 7

7.0 References

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