Site C Clean Energy Project

Peace River Fish Community (Mon-2)

Task 2f - Beatton River Arctic Grayling Status Assessment

Construction Year 3 (2017)

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5 September 2018

REPORT

Beatton River Arctic Grayling Status Assessment

Study Year 1, 2017 (Site C Construction Year 3)

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Cover Photo: Upstream view of potential sample site on Holman Creek, 2 October 2017.

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1.0 INTRODUCTION

1.1 Background

Fish and fish habitat are valued components of the Peace River that are considered important to BC Hydro, Aboriginal groups, the public, the scientific community, and government agencies. The Site C Clean Energy Project (the Project), including Project construction, reservoir filling, and operation, may affect fish and fish habitat via three key pathways: changes to fish habitat, changes to fish health and fish survival, and changes to fish movement (Site C Environmental Impact Statement [EIS], Volume 2[1]).

In accordance with Provincial Environmental Assessment Certificate Condition No. 7 and Federal Decision Statement Condition Nos. 8.4.3 and 8.4.4 for the Project, BC Hydro developed the Site C Fisheries and Aquatic Habitat Monitoring and Follow-up Program (FAHMFP). The Peace River Fish Community Monitoring Program (Mon-2) represents one component of the FAHMFP that monitors fish abundance, biomass, distribution, community composition, and population structure in the Peace River. The Beatton River Arctic Grayling Status Assessment (Task 2f) is one component of Mon-2 that aims to increase the current knowledge and understanding of the life history patterns of Arctic Grayling (*Thymallus arcticus*) in the Beatton River Watershed.

BC Hydro submitted an application to Fisheries and Oceans Canada (DFO) for an authorization under Section 35(2)b of the *Fisheries Act* for several components of the Project associated with Dam Construction, Reservoir Preparation, and Filling (BC Hydro 2015). Section 9.6 of the *Fisheries Act* Authorization summarizes the impacts of the Project on Arctic Grayling in the Peace River Basin and outlines the need for additional data collection to help support management of the species in the region. Briefly, the main effects of the Project (BC Hydro 2015) on Arctic Grayling are as follows:

- *A reduction in abundance caused by the loss of riverine habitat inundated by the reservoir; and*
- *A potential loss of the distinct group of Arctic Grayling that spawn in the Moberly River and rear in the Peace River because of changes in habitat and hindered fish movement.*

BC Hydro does not anticipate the Project will affect Beatton River Arctic Grayling, as the population appears to be resident to the Upper Beatton River and its tributaries and is genetically distinct from other populations in the Peace River Basin (Taylor and Yau 2012). Mon-2, Task 2f will collect information on the age and size structure, growth, recruitment, and population abundance of Beatton River Arctic Grayling and make inter-year comparisons of these population dynamics. Comparisons to populations elsewhere in the Peace River Basin (e.g., Moberly and Halfway rivers through the Mon-1b, Task 2c monitoring program) that will be affected by the Project will also be made. Such information will help fill data gaps on Arctic Grayling in British Columbia (BCCF 2015) and provide Complementary Measures for offsetting[2] through "*investments in data collection and scientific research related to maintaining or enhancing the productivity of commercial, recreational and Aboriginal fisheries*" (BC Hydro 2015).

BC Hydro's *Fisheries Act* Authorization for Dam Construction, Reservoir Preparation and Filling (BC Hydro 2015) provides the following summary with regards to monitoring Arctic Grayling in British Columbia:

[1] Available at http://www.ceaa-acee.gc/ca/050/document-eng-cfm?document=85328.
[2] Available at http://www.dfo-mpo.gc.ca/pnw-ppe/offsetting-guide-compensation/index-eng.html

> *Monitoring and assessment data are a key component of Arctic Grayling management because they are geographically widespread, targeted by anglers, vulnerable to harvest pressure, sensitive to environmental degradation, and have complex life history patterns. These threats have led to poorly documented declines in status in some regions. For example, a status assessment of Alberta Arctic Grayling indicated that 50% of populations have declined by over 90%, mostly during the 1950–1980 time period (ASRD 2005). Data on the basic biology, population status and habitat condition are key elements to inform management and prevent these declines and restore populations. The Monitoring Plan for the Site C Project will generate these types of data, including the four Measures of status provided by BC MOE (2011) for Arctic Grayling.*
>
> *The BC Conservation Framework provides information on management and data needs for Arctic Grayling (BCCF 2015). The highest priority for Arctic Grayling is Goal 2 [Prevent species and ecosystems from becoming at risk] and the recommended Actions depend on the collection and analysis of data. In addition to a direct need for monitoring trends, habitat protection and restoration depend on data that identifies the locations and characteristics of critical habitat. Regulation of harvest requires estimates of sustainable harvest rates and abundance targets, which require data on current values and trends of indicators such as growth, survival and density.*
>
> *Management plans for BC Arctic Grayling (Northcote 1993; Blackman 2001; Williamson and Zimmerman 2005; Ballard and Shrimpton 2009; FWCP 2014) have consistently placed a high priority on research and monitoring to provide information on Arctic Grayling distribution, habitat use, demographic information, and interspecific interactions to inform management decisions.*

BC Hydro (2015) also outlines the benefits of the FAHMFP in helping guide the management of Arctic Grayling in the Peace River Basin through the BC Conservation Framework:

> *There are several aspects of the Site C Monitoring Plan that would assist management agencies in meeting 'Ecological Integrity and Sustainable Use' Objectives for Arctic Grayling in the lower Peace River Basin (BC MOE 2011). These include:*
>
> 1. *Additional information on the genetic and demographic structure of Arctic Grayling within the LAA (Local Assessment Area) relative to other Arctic Grayling in the lower Peace*
> 2. *Assessment and ongoing monitoring of:*
>   a. *Abundance, growth rates, age, and size distribution*
>   b. *Habitat preferences and status by age and size class*
>   c. *Threats to Arctic Grayling and their habitat*
>   d. *Exploitation rates in recreational and First Nations fisheries*
>   e. *Opportunities for habitat enhancement*
> 3. *Application of monitoring and assessment data to establish watershed-specific Targets for Arctic Grayling Conservation and Use Objectives*

4. *Planning and implementing Management Actions designed to meet Objectives including:*
    a. *Harvest regulation*
    b. *Habitat protection*
    c. *Habitat restoration*
5. *Monitoring the effectiveness of these Management Actions*

In addition to information already identified in the Monitoring Plan, additional data collection and evaluations of the status of Arctic Grayling within the Halfway and Beatton rivers are described here. Status assessment would involve collection of data on age and size structure for comparison with data from other systems (e.g., Ballard and Shrimpton 2009) as well as for a within-system time trend analysis. This type of data can be used to assess whether a population is subject to high adult mortality (younger than expected age distribution), poor growth conditions for adults (lower than expected length-at-age, condition, lipid concentration), or poor recruitment conditions (higher than expected lengths of mature adults combined with lower than expected juvenile length-at-age, condition, and lipid concentration).

Mon-2, Task 2f will help management agencies address the objectives listed above through monitoring the Beatton River Arctic Grayling population in Construction Years 3 and 4, and once every five years from Operation Years 1 to 30. The information collected during this program will also support the management of fisheries within the Peace River Basin and would inform potential mitigation requirements under the Site C Fisheries and Aquatic Habitat Management Plan.

1.2 Objectives, Management Questions, and Hypotheses

The overarching management question for the Peace River Fish Community Monitoring Program (Mon-2) is as follows:

1) *How does the Project affect fish in the Peace River between the Project and the Many Islands in Alberta during the short (10 years after Project operations begin) and longer (30 years after Project operations begin) term?*

Information gathered in the Beatton River Arctic Grayling Status Assessment will test the following management hypothesis:

H_8: *Use of the Upper Beatton River by resident Arctic Grayling does not change with the construction and operation of the Project.*

1.3 Report Scope

This document reports on the sampling activities conducted during Construction Year 3 (2017) of this monitoring program. As the fish sampling component of the planned program was cancelled in 2017 due to the accidental release of contaminants within the study area (see Section 2.1), this document details findings of a literature review, the reconnaissance survey conducted to assess the habitat quality and access to potential sample locations, as well as the methodology that will be employed once fish sampling commences. Recommendations

have also been provided to adjust the British Columbia Scientific Fish Collection Permit and sites selected for sampling.

2.0 STUDY AREA

The Beatton River basin was divided into five regions (Figure 1) as described by Mainstream (2011):

1) The Lower Mainstem Region extends from the confluence with the Peace River to the mouth of Blueberry River, which is the largest tributary in the watershed.

2) The Middle Mainstem Region extends from the Blueberry River confluence to approximately 80 km upstream where the Beatton River enters the foothills of the mountains.

3) The Upper Mainstem Region extends to the headwaters.

4) The East Inputs Region includes the Doig River, Milligan Creek, Big Arrow Creek, Black Creek, and their tributaries.

5) The West Inputs Region includes Montney Creek, the Blueberry River, Nig Creek, and their tributaries.

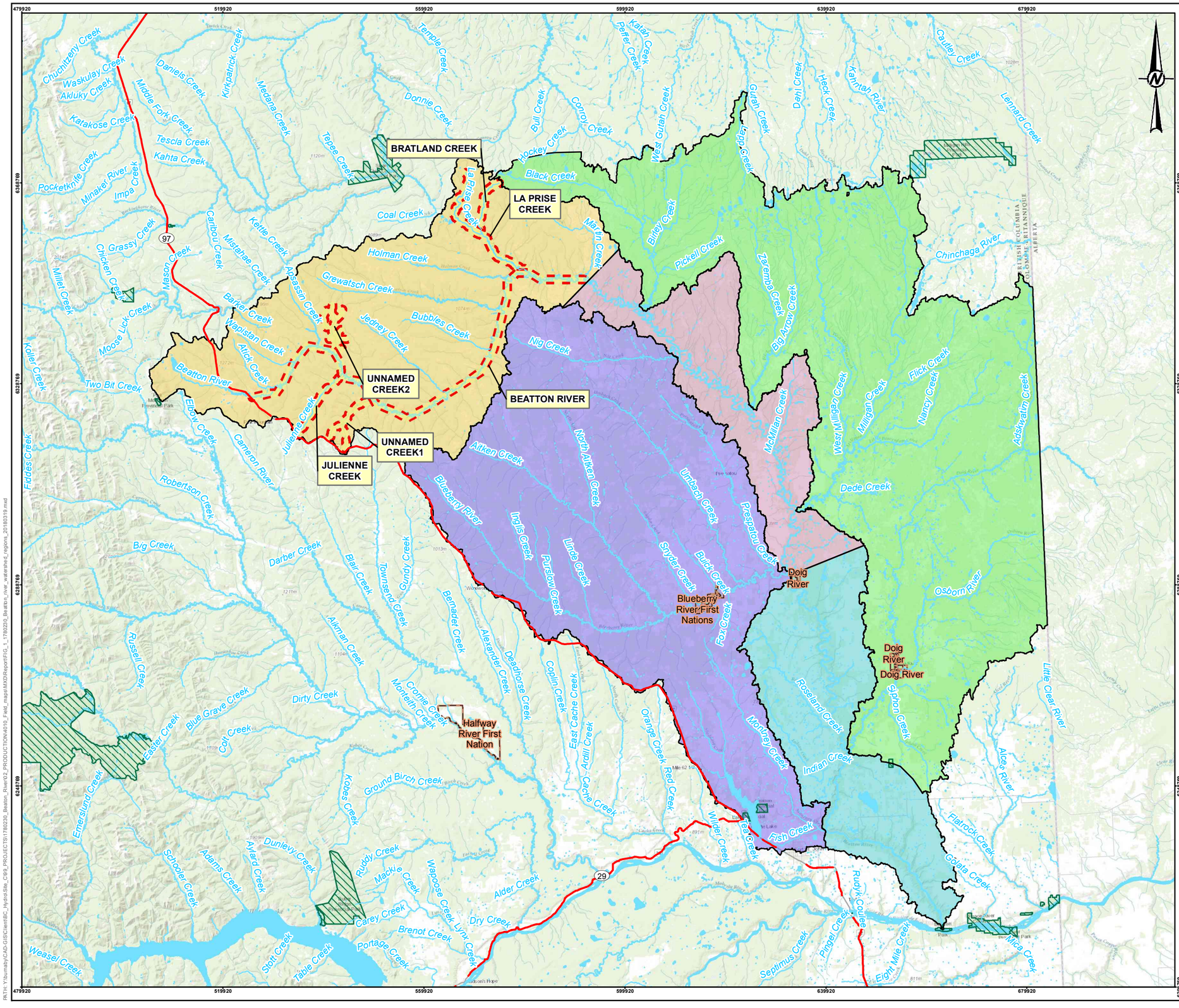
The study area for the Beatton River Arctic Grayling Status Assessment (Mon-2, Task 2f) encompasses the Upper Mainstem Region of the Beatton River, including several of its tributaries.

2.1 Sampling Chronology

This monitoring program was originally scheduled to commence during Construction Year 3 of the Project. On 28 September 2017, approximately two days prior to field crews arriving on site to conduct fish sampling activities, an industrial vehicle drove into the Beatton River at the bridge on Mile Road 135. As reported by the Government of BC[3], this incident caused the release of hydraulic oil and diesel fuel into the Beatton River. As the release of contaminants was near the upstream end of this program's study area and the downstream extent and effect of the release was unknown, it was determined, in consultation with the BC Hydro contract authority, that sampling would be delayed until Construction Year 4.

Due to the release of contaminants into the Beatton River and subsequent cancellation of the sampling, the field crew conducted a reconnaissance survey from 30 September to 2 October 2017 to review and refine the identified sample sites. Fish capture and habitat data collection was postponed to Construction Year 4, and once every five years from Operation Years 1 to 30.

[3] (https://www2.gov.bc.ca/gov/content/environment/air-land-water/spills-environmental-emergencies/spill-incidents/industrial-vehicle-in-the-beatton-river



LEGEND

- STUDY AREA

REGION NAME

- EAST INPUTS
- WEST INPUTS
- UPPER MAINSTEM
- LOWER MAINSTEM
- MIDDLE MAINSTEM

BASE MAP FEATURES

- HIGHWAY
- WATERCOURSE
- WATERBODY
- PARK / PROTECTED AREA
- INDIAN RESERVATION

KEY PLAN

0 15 30

1:750,000 KILOMETRES

REFERENCES

1. ROAD, WATERCOURSE AND WATERBODY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. WATERSHED DATA OBTAINED FROM THE GOVERNMENT OF BRITISH COLUMBIA
3. BASEDATA SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESR I JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.

CLIENT
BC HYDRO

PROJECT
SITE C BEATTON RIVER ARCTIC GRAYLING STATUS ASSESSMENT (MON-2, TASK 2F)

TITLE
BEATTON RIVER WATERSHED REGIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2018-08-28
DESIGNED	DR
PREPARED	JG
REVIEWED	DF
APPROVED	SR

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3.0 LITERATURE REVIEW

Prior to the onset of the Arctic Grayling sampling program in the Upper Mainstem Region, a literature review was conducted. The literature review portion of this program consisted of the following two components:

1) Summarizing existing datasets for the Beatton River with an emphasis on increasing the current knowledge and understanding of the life history patterns of Arctic Grayling in the Beatton River Watershed.

2) Identifying habitat parameters for index sampling locations that will be repeatedly sampled as part of a long-term Arctic Grayling monitoring program.

As part of the literature review, comparisons to the habitat use and migration patterns of Arctic Grayling populations in the Peace River and its other major tributaries were made.

3.1.1 Habitat Use of Arctic Grayling in the Beatton River Watershed

3.1.1.1 General Habitat Use

In British Columbia, Arctic Grayling are primarily a riverine species (McPhail 2007). Across the distribution range of Arctic Grayling in British Columbia, all life history stages typically require clear, low gradient, shallow stream reaches with abundant pools and riffles (Butcher et al. 1981; Ford et al. 1995; Northcote 1993; Stamford et al. 2017). Arctic Grayling are often found downstream of riffles, and utilize riffle habitats during spawning and migration (Ford et al. 1995). Thermal habitat requirements, interspecific competition, and predation are also potential factors influencing habitat use (Stamford et al. 2017). Specific to the Peace River Region, Arctic Grayling are most commonly found in fast-flowing glides (AMEC 2008).

Arctic Grayling are the most abundant and widespread cold-water sportfish in the Beatton River Watershed (Mainstream 2011), and the only cold-water sportfish that has been documented in the Upper Mainstem Region of the Beatton River (Diversified 1999, 2001).

3.1.1.2 Lower and Middle Mainstem Regions

Detailed data on Arctic Grayling habitat use in the Lower and Middle Regions of the Beatton River have not been collected to date (Mainstream 2011, 2012). In 2012, Mainstream conducted a summer fish survey on the Lower Mainstem Region. The study area included four reaches of the Beatton River between its confluence with the Peace River and 90 km upstream. Sampling methods for the survey included beach seine, backpack electrofisher, and small fish boat electrofisher. Although approximately 3000 fish were captured, Arctic Grayling were not encountered during the survey (Mainstream 2013c).

3.1.1.3 Upper Mainstem Region

Mesohabitat information for the Upper Mainstem Region of the Beatton River was described by Diversified (2001) and Mainstream (2012) as riffle/pool habitat, with rearing cover provided by deep pools and large woody debris, with substrate consisting of cobbles, gravels, and fines.

Fisheries inventories of several tributaries to the Upper Mainstem Region were conducted between 1993 and 2005 (Aquatic Resources Ltd. 1993; Diversified 1995a, 1997, 1998, 1999, 2001, 2005). Aquatic Resources Ltd. (1993) reported that although sportfish were not captured in Grewatsch Creek during spring sampling, the system had the habitat available to support them. In 1995, rearing Arctic Grayling were captured in Martin Creek, indicating the presence of suitable spawning habitat in the middle and upper portions of the creek (Diversified 1995a). In 1996, La Prise Creek, Bratland Creek, and Holman Creek were surveyed (Diversified 1997). In La Prise Creek, Arctic Grayling densities were typically highest in upstream sections as turbidity in these areas was lower and the number of low gradient runs and riffles was higher. Results from this survey also indicated that Arctic Grayling may move into smaller tributaries of La Prise creek as a refugia from high turbidity levels. Diversified (1997) also noted that rearing young-of-the-year (YOY) Arctic Grayling had the highest density in habitats with deep pool, large organic (woody) debris, cutbanks, and overhanging vegetation cover. In Bratland and Holman creeks, Arctic Grayling numbers were highest in the downstream portions of the creeks (Diversified 1997). Bratland Creek has been characterized to have high potential for spawning and rearing based on the availability of suitable habitat (Diversified 1997, 2001; Mainstream 2012).

In 1997 and 1998, several unnamed tributaries in the Upper Mainstem Region were sampled and given fish bearing status based on the potential for access and use by Arctic Grayling, and on the presence of suitable seasonal rearing habitat (Diversified 1998, 1999). Other unnamed creeks were classified as non-fish bearing for Arctic Grayling based on high levels of turbidity, absence of a continuous stream channel, absence of suitable rearing and feeding habitat, and lack of access due to low seasonal flows and steep gradients (Diversified 1998, 1999). In 1998, Arctic Grayling ranging from age 0+ to 3+ were captured during late summer sampling (Diversified 1999). Distribution data from sampled tributaries to the Upper Mainstem Region suggests that if juveniles are present, they are likely to be in high densities and use the upper reaches of small streams for rearing and summer feeding (Diversified 1999).

In 2000, Julienne Creek and an unnamed tributary in the Upper Mainstem Region were surveyed in the summer and found to have low to moderate quality spawning and rearing habitat (Diversified 2001). Arctic Grayling YOY were sampled in the mainstem of Julienne Creek, which indicated that spawning occurs in this tributary. Age-0+ to age-3+ individuals were sampled in the upper reaches of the stream, which supports the 1999 finding that older Arctic Grayling use the upper reaches of small streams for summer feeding (Diversified 1999, 2001). In 2005, Apsassin Creek, a tributary to the Upper Beatton River, was reported to provide spawning and rearing habitat for the Upper Beatton River Arctic Grayling population (Diversified 2005).

3.1.1.4 West Input Region

In the West Input Region, habitat consists of highly turbid, riffle/pool complexes with rearing cover provided by deep pools and large woody debris. Substrates are generally composed of cobbles, gravels, and substantial aggregates of fines (Diversified 2002). A cumulative effects study in the West Input Region also reported that the tributaries in this region are typically low-gradient, highly turbid streams with substrates composed of cobbles, gravels, and fine sediments (Salmo and Diversified 2003).

Within the West Input Region, the upper Blueberry River supports a small Arctic Grayling population (Diversified 2002). Spawning potential has been classified as moderate to high in several smaller tributaries in the region (Applied 2006, Diversified 1995b). Rearing habitat in tributaries across the region has also been classified as moderate to high and consists of rifle-pool configurations with several types of available rearing cover

(Salmo and Diversified 2003; Applied 2006). The suitability for Arctic Grayling was documented to be higher in Nig Creek and one of its tributaries (unnamed) based on the availability of spawning and rearing habitat, and previous sampling results, which suggest high seasonal densities of rearing juveniles (BC MOE 2017; Diversified 1995b; Salmo and Diversified 2003).

The presence of juvenile Arctic Grayling has also been previously documented in four tributaries to the Blueberry River (BC MOE 2017; Diversified 2002). Juvenile Arctic Grayling were encountered in Inglis Creek (Diversified 1993), in an unnamed tributary near the headwaters of the Blueberry River drainage basin (Triton 1994), and in two unnamed tributaries to Aitken Creek (Applied 2006). Stantec (2012) conducted fish sampling in the Blueberry River and one if its unnamed tributaries in 2012, and although fish were not encountered, good overall habitat conditions for Arctic Grayling in the program's study area were observed.

3.1.1.5 East Input Region

In the East Input Region, the majority of Arctic Grayling previously sampled were in the Milligan Creek drainage (BC MOE 2017). Mainstream (2012) reported that Milligan Creek contained moderate gradient, riffle/pool habitats with granular substrates, which offer suitable spawning and rearing habitat for Arctic Grayling. Very few Arctic Grayling have been sampled in the downstream portions of the East Input Region (BC MOE 2017).

3.1.1.6 Habitat use in other watersheds in the Peace River System

In 2006, small-fish surveys in the Peace River mainstem showed that adult Arctic Grayling were associated with run habitat, and higher catch rates of Arctic Grayling were observed in sites having no physical cover (Mainstream 2009a). Adult Arctic Grayling were also reported to be found in deep and shallow glides with varying gradients, whereas juveniles found in the Peace River mainstem were most often associated with shallow glide and riffle areas with cover. Arctic Grayling YOY, which were likely from eggs spawned in tributaries, were widely distributed over the mainstem Peace River, which indicated that Arctic Grayling migrated downstream to use the Peace River for overwintering (AMEC 2008). During the 2002 Peace River Indexing Program, catch rates for Arctic Grayling were higher in areas associated with cover (P & E 2002). In 2012 and 2016, Arctic Grayling were captured at sites in the Peace River mainstem with varying amounts of cover (Mainstream 2013d; Golder and Gazey 2017).

Small-fish surveys in the Halfway River in 2006 indicated that Arctic Grayling were also associated with run habitat, with higher catch rates at sites with no physical cover (Mainstream 2009a). During a summer fish and fish habitat inventory of the Halfway River in 2008 (Mainstream 2009c), Arctic Grayling catch was dominated by juveniles and were found only in the upper section of the river. In a Halfway River summer fish survey conducted in 2009 (Mainstream 2010a), the study area was stratified into four zones downstream of the confluence of the Chowade River, identified sequentially from upstream to downstream. The highest catch rates for Arctic Grayling were in the upper sections of the river in Zones 1 and 2. Zone 1 was characterized by numerous riffle/run complexes with some large woody debris, shallow water depths, and clean gravel and cobbles. Zone 2 was characterized as a wide channel with a short braided section dominated by runs, interspersed with riffles and some rapids with gravel, cobble and boulder substrates. The greatest number of YOY Arctic Grayling during this program were caught in Zone 1 (Mainstream 2010a).

During electrofishing surveys in the summer of 2006, three YOY Arctic Grayling were captured in the Moberly River (AMEC and LGL 2008c). Two were captured in run habitat and the other was captured in riffle habitat. Arctic Grayling were not captured in any of the Moberly River tributaries that were sampled, indicating that Arctic Grayling successfully spawned throughout the Moberly River mainstem in spring 2006 (AMEC and LGL 2008c). In the Moberly River summer fish survey conducted in 2009 (Mainstream 2010a), the study area was stratified into four zones downstream of Moberly Lake, identified sequentially from upstream to downstream. The highest catch rates for Arctic Grayling were observed in Zones 2 and 3. Zone 2 is characterized by extended runs interspersed with short riffle/rapid sections. Substrate in Zone 2 consisted of gravel and sands within the run sections and cobble and boulders within the riffle/rapid sections. Zone 3 is characterized by a higher gradient, laterally unstable, braided channels with a number of secondary channels flowing into the Moberly River. Woody debris accumulation was common in Zone 3 and the substrate consisted of small- and medium-sized cobble with boulders in high velocity zones. Arctic Grayling YOY were captured in Zones 2 and 3, which indicated successful spawning in these areas (Mainstream 2010a). In 2008, Arctic Grayling captured in the Moberly River were more abundant in the Lower Section compared to the Upper Section, with the catch dominated by YOY (Mainstream 2009b).

In the Pine River, cold-water species such as Arctic Grayling are typically restricted to upstream areas of the river, while the downstream portions of the river are dominated by cool-water species (AMEC 2008).

3.1.2 Migration Patterns of Arctic Grayling in the Beatton River Watershed

Scott and Crossman (1973) and McPhail (2007) report that Arctic Grayling typically overwinter in larger waterbodies (lakes and larger streams). When ice break-up occurs, fish begin migrating to tributaries with gravel substrates to spawn. Salmo and Diversified (2003) reported that some Arctic Grayling migrate long distances between spawning, summer feeding, and overwintering areas.

Specific to the Beatton River, telemetry studies indicated that some spawning migrations by Arctic Grayling likely occur from the Peace River mainstem into the Lower Mainstem Region of the Beatton River (AMEC and LGL 2009). Although substantial upstream migration into the Beatton River was not observed, several adult fish were captured and radio-tagged within the vicinity of the Beatton River confluence with the Peace River in September 2005. Additionally, during the 2006 and 2007 radio telemetry studies, several Arctic Grayling were detected near the mouth of the Beatton River between spring and fall (AMEC and LGL 2009), and one Arctic Grayling was detected in the Beatton River approximately 20 km from the confluence (AMEC and LGL 2008b).

Currently, it is unknown if the Arctic Grayling population in the Upper Mainstem Region of the Beatton River is resident and restricted to this portion of the watershed, or if mature adults seasonally migrate into and out of the region (Diversified 1999). In the West Input Region, there has been no previous evidence that indicates Arctic Grayling have a migratory lifeform that moves out of the region (Salmo and Diversified 2003). In 2012, Stantec documented the possibility that portions of the Upper Blueberry River and some of its tributaries freeze to the bottom during the winter season, indicating that Arctic Grayling in this area likely migrate downstream to overwinter in deeper sections of the Blueberry River (Stantec 2012).

3.1.2.1 Migration patterns in other watersheds in the Peace River System

Arctic Grayling in the Peace River migrate into tributaries in the spring to spawn, which allows rearing juveniles to avoid potentially adverse conditions in the mainstem of the Peace River (P & E 2002). By late-summer, the majority of the adult population that migrated to tributaries to spawn return to the Peace River mainstem (P & E 2002). Previous studies have indicated that Arctic Grayling also use Farrell and Maurice creeks for spawning (AMEC 2008, AMEC and LGL 2008a). RL&L (2001) stated that juvenile Arctic Grayling were rarely encountered during electrofishing surveys in the Peace River mainstem, and therefore use tributaries for spawning and rearing. Though uncommon in the mainstem, overall abundance of juvenile Arctic Grayling increased in the late summer and fall, suggesting an influx of individuals from tributaries (RL&L 1991).

In 2007, some movement of adults from the Peace River mainstem into the tributaries was detected for Arctic Grayling in late April, indicative of the beginning of the spawning migration (AMEC and LGL 2008b). During the 2011 Peace River Inventory Study, Arctic Grayling were found throughout the Peace River in mainstem habitat (Mainstream 2013a). Large Arctic Grayling (>200 mm) had the highest catch rates in the fall, whereas small Arctic Grayling (≤200 mm) had the high catch rates in the summer and fall. Few Arctic Grayling of either size group were encountered in the spring, which coincides with their spawning life history (Mainstream 2013a).

During telemetry surveys in 2007 (AMEC and LGL 2008b), the number of Arctic Grayling in the Moberly River increased substantially over the spring season, with the farthest upstream fish being approximately 20 km from the mouth. By late May, very few Arctic Grayling were detected in the Moberly River indicating a migration downstream to the Peace River (AMEC and LGL 2008b). Additionally, hoop netting studies conducted in the spring of 2006 found ripe adult Arctic Grayling moving upstream into the Moberly River (AMEC and LGL 2008c).

Arctic Grayling were captured in the Halfway River, the Moberly River, and the Peace River upstream and downstream of the Project during an elemental signature study conducted in 2012 (Earthtone and Mainstream 2013). Results indicated that the majority of Arctic Grayling captured in the Moberly River and in the mainstem of Peace River originated from the Moberly River, whereas smaller numbers of Peace River mainstem fish originated from the Halfway, Beatton, and Pine rivers. None of the Arctic Grayling captured in the Moberly River originated from the Beatton River. A small number of individuals captured in the Halfway River originated in the Beatton River.

A rotary screw trap was deployed in the lower reach of the Moberly River between May and October 2010, and captured a total of 253 Arctic Grayling moving downstream (Mainstream 2010b). Arctic Grayling YOY were encountered throughout the sampling period, but were most frequently captured from mid-June to mid-July and from September to November. Juvenile Arctic Grayling were captured most frequently between May and July. All but one adult Arctic Grayling were captured from mid to late May. The downstream movement of adult Arctic Grayling in May aligns with the end of the spawning period for this species (Mainstream 2010b). In 2012, Arctic Grayling YOY were captured in the Moberly River during the months of July, August, and October (Mainstream 2013b).

Between 1996 and 1999, a radio telemetry study on the movements of Arctic Grayling in the upper Peace River Watershed was conducted (AMEC and LGL 2010). Arctic Grayling were captured, tagged, and released in the Halfway and Pine River watersheds. Results of this study indicated that Arctic Grayling in the headwaters of the Halfway and Pine rivers constitute resident populations (AMEC and LGL 2010). This result is supported by the findings of a 2007 telemetry program, which found that a large portion of the Arctic Grayling population in the upper Pine River watershed represent a resident population (AMEC and LGL 2008b). In the Halfway River, radio-tagged Arctic Grayling moved into small Halfway River tributaries to spawn in the spring (AMEC 2008). In

contrast, Arctic Grayling in the Pine/Sukunka River system showed no evidence of movement into tributary streams during the same time period (AMEC and LGL 2008b).

4.0 SAMPLE SITE RECONNAISSANCE

A total of 22 sites on the Beatton River mainstem and several of its tributaries were selected as potential sample sites (Figure 2) based on site accessibility and potential habitat suitability as determined from the literature review (Section 3.1.1). Upon arrival to site on 30 September 2017, the field crew attempted to assess the extent of the release of contaminants from the industrial vehicle at the bridge over the Beatton River on Mile 135 Road. As the site was controlled when the field crew arrived, potential sample locations on the Beatton River in the immediate vicinity of the bridge were not assessed for suitability until 2 October 2018. The field crew documented a faint sheen on the surface of the water in eddies at the Beatton Access 5 sample site, approximately 25 km downstream of the spill (Appendix A; Photographic Plate 1). It is not known if the sheen at this location was from the spill or another source.

513025 553025 593025

6344290

Medana Creek
Tepee Creek
Green Creek
1120m
Sikanni Chief River
SIKANNI CHIEF RIVER WATERSHED
Medicine Creek
Caribou Creek
Mistahaa Creek
Kettle Creek
Coal Creek
1089m
Holman Creek
Holman Creek
Grewatsch Creek
Grewatsch Creek
Apsassin Creek
1196m
Sikanni Trail
Barker Creek
1074m
Bubbles Creek
Wapistan Creek
1272m
Jedney Creek
Beatton River
Attick Creek
Julienne Creek
Pink Mountain
Elbow Creek
Cameron River
Cameron River
Boreal Ranch
HALWAY RIVER WATERSHED
Townsend Creek
Aitken Creek
Aitken Creek
North Aitken Creek
Blueberry River
Umbach Creek
North Aitken Creek
Nig Creek
BEATTON RIVER WATERSHED
BEATTON RIVER
West Conroy Creek
Bull Creek
Conroy Creek
Hockey Creek
Black Creek
Martin Creek
La Prise Creek
BRATLAND CREEK
LA PRISE CREEK
JULIENNE CREEK
UNNAMED CREEK2
UNNAMED CREEK1
La Prise Access 3
La Prise Access 2
Bratland Access 2
Bratland Access 1
La Prise Access 1
Beatton Access 1
Beatton Access 2
Beatton Access 3
Holman Creek Access 1
Beatton Access 4
Unnamed Creek 2 Access 2
Unnamed Creek 2 Access 1
Beatton Access 8
Beatton Access 9
Beatton Access 6
Beatton Access 7
Julienne Access 2
Julienne Access 1
Unnamed Creek 1 Access 1
Beatton Access 5
Julienne Access 3
Unnamed Creek 1 Access 2
97

6304290

513025 553025 593025

PATH: Y:\Journalby\CAD-GIS\Client\BC_Hydro\Site_C\69_PROJECTS\1780230_Beaton_River\02_PRODUCTION\4010_Field_maps\MXD\ReportFIG.2_1780230_OVERVIEW_20180215.mxd

LEGEND

- POTENTIAL SAMPLE SITES
- STUDY AREA

BASE MAP FEATURES

- HIGHWAY
- ROAD
- WATERCOURSE
- WATERBODY
- MAJOR WATERSHED
- PARK / PROTECTED AREA

KEY PLAN

0 5 10

1:300,000 KILOMETRES

REFERENCES

1. ROAD, WATERCOURSE AND WATERBODY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. WATERSHED DATA OBTAINED FROM THE GOVERNMENT OF BRITISH COLUMBIA
3. BASEDATA SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESR I JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.

CLIENT
BC HYDRO

PROJECT
SITE C BEATTON RIVER ARCTIC GRAYLING STATUS ASSESSMENT (MON-2, TASK 2F)

TITLE
OVERVIEW OF THE SITE C BEATTON RIVER ARCTIC GRAYLING STATUS ASSESSMENT (MON-2 TASK 2F) STUDY AREA AND POTENTIAL SAMPLE SITES, 2017

CONSULTANT
GOLDER

YYYY-MM-DD	2018-08-28
DESIGNED	DR
PREPARED	JG
REVIEWED	DF
APPROVED	SR

PROJECT NO.	CONTROL	REV.	FIGURE
1780230		0	2

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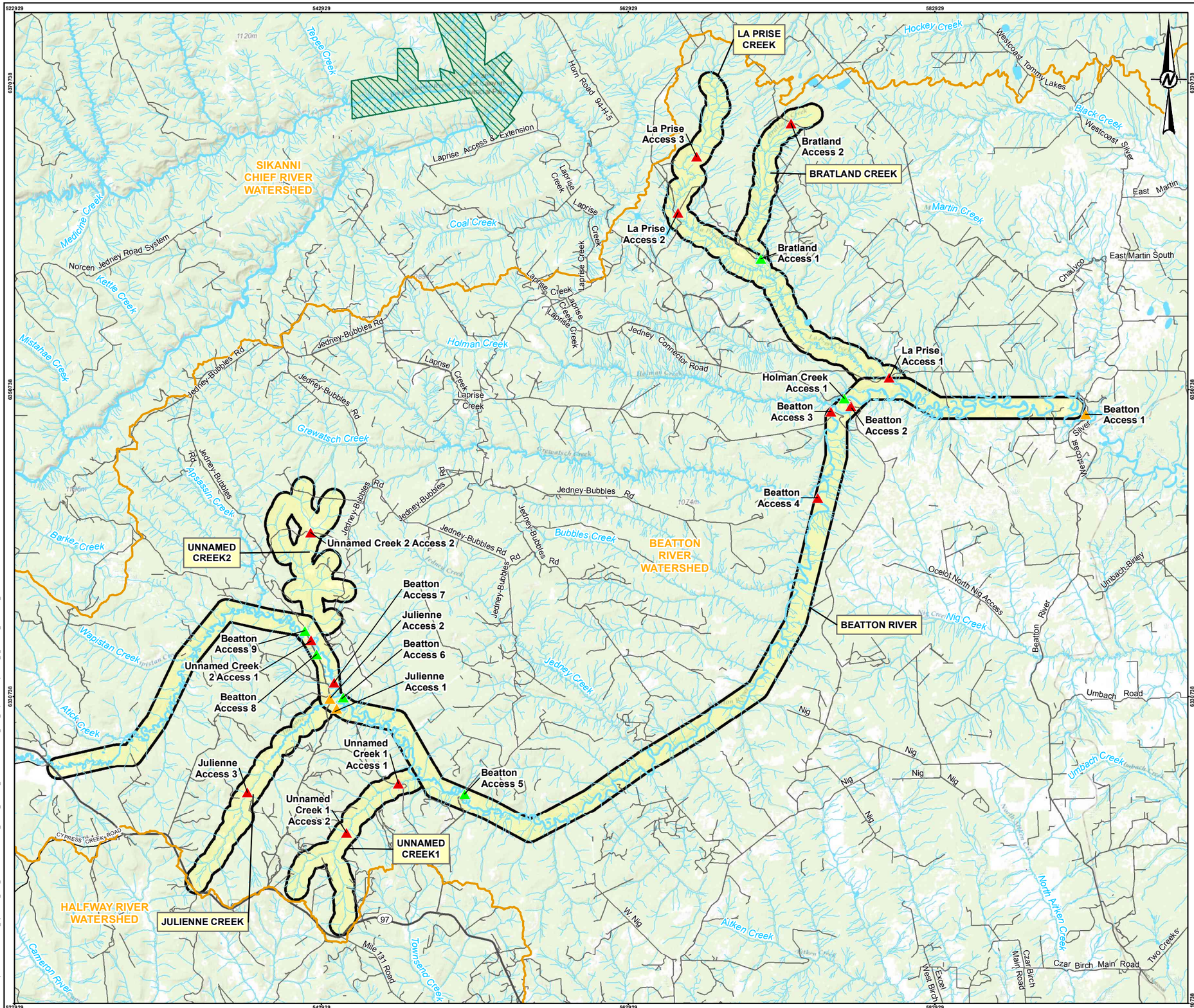
0 25mm

During the reconnaissance survey, the field crew assessed 11 of the 22 sites pre-selected for sampling (Table 1; Figure 3). The 11 sites that were not assessed could not be accessed by 4X4 truck. Based on the availability of preferred Arctic Grayling habitat (riffles and runs, cobble and gravel substrate) at the assessed sites and accessibility by 4X4 truck, six of the sites were classified with a high suitability for sampling (Appendix A; Photographic Plates 2 to 7). Of the remaining five sites that were assessed, Beatton Access 1 and Julienne Access 1 and 2 were classified with a moderate suitability for sampling (Table 1; Figure 3). During the reconnaissance assessment, the area of Holman Creek near its confluence with the Beatton River met both the habitat and access criteria were classified as a highly suitable location for long term monitoring. The Provincial Scientific Fish Sampling Permit will be amended to include this stream for sampling as part of this program. The field crew also attempted to assess potential sample site locations upstream of the spill on the Beatton River between the bridge on Mile 135 Road and where Highway 97 crosses the Beatton River. Sample sites with suitable habitat and accessibility were not found in this area.

Table 1: Results of Reconnaissance Assessment of Potential Sample Locations, September and October 2018.

Sample Site	Suitability for Sampling (Low/Moderate/High)	Description
Beatton Access 1	Moderate	Limited preferred habitat available, good access by 4X4 truck
Beatton Access 2	Low	Preferred habitat not available, good access by 4X4 truck
Beatton Access 3	N/A	Unable to access site via 4X4 truck
Beatton Access 4	N/A	Unable to access site via 4X4 truck
Beatton Access 5	High	Preferred habitat available, good access by 4X4 truck (Photographic Plate 2)
Beatton Access 6	High	Preferred habitat available, good access by 4X4 truck (Photographic Plate 3)
Beatton Access 7	N/A	Unable to access site via 4X4 truck
Beatton Access 8	High	Preferred habitat available, good access by 4X4 truck (Photographic Plate 4)
Beatton Access 9	High	Preferred habitat available, good access by 4X4 truck (Photographic Plate 5)
Julienne Access 1	Moderate	Limited preferred habitat available, good access by 4X4 truck
Julienne Access 2	Moderate	Preferred habitat available, poor access by 4X4 truck
Julienne Access 3	N/A	Crew did not assess this location
La Prise Access 1	N/A	Unable to access site via 4X4 truck
La Prise Access 2	Low	Preferred habitat not available, good access by 4X4
La Prise Access 3	N/A	Crew did not assess this location
Bratland Access 1	High	Preferred habitat available, good access by 4X4 truck (Photographic Plate 6)
Bratland Access 2	N/A	Crew did not assess this location
Unnamed Creek 1 Access 1	N/A	Unable to access site via 4X4 truck
Unnamed Creek 1 Access 2	N/A	Unable to access site via 4X4 truck
Unnamed Creek 2 Access 1	N/A	Crew did not assess this location as Bridge over Mile 135 Road to access this site was closed during spill cleanup
Unnamed Creek 2 Access 2	N/A	Crew did not assess this location as Bridge over Mile 135 Road to access this site was closed during spill cleanup
Holman Creek Access 1	High	Preferred habitat available, good access by 4X4 truck (Photographic Plate 7)



LEGEND

SAMPLE SITE SUITABILITY

- HIGH
- MODERATE
- LOW/NA
- STUDY AREA

BASE MAP FEATURES

- HIGHWAY
- ROAD
- ACCESS ROAD (APPROX.)
- WATERCOURSE
- WATERBODY
- PARK / PROTECTED AREA
- MAJOR WATERSHED

0 5 10

1:250,000 KILOMETRES

REFERENCES

1. ROAD, WATERCOURSE AND WATERBODY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. WATERSHED DATA OBTAINED FROM THE GOVERNMENT OF BRITISH COLUMBIA
3. BASEDATA SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESR I JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.

CLIENT
BC HYDRO

PROJECT
SITE C BEATTON RIVER ARCTIC GRAYLING STATUS ASSESSMENT (MON-2, TASK 2F)

TITLE
SUITABILITY OF SITE C BEATTON RIVER ARCTIC GRAYLING STATUS ASSESSMENT (MON-2 TASK 2F) SAMPLE SITES

CONSULTANT
GOLDER

YYYY-MM-DD	2018-08-28
DESIGNED	DR
PREPARED	JG
REVIEWED	DF
APPROVED	SR

PROJECT NO.	CONTROL	REV.	FIGURE
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5.0 PROPOSED SAMPLING METHODOLOGY

Based on the results of the sample site reconnaissance conducted in the fall of 2017, and in consultation with the BC Hydro contract authority, the following methodologies are proposed for the sampling in 2018.

5.1 Index Site Sampling

At selected index sites (Section 4.0), backpack electrofishing surveys targeting Arctic Grayling will be conducted. Each survey crew will consist of one crew member operating a backpack electrofisher, and one netter. The crew will sample approximately 50 to 200 m of shoreline habitat at each site in an upstream direction. Sampling will focus on sites that were documented to have high and moderate suitability during the reconnaissance survey in 2017 (Section 4.0). Each site will be sampled completely and a site form will be completed for each sampled site. Site habitat conditions, the effort expended, and settings used during backpack electrofishing, and the number and species of fish captured and observed (but not captured by the field crew) will be recorded.

The methodology that will be used during this program is widely used for researching freshwater fish species and is not anticipated to result in any effects on the Arctic Grayling productivity within the study area.

5.2 Fish Handling and Processing

Fish collected during sampling will be kept in a large bucket until the site survey is complete. Fresh water will be routinely added to the bucket to maintain oxygen levels and water temperature within the bucket. After the site survey is completed, the field crew will then process each captured fish and release the fish back into the index site.

The following life history parameters, ageing structure, and tag information will be collected for all captured Arctic Grayling:

1) Length – fork length to the nearest 1 mm
2) Weight – the weight of the fish to the nearest 1 g
3) Scales – for ageing, taken from the left side of the fish near the dorsal fin
4) Otoliths – to be collected from any fish that succumb to the sampling procedure
5) Tag Type – the type of tag applied (only PIT tags will be applied) or present at capture
6) Tag Number – the number of the applied or present tag at capture
7) Tag Scar – the presence of a scar from a previous tag application
8) Fin Clip – the presence of an adipose fin clip
9) Condition – the general condition of the fish (i.e., alive, dead, unhealthy, etc.)
10) Comments – any additional comments regarding the fish

For all other species of fish collected, the species, fork length or total length (depending on the species) to the nearest 1 mm, weight to the nearest 1 g, and condition will be recorded.

All Arctic Grayling that are 80 mm in length or greater and in good condition following processing will be marked with a half-duplex (HDX) PIT tag (ISO 11784/11785 compliant). Depending on the size of the fish, tags will be implanted within the left axial muscle below the dorsal fin origin and oriented parallel with the anteroposterior axis. All tags and tag applicators will be immersed in an antiseptic (Super Germiphene™) and rinsed with distilled water prior to insertion.

The size and location of PIT tags to be used will be based on the fork length of the fish:

1) Fish between 80 and 199 mm FL will be dorsally marked with 12 mm tags

2) Fish between 200 and 299 mm FL will be dorsally marked with 23 mm tags

3) Fish greater than 299 mm FL will be dorsally marked with 32 mm tags

These sizes and tagging locations are consistent with other monitoring programs, including the Peace River Large Fish Indexing Survey (Mon-2, Task 2a) and the Site C Reservoir Tributaries Fish Population Indexing Survey (Mon-1b, Task 2c). HDX tags will be used for compatibility with other monitoring programs currently underway in the Peace River that require PIT tags to be detected by fixed arrays (Mon-1b, Task 2b). PIT tags will be read using a Datamars Data Tracer FDX/HDX Reader.

6.0 DISCUSSION

The following sections summarize and discuss the available information collected by the previous study programs as they relate to addressing the overarching Peace River Fish Community Monitoring Program (Mon-2) management question:

1) How does the Project affect fish in the Peace River between the Project and the Many Islands in Alberta during the short (10 years after Project operations begin) and longer (30 years after Project operations begin) term?

The information gathered in Year 1 of the Beatton River Arctic Grayling Status Assessment also provides background data to test the management hypothesis:

H_8: *Use of the Upper Beatton River by resident Arctic Grayling does not change with the construction and operation of the Project.*

This summary will focus on previously documented data on the habitat use and migration patterns of Arctic Grayling in the Beatton River Watershed.

6.1 Habitat Use

Based on the results of the literature review conducted for this program, all Arctic Grayling life stages in the Beatton River Watershed require low turbidity, riffle/run habitat that contain coarse substrates (cobbles and gravels). The presence of suitable cover (i.e., deep pools, vegetation, and woody debris) is essential for both the

YOY and juvenile life stages (Diversified 1997; Salmo and Diversified 2003; Applied 2006). These habitat characteristics have been documented in high abundance in the Upper Mainstem and West Input regions of the Beatton River. Although these habitat characteristics have been documented in the Lower Mainstem, Middle Mainstem and East Input regions, limited studies in these areas preclude any conclusions of Arctic Grayling habitat use. Tributary use and the potential for range expansion may be affected by movements within a metapopulation (Stamford et al. 2017).

Due to the abundance of suitable spawning, rearing, and summer feeding habitat present, the Upper Mainstem Region likely supports a substantial Arctic Grayling population (Diversified 1999). The current dataset indicates that the upper sections of the West Input Region also support a limited Arctic Grayling population (Salmo and Diversified 2003). The Upper Blueberry River and Nig Creek are two of several sub-populations within the Beatton River Watershed (Salmo and Diversified 2003).

The findings of the previous studies in the Beatton River Watershed are consistent with the findings of other programs conducted in the Peace River system. Arctic Grayling catch rates in the Peace, Moberly, and Halfway rivers were also highest in shallow riffle/run habitat (Mainstream 2009a and 2010a). In the Peace River, Arctic Grayling were captured at sites in the Peace River mainstem with varying amounts of cover (Mainstream 2009a and 2013d; P & E 2002).

6.2 Migration Patterns

Several seasonal migrations of Arctic Grayling occur on an annual basis, including: 1) upstream pre-spawning migrations in spring; 2) downstream post-spawning migrations; 3) migration to summer resources; and 4) fall downstream migrations to overwintering habitats (Ford et al. 1995). During the spring, upstream migrations from the Peace and Beatton River mainstems into tributary spawning habitats occur (P & E 2002; AMEC 2008, AMEC and LGL 2008b, 2009). Adult Arctic Grayling have demonstrated moderate upstream migrations to spawning habitats in the Peace River system (AMEC and LGL 2009). Additional upstream migrations may occur as Arctic Grayling move into smaller tributaries as a refugia from higher turbidity levels (Diversified 1997).

The majority of Arctic Grayling sampled during the elemental signature study spent their first summer in habitats that were chemically similar to their natal streams (Earthtone and Mainstream 2013). In the summer season after spawning, adult Arctic Grayling have been documented migrating downstream to summer feeding habitats (AMEC and LGL 2008b; Mainstream 2010b; Stantec 2012). This summer downstream migration was also documented for juveniles (AMEC and LGL 2008b; Stantec 2012). Downstream dispersal by younger age-classes of Arctic Grayling is a major source of recruitment for the Peace River population (Mainstream 2012). Peace River Arctic Grayling recruit from the Moberly, Halfway, Pine, and Beatton rivers (Mainstream 2012). A microsatellite DNA analysis study conducted by Taylor and Yao (2012) found that Arctic Grayling from the Beatton River were fundamentally more distinct than other populations in the major tributaries to the Peace River, which indicates the presence of a resident population within the Beatton River. Alternatively, Arctic Grayling from the Peace and Moberly rivers were very similar genetically, which suggests the majority of recruitment for the Peace River population is from the Moberly River (Taylor and Yao 2012). This is supported by the findings of a 2007 telemetry program, which found that the Moberly River likely contributes more to annual recruitment of the Peace River Arctic Grayling population than any other tributary upstream of the Project (AMEC and LGL 2008b). Arctic

Grayling in the Halfway and Beatton rivers were determined to be genetically discrete populations with restricted gene flow, which indicates that migration between these two systems does not occur (Stamford and Taylor 2004).

The overall range of travel for Arctic Grayling documented in telemetry programs reduces the likelihood that Peace River mainstem Arctic Grayling populations travel to the upper reaches of the Beatton River Watershed for spawning (AMEC and LGL 2009). Instead, it is more likely that Arctic Grayling within the upper reaches of the Beatton River Watershed are resident populations that do not leave the drainage (AMEC and LGL 2009). This is similar to findings of Arctic Grayling studies in the upper Pine and Halfway rivers. Telemetry survey results indicated that there is a resident population of Arctic Grayling in these rivers that remain in these drainages year round (AMEC and LGL 2010).

7.0 CLOSURE

We trust that this report meets your current requirements. If you have any further questions, please do not hesitate to contact the undersigned.

Golder Associates Ltd.

Brad Hildebrand, BSc
Project Manager, Fisheries Biologist

Shawn Redden, RPBio
Associate, Project Director, Senior Fisheries Biologist

BH/SR/lih

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APPENDIX A

Photographic Plates

Plate 1 Contaminants from spill observed immediately upstream of Beatton Access 5 sample site, taken on September 30, 2017.

Plate 2 Overview of Beatton Access 5 sample site taken on September 30, 2017.

Plate 3 Downstream view of Beatton River 6 sample site taken on September 30, 2017.

Plate 4 Overview of Beatton Access 8 sample site taken on October 2, 2017. Sample site will encompass the riffle in the upper portion of the photograph.

Plate 5 Downstream view of Beatton River 9 sample site taken on October 2, 2017.

Plate 6 Overview of Bratland Access 1 sample site, taken on October 2, 2017.

Plate 7 Overview of Holman Creek Access 1 sample site. taken on October 1, 2017.

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