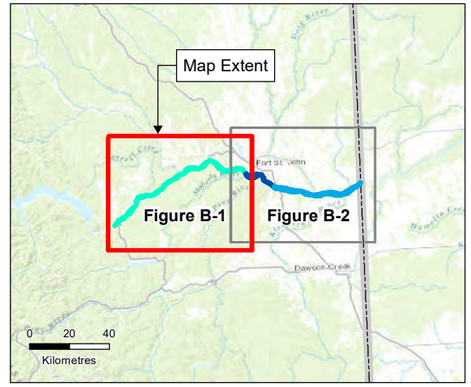
APPENDIX B

Spatial Representation of Waterbird Observations within the Peace River Study Area in Spring and Fall 2019 (Figures B-1 to B-4)

Migratory Waterbird Follow-up Monitoring Program
2019 Report
Site C, Peace River, BC

Inundation/Reservoir Impact Area
Spring 2019



Halfway River
Charlie Lake
Cache Creek
Halfway River
Peace River
Moberly River
Pine River
Hudson's Hope
Peace Canyon Dam

Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Number of Bird Observations

- 1 - 2 birds
- 3 - 9 birds
- 10 or more birds

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

1:220,000

0 2 4 6 8 10
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Feb 27, 2020	Figure B-1

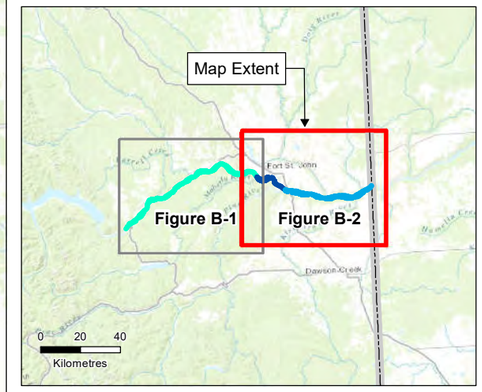
Hemmera An Ausenco Company

BC hydro

Path: S:\Graphics\Projects\989619\07_waterfowl monitoring\Program2019\Fig8-1_989619_07_WaterbirdIa_SpringCount_ReservoirInundationImpactArea_202227.mxd

Migratory Waterbird Follow-up Monitoring Program
2019 Report
Site C, Peace River, BC

Flow Regime Impact Area and Control Area
Spring 2019



Charlie Lake
Fort St. John
Old Fort
Taylor
Beatton River
Pine River
Peace River
Kiskatinaw River
BRITISH COLUMBIA
ALBERTA

Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Number of Bird Observations

- 1 - 2 birds
- 3 - 9 birds
- 10 or more birds

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

1:220,000

0 2 4 6 8 10
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Feb 27, 2020	Figure B-2

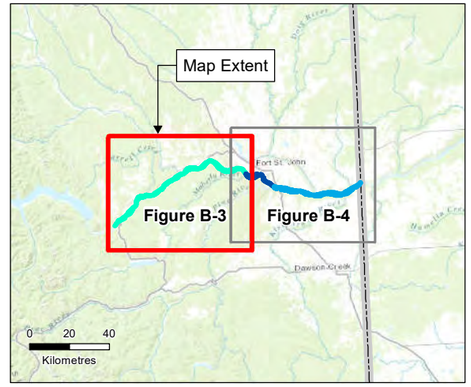
Hemmera
An Ausenco Company

BC hydro

Path: S:\Geomatics\Projects\989619\07_waterfowl\mxd\MonitoringProgram2019\FigB-2_989619_07_Waterbirds_SpringCount_FlowRegimeChangeImpactArea_Control.mxd, 20027

Migratory Waterbird Follow-up Monitoring Program
2019 Report
Site C, Peace River, BC

Inundation/Reservoir Impact Area
Fall 2019



Halfway River
Charlie Lake
Cache Creek
Halfway River
Peace River
Moberly River
Pine River
Hudson's Hope
Peace Canyon Dam

Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Number of Bird Observations

- 1 - 2 birds
- 3 - 9 birds
- 10 or more birds

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

1:220,000

0 2 4 6 8 10
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Feb 27, 2020	Figure B-3

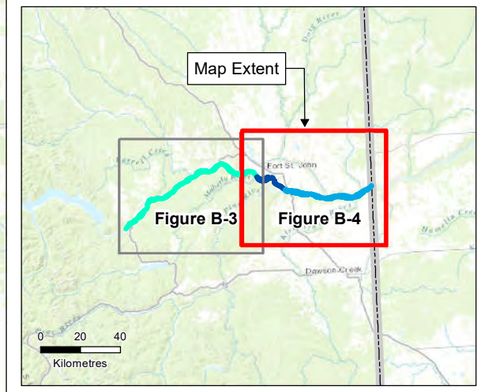
Hemmera An Ausenco Company

BC hydro

Path: S:\Groups\acs\Projects\989619\07_waterfowl monitoring\Program2019\Figs\B-3_989619_07_Waterbirds_FallCount_ReservoirInundationImpactArea_230227.mxd

Migratory Waterbird Follow-up Monitoring Program
2019 Report
Site C, Peace River, BC

Flow Regime Impact Area and Control Area
Fall 2019



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Number of Bird Observations

- 1 - 2 birds
- 3 - 9 birds
- 10 or more birds

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

1:220,000

0 2 4 6 8 10
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Feb 27, 2020	Figure B-4

Hemmera
An Ausenco Company

BC hydro

Path: S:\Geomatics\Projects\989619\07_waterfowl\mxd\MonitoringProgram2019\FigB-4_989619_07_WaterbirdFallCount_FlowRegimeChangeImpactArea_ControlArea_202227.mxd

APPENDIX C

2019 Wetland Survey Effort by Survey Station with Dominant and Sub-Dominant Wetland Classifications

Appendix C: 2019 Wetland Survey Effort by Survey Station with Dominant and Sub-Dominant Wetland Classifications

Dominant Wetland Type Sub Dominant Wetland Type	Station ID	Survey Method	Spring Surveys			Fall Surveys				Grand Total
			Early	Middle	Late	Early	Middle-Early	Middle-Late	Late	
Open water (OW)										
Open water (OW)	OW01	Transect, Standwatch	*Frozen*	2	2	1	2	2	1	10
Open water (OW)	OW02	Standwatch	*Frozen*	1	2	1	2	2	1	9
Open water (OW)	OW04*	Standwatch	*Frozen*	2	1	1	2	2	0	8
Open water (OW)	OW06*	Transect, Standwatch	*Frozen*	2	2	1	2	2	0	9
Sedge (SE)	OW07	UAV	*Frozen*	1	1	1	1	2	0	6
Open water (OW)	OW09*	Standwatch	*Frozen*	2	2	1	2	2	0	9
Sedge (SE)	OW10	UAV	*Frozen*	2	2	1	2	2	1	10
Willow-sedge (WS)	OW11*	Transect, Standwatch	*Frozen*	1	2	1	2	2	1	9
Sedge (SE)										
Willow-sedge (WS)	SE01	Transect	*Frozen*	1	2	1	2	2	0	8
Sedge (SE)	SE02	Transect, UAV	*Frozen*	2	1	1	2	2	1	9
Open water (OW)	SE03	Transect, UAV	*Frozen*	2	2	1	2	2	0	9
Open water (OW)	SE04	Transect, UAV	*Frozen*	2	2	1	2	2	0	9
Willow-sedge (WS)	SE05	Transect	*Frozen*	1	2	1	1	2	0	7
Open water (OW)	SE06	Transect, UAV	*Frozen*	2	1	1	2	2	1	9
Open water (OW)	SE07	Transect, UAV	*Frozen*	2	2	1	2	2	0	9
Open water (OW)	SE08	Transect, UAV	*Frozen*	2	1	1	1	2	0	7
Open water (OW)	SE09	Transect, UAV	*Frozen*	1	2	1	2	2	1	9
Open water (OW)	SE10	Transect, UAV	*Frozen*	2	2	1	2	2	1	10
Willow-sedge (WS)	SE11	Transect	*Frozen*	1	2	1	1	2	0	7
Sedge (SE)	SE12	UAV	*Frozen*	2	2	1	2	2	0	9
Sedge (SE)	SE13	UAV	*Frozen*	2	2	1	1	2	0	8
Open water (OW)	SE14	Transect, UAV	*Frozen*	2	2	1	1	2	0	8
Willow-sedge (WS)										
Sedge (SE)	WS01	Transect	*Frozen*	1	2	1	2	2	0	8
Sedge (SE)	WS02	Transect	*Frozen*	2	2	1	2	2	0	9
Tamarack-sedge (TS)	WS03	Transect	*Frozen*	2	2	1	2	2	0	9
Total			**0**	**42**	**45**	**25**	**44**	**50**	**8**	**214**

* Stations surveyed in 2017 with standwatch methods

APPENDIX D
Wetland Survey Station Photos

Photo 1 Aerial Photograph of Wetland Survey Station OW01 (September 9, 2018)

Photo 2 Aerial Photograph of Wetland Survey Station OW02 (September 18, 2018)

Photo 3 Aerial Photograph of Wetland Survey Station SE03 (lower left) and OW04 (upper right; August 22, 2019)

Photo 4 Aerial Photograph of Wetland Survey Station OW06 (October 17, 2018)

Photo 5 Aerial Photograph of Wetland Survey Station OW07 (August 22, 2019)

Photo 6 Photograph of Wetland Survey Station OW09 (October 17, 2018) Showing Habitat Representative of the Wetland Area Surveyed

Photo 7 Aerial Photograph of Wetland Survey Station OW10 (August 22, 2019)

Photo 8 Aerial Photograph of Wetland Survey Station OW11 (August 22, 2019)

Photo 9 Aerial Photograph of Wetland Survey Station SE01 (August 8, 2018)

Photo 10 Aerial Photograph of Wetland Survey Station SE02 (August 22, 2019)

Photo 11 Aerial Photograph of Wetland Survey Station SE04 (August 22, 2019)

Photo 12 Aerial Photograph of Wetland Survey Station SE05 (August 6, 2018)

Photo 13 Aerial Photograph of Wetland Survey Station SE06 (August 12, 2019)

Photo 14 Aerial Photograph of Wetland Survey Station SE07 (August 22, 2019)

Photo 15 Aerial Photograph of Wetland Survey Station SE08 (August 22, 2019)

Photo 16 Aerial Photograph of Wetland Survey Station SE09 (August 7, 2018)

Photo 17 Aerial Photograph of Wetland Survey Station SE10 (August 22, 2019)

Photo 18 Aerial Photograph of Wetland Survey Station SE11 (August 6, 2018)

Photo 19 Aerial Photograph of Wetland Survey Station SE12 (August 12, 2019)

Photo 20 Aerial Photograph of Wetland Survey Station SE13 (August 11, 2019)

Photo 21 Aerial Photograph of Wetland Survey Station SE14 (August 6, 2018)

Photo 22 Aerial Photograph of Wetland Survey Station WS01 (August 6, 2018)

Photo 23 Photograph of Wetland Survey Station WS02 (October 17, 2018) Showing Habitat Representative of the Wetland Area Surveyed

Photo 24 Aerial Photograph of Wetland Survey Station WS03 (August 7, 2018)

Appendix 6. Wetland Monitoring 2019 Field Summary Report

Site C Clean Energy Project
Wetland Monitoring Program
2019 Annual Report

DATE: MARCH 31, 2020

PRESENTED TO:

BC Hydro
1111 West Georgia Street, 9th floor
Vancouver, BC V6E 4G2

PRESENTED BY:

EcoLogic Consultants Ltd.
Unit 4 - 252 East 1sat Street
North Vancouver, BC V7L 1B3
Phone: 604 803-7146

EXECUTIVE SUMMARY

BC Hydro developed a Wetland Monitoring Program (the Program) for the Site C Clean Energy Project to address, in part, requirements outlined in the Federal Decision Statement Condition 11 and Environmental Assessment Certificate Condition 12. The Program consists of two components: baseline wetland monitoring, which is focused on gathering information on the physical, ecological, biogeochemical and hydrological conditions of wetlands prior to construction activities; and wetland monitoring during construction and operations, which is focused on gathering information to evaluate changes from baseline conditions due to Site C Project activities.

The 2019 field program focused on data collection at additional baseline monitoring wetlands (i.e., Baseline Monitoring Wetlands), monitoring of wetlands that may be affected by construction activities (i.e., construction phase wetlands), and determining the suitability of groundwater monitoring wetlands. The baseline monitoring field work included finding and assessing specific wetland types to increase the total sample size of each wetland type for monitoring. 2019 was the first year of construction phase monitoring, with the re-assessment of wetlands that were surveyed during the 2016 field program, prior to the start of Project construction. The assessment of wetlands for groundwater monitoring involved locating and sampling impact and reference wetlands that were suitable for the long-term groundwater program.

For the 2019 field program, six changes to the monitoring program methodology were incorporated, based on the results and recommendations of the 2018 field program:

- the use of the Solocator App to digitally label and georeference photos in the field;
- recording structural stage and composition along with disturbance of adjacent ecosystems instead of classifying to the site series level;
- completing a Floristic Quality Index assessment in each wetland to monitoring change over time in vegetation;
- sampling bog wetlands outside of the transmission line to capture pre-disturbance wetland conditions;
- georeference the location of water depth measurements; and
- the inclusion of additional fields in the wetland condition forms.

The field team surveyed a total of 49 wetlands: 5 potential groundwater monitoring sites, 15 construction phase wetlands, and 29 previously un-sampled baseline monitoring wetlands. Data on the physical, ecological, biogeochemical and hydrological conditions collected at each of the 2019 wetlands are presented in this report.

TABLE OF CONTENTS

List of Figures

List of Tables

List of Plates

List of Appendices

1. INTRODUCTION

1.1 PROJECT CONDITIONS

BC Hydro developed a Baseline and Construction Phase Wetland Monitoring Program (Native Plant Solutions 2018a) for the Site C Clean Energy Project (the Project) to address, in part, requirements outlined in the Federal Decision Statement Condition 11 and Environmental Assessment Certificate Condition 12.

> ***Condition 11.4.1****. Baseline data on the biogeochemical, hydrological and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Designated Project, including: ground and surface water quality and quantity; vegetation cover; biotic structure and diversity; migratory bird abundance, density, diversity and use; species at risk abundance, density, diversity and use; and current use of the wetlands for traditional purposes by Aboriginal people, including the plant and wildlife species that support that use.*
>
> ***Condition 11.4.3****. An approach to monitor and evaluate any changes to baseline conditions, as defined in condition 11.4.1 and identify improvements based on monitoring data.*
>
> ***Condition 12****. The EAC Holder must monitor construction and operation activities that could cause changes in wetland functions.*

1.2 PROJECT OVERVIEW

The Wetland Monitoring Program (the program; Native Plant Solutions 2018a) consists of two components:

1. Baseline wetland monitoring – gathers information (i.e., biogeochemical, hydrological and ecological) on wetlands prior to construction activities, including verification of ecosystem mapping and wetland condition.
2. Construction and operations wetland monitoring – gathers information at two- and five-year intervals after initiation of construction to evaluate changes from baseline conditions due to Project activities.

The program is designed to allow for the following:

- collection of baseline data on the biogeochemical, hydrological, and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Project;
- an evaluation of the change to baseline wetland conditions due to the Project;
- selection of mitigation measures for loss of wetland areas and functions, including reclamation, improvement, creation and protection (BC Hydro 2015); and

- flexibility in the monitoring program to allow for further refinement in the characterization of baseline and affected wetlands, as data become available.

1.3 Study Area

The wetland monitoring study area includes three distinct areas within the Project Activity Zone (PAZ) and downstream of the dam site:

- the reservoir footprint (the future inundation zone), which is composed of the Western Reservoir, Middle Reservoir, Eastern Reservoir, and the Dam Site Area;
- the transmission line, separated into Phase A and Phase B; and
- the Downstream area.

2. METHODS

2.1 BASELINE WETLAND MONITORING SITE SELECTION

The 2019 field season focused on assessing specific wetland types to meet the overall baseline sampling plan (Native Plant Solutions 2019a). The sampling plan had a target of sampling 20% of all wetland types relative to the number of times they are mapped in the PAZ (i.e., 20% by polygon count per wetland type; Native Plant Solutions 2019a). A total of 30 baseline wetlands, comprising four different wetland types (Native Plant Solutions 2019a), were targeted for 2019 (Table 2.1-1). Site selection for baseline wetland monitoring focused on the previously un-sampled area downstream of the dam, with other areas of the PAZ to be sampled if the target wetland types could not be located downstream (Table 2.1-1).

Table 2.1-1. Wetland Type and 2019 Target Number

Wetland Type	Code	2019 Target
Black spruce-Labrador tea-sphagnum	BT	11
Tamarack sedge	TS	8
Willow-horsetail-sedge riparian wetland	WH	10
Willow sedge wetland	WS	1

2.2 CONSTRUCTION PHASE WETLAND MONITORING

The 2019 field program included the first year of construction monitoring for wetlands that were initially sampled in 2016. A total of 15 construction phase wetlands were selected for 2019 (Native Plant Solutions 2019a), consisting of five wetland types (Table 2.1-2). Site selection for construction phase wetland monitoring focused predominantly along the transmission line within the cleared corridor. Additional pre-selected sites along the transmission line identified as potential candidates for the groundwater monitoring program were also included in the 2019 field program.

Table 2.1-2. Target Number and Type of Construction Phase Wetlands for 2019

Wetland Type	Code	2019 Target
Black spruce-Labrador tea-sphagnum	BT	2
Shallow open water	OW	1
Sedge wetland	SE	10
Tamarack sedge	TS	1
Willow sedge wetland	WS	1

2.3 GROUNDWATER MONITORING SITE SELECTION

Federal Conditions 11.4.1 and 11.4.3 require baseline data on groundwater quality and quantity, an approach to monitoring and an evaluation of changes to baseline conditions. In order to meet these

conditions, a wetland groundwater monitoring program was designed to fit within the full Wetland Monitoring Program (Native Plant Solutions 2019b). Native Plant Solutions designed the groundwater program to use Sedge Wetlands (SE) - either marsh or fens - that meet the following criteria:

- greater than 0.1 ha,
- not part of a large complex,
- previously recorded as groundwater fed, and
- located within the PAZ (Native Plant Solutions 2019b).

Both impacted sites (wetlands that are directly affected by construction activities) and reference sites (wetlands of a similar type that are in the PAZ, but outside of expected construction impacts) were selected for assessment. Native Plant Solutions (2019b) provided a list of five impacted sites and four reference sites for the 2019 field program (Table 2.3-1).

Table 2.3-1. Potential Groundwater Monitoring Sites

Site Name	Site Code	Northing	Easting
Impacted Site (already field verified)	ISV	6216718	614516
Preferred Reference Site	PR	6226701	629422
Backup Reference Site 1	BR1	6222328	624439
Backup Reference Site 2	BR2	6227495	628869
Backup Reference Site 3	BR3	6222355	624145
Potential Impacted Site 1	PI1	6215640	612506
Potential Impacted Site 2	PI2	6219165	618801
Potential Impacted Site 3	PI3	6221936	624079
Potential Impacted Site 4	PI4	6226742	628536

At each of the impacted and reference sites, the site was first assessed to ensure it met the previously described selection criteria. Suitable sites were then fully described using the full baseline monitoring methodology as per *BC Hydro Site C Wetland Monitoring Program Field Manual; Baseline and Construction Phase* (Appendix D of Native Plant Solutions 2018b). In addition, the location of approximate groundwater monitoring wells and piezometers were marked and recorded in the field with the use of wooden stakes and GPS. The sites were laid out as per Native Plant Solutions guidance (Native Plant Solutions 2019b), with well Monitoring Location A located in the centre of the wetland (or edge of open water if present), well Monitoring Location B at the interface between the wetland and adjacent upland community, and well Monitoring Location C placed in the adjacent upland community approximately 30 m from the wetland edge.

2.4 FIELD METHODOLOGY

The 2019 field program collected information for site-level data categories (Table 2.4-1). Comprehensive and detailed methods are provided in the *BC Hydro Site C Wetland Monitoring Program Field Manual; Baseline and Construction Phase* (Appendix D of Native Plant Solutions 2018b). For the construction phase wetlands, the collection of full Level II water samples as well as wetland delineation was requested by Native Plant Solutions as they were not completed in the 2016 baseline monitoring (Native Plant Solutions 2019a).

Table 2.4-1. Baseline and Construction Phase Wetland Monitoring Program: Data Categories and Parameters

Category	Parameter	Monitoring Phase [a]	Federal Condition 11.4.1
Site Information	Photo stations	B/C	–
	Site diagram	B/C	–
	Wetland ecosystem classification	B/C	–
Physical Parameters	Wetland delineation	B/C *	–
	Adjacent ecosystems	B/C *	–
	Slope position	B	–
Ecological Parameters	Cover type and percent open water	B/C	biotic structure, biotic diversity
	Vegetation cover and communities present	B/C	Vegetation cover, biotic structure, biotic diversity
	Successional stage and structural stage	B/C	biotic structure, biotic diversity
	Incidental wildlife observations	B/C	biotic structure, biotic diversity
Biogeochemical Parameters	Water quality sampling	B/C *	Groundwater quality, surface water quality
	Soil profiles	B	–
Hydrological Parameters	*Hydrology*	B/C	–
	Water depth	B/C	Surface water quantity
	Inlets/outlets	B/C	–

[a] B = baseline field monitoring; C = construction phase monitoring;
* - reduced construction phase monitoring.
Italicized parameters indicate key parameters that will be used to define wetland types.
Source: Native Plant Solutions (NPS) 2018b.

For the 2019 field program, six changes to the 2018 monitoring program methodology were incorporated (Native Plant Solutions 2019c), based on the results and recommendations of the 2018 field program:

1. using the Solocator App to digitally georeference and label each photo taken for the Project;
2. recording structural stage, canopy composition, and the type and extent of disturbance in adjacent polygons as an alternative to assessing each adjacent ecosystem to the site series level;
3. completing a Floristic Quality Index (FQI) vegetation assessment in each wetland to monitor changes to vegetation in the wetland and on the wetland edge over time;
4. if necessary, sampling Black Spruce-Labrador tea-sphagnum (BT) and Tamarack sedge (TS) wetlands that are outside of the transmission line, but directly adjacent to the transmission line, in order to capture more accurate pre-disturbance wetland conditions;
5. identifying and georeferencing where water depth and sample locations were located in each wetland; and
6. updating (including additional fields) wetland condition assessment forms.

2.4.1 Georeferenced Photos

The use of the Solocator App for all photos taken during the field studies was implemented during the 2019 field program. Solocator images contain the photo direction on the top, with UTMS and elevation beneath. The bottom of the photo contains date, time, the plot name, and any other information relevant to the site (Plate 2.4-1).

Plate 2.4-1. Example of a marked-up Solocator photo.

2.4.2 Adjacent Ecosystems

Adjacent ecosystems were described in the field using visual assessments of standard site descriptions from the Field Manual for Describing Terrestrial Ecosystems; Second Edition (BC MOE and MOF 2010). When possible, the site association or wetland types were recorded. Appendix A contains a summary of the methods used to describe adjacent ecosystems, including structural stage, canopy composition and modifiers, and successional status.

2.4.3 Floristic Quality Index

FQI is a useful tool for assessing the biological condition of vegetation communities (including wetland communities in northern Canada), quantifying anthropogenic influences on vegetation communities, and tracking changes over time (Bourdaghs et al. 2006; Rooney and Rogers 2002; Washington 1984; Wilson et al. 2013). The FQI relies on a species' Coefficient of Conservation, a value assigned to local species by qualified botanists that signifies a species' habitat specificity and tolerance to disturbance. The FQI provides maximal value when comparing vegetation communities over time within the same wetland or when comparing among wetlands within the same type or class (e.g., comparing a reference wetland to a disturbed wetland of the same type in the same season).

The following standards and field protocols were used for vegetation FQI sampling:

- The standard seven-letter code naming system was used for recording observed species. Naming conventions used for vegetation species were from the British Columbia Conservation Data Centre (CDC).
- FQI plots were established and surveyed within each monitoring wetland. Three pairs of quadrats (six quadrats in total) were deployed randomly throughout each wetland. A power analysis done by Wilson et al. (2013) in their Floristic Quality Assessment for Marshes in Alberta's Northern Prairie and Boreal Regions showed that six quadrats were sufficient to detect differences in species richness within the same wetland type or site associations.
- The quadrat pair sample locations were subjectively selected in the field within the wetland and then the quadrats were tossed in a randomly selected cardinal direction to add randomness to the location.
- Quadrat pairs were positioned directly beside each other.
- Each quadrat measured one square metre.
- Quadrat data were recorded on standard FQI field sheets with the standard naming convention for the Wetland Monitoring Program.
- Within each of the quadrats, all herbaceous, shrub, and tree species and their percent cover were recorded. Percent cover estimations included overlapping vegetation; therefore, the total percent cover could be over 100%.

- Percent cover of live vegetation was estimated for each species present using the recording increment vegetation cover method shown in Table 2.4-2, and from the comparison charts for estimation of foliage cover from the Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2010).
- Photos of the quadrat were taken using the Solocator Application for iPhones to facilitate future monitoring by photograph comparisons.

Table 2.4-2. Increments Used for Recording Vegetation Cover for the Wetland FQI Quadrats[1]

Cover Range	Recording Increment (%)	Examples (%)
A single plant	Exactly 0.1	0.1
Several plants	Exactly 0.5	0.5
1%–10%	To the nearest 1	1, 2, 3, 5, 8
10%–30%	To the nearest 5	10, 15, 25
30%–100%	To the nearest 10	30, 40, 50, 60, 70, 80, 90

[1] *Adapted from the Ecological Land Survey Site Description Manual (Alberta Sustainable Resource Development 2003).*

2.4.4 Wetland Condition Assessment

As per Native Plant Solutions guidance (Native Plant Solutions 2019c), the following changes were made to the wetland condition assessment forms:

- Wetland Conditions A through J: A column was added in each of the data sheets to describe potential effects to the wetland that should be monitored in subsequent surveys based on the activities taking place currently (e.g., a new road potentially resulting in hydrological modifications or an increase in invasive species).
- Wetland Condition A: Clearing and Grubbing: A column was added for noting clearing and grubbing activities outside the wetland footprint, but within a 30-m buffer of the wetland.

3. RESULTS

3.1 SUMMARY OF 2019 FIELD SURVEY EFFORT

Field surveys were completed July 12 to 16, 2019, and August 20 to 27, 2019. A total of 49 wetlands were sampled (Figure 3.1-1): 5 wetlands that were pre-selected as potential groundwater monitoring sites, 15 wetlands that had previously been assessed in 2016 (construction phase monitoring), and 29 previously un-sampled wetlands (baseline monitoring wetlands).

Field data and analyses from the 2019 field program include:

- 2019 field plot data;
- spatial (ESRI shapefile) data of plot locations and wetland delineation;
- plot photographs;
- vegetation floristic quality index data;
- vegetation floristic quality index analysis;
- analytical results – water quality; and
- wetland condition assessments.

3.1.1 Baseline Wetland Monitoring

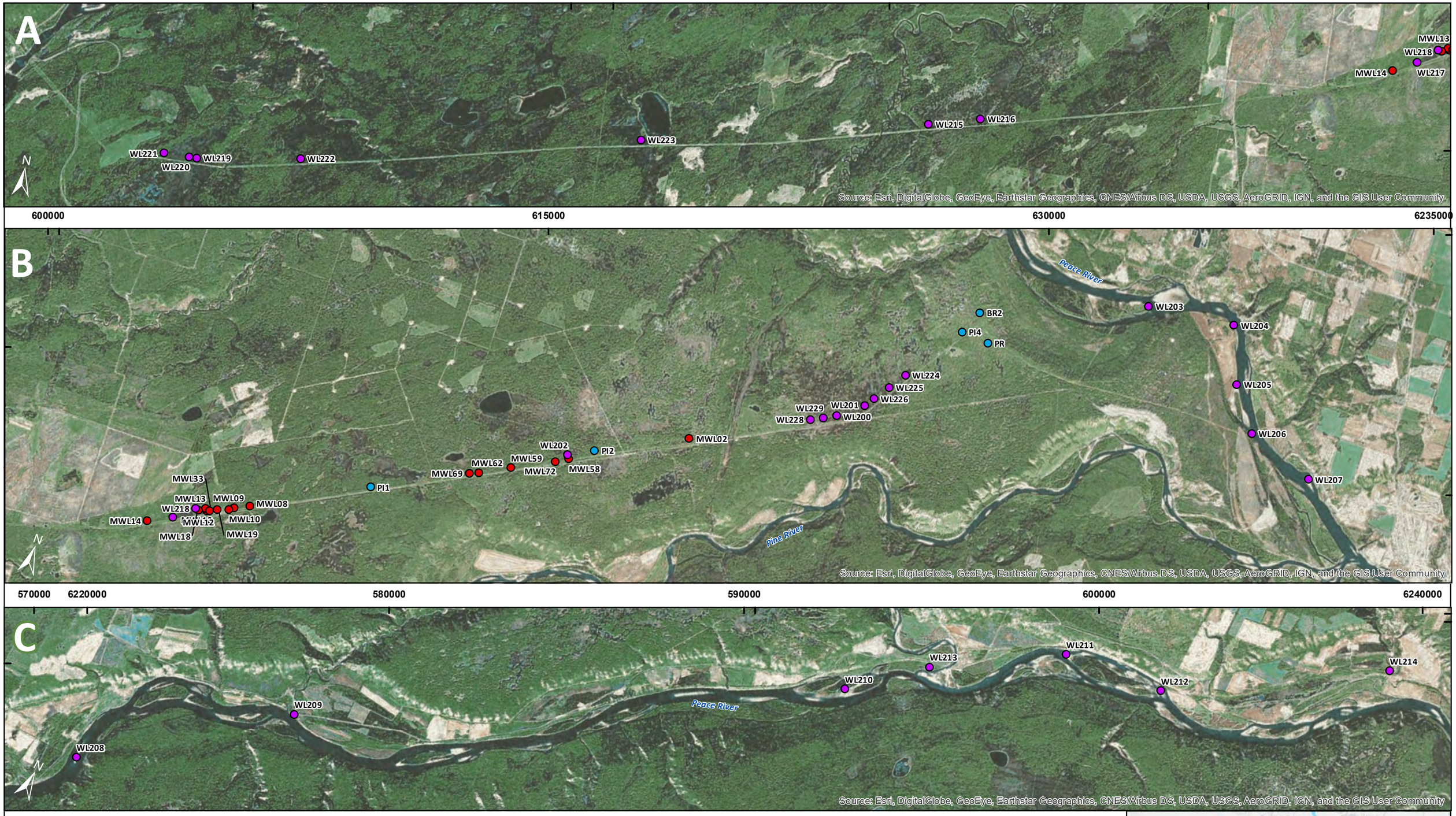
The sampling objectives were achieved for three of the four baseline monitoring wetland types in 2019 (Table 3.1-1). Only six TS ecosystems were sampled in 2019, as additional sites could not be located in the PAZ. One extra WS ecosystem was sampled, as the site association classification could not be confirmed until the field data were collected. One new site association was found during the Baseline Monitoring portion of the 2019 field program: Wb08 Black spruce – Soft-leaved sedge – Peatmoss bog, which fits within the BT wetland type. Table 3.1-2 provides a summary of all the baseline wetlands assessed in 2019, and Figure 3.1-1 shows their locations.

Table 3.1-1. Baseline Wetlands Targeted and Actual Wetlands Assessed in 2019

Ecosystem Unit	Code	2019 Target	Assessed in 2019
Black spruce-Labrador tea-sphagnum	BT	11	11
Tamarack sedge	TS	8	6
Willow-horsetail-sedge riparian wetland	WH	10	10
Willow sedge wetland	WS	1	2

Table 3.1-2. Baseline Monitoring Wetlands

Plot ID	Location	Date	Class	Site Association	Wetland Type
WL200	TL Phase A	July 13 2019	Bog	Wb08	BT
WL201	TL Phase A	July 13 2019	Bog	Wb08	BT
WL202	TL Phase A	July 14 2019	Bog	Wb03	BT
WL203	Downstream	Aug 20 2019	Swamp	Ws02	WS
WL204	Downstream	Aug 20 2019	Floodplain	Fl06	WH
WL205	Downstream	Aug 20 2019	Floodplain	Fl00	WH
WL206	Downstream	Aug 20 2019	Floodplain	Fl06	WH
WL207	Downstream	Aug 20 2019	Floodplain	Fl00	WH
WL208	Western Reservoir	Aug 21 2019	Floodplain	Fl00	WH
WL209	Western Reservoir	Aug 21 2019	Swamp	Ws02	WS
WL210	Mid Reservoir	Aug 21 2019	Floodplain	Fl06	WH
WL211	Mid Reservoir	Aug 21 2019	Floodplain	Fl06	WH
WL212	Mid Reservoir	Aug 21 2019	Floodplain	Fl03	WH
WL213	Mid Reservoir	Aug 22 2019	Floodplain	Fl06	WH
WL214	Mid Reservoir	Aug 22 2019	Floodplain	Fl06	WH
WL215	TL Phase B	Aug 23 2019	Bog	Wb03	BT
WL216	TL Phase B	Aug 23 2019	Bog	Wb06	TS
WL217	TL Phase A	Aug 23 2019	Bog	Wb03	BT
WL218	TL Phase A	Aug 24 2019	Bog	Wb03	BT
WL219	TL Phase B	Aug 25 2019	Bog	Wb08	BT
WL220	TL Phase B	Aug 25 2019	Bog	Wb06	TS
WL221	TL Phase B	Aug 25 2019	Bog	Wb08	BT
WL222	TL Phase B	Aug 25 2019	Bog	Wb08	BT
WL223	TL Phase B	Aug 26 2019	Bog	Wb08	BT
WL224	TL Phase A	Aug 27 2019	Bog	Wb03	BT
WL225	TL Phase A	Aug 27 2019	Bog	Wb06	TS
WL226	TL Phase A	Aug 27 2019	Bog	Wb06	TS
WL228	TL Phase A	Aug 27 2019	Bog	Wb06	TS
WL229	TL Phase A	Aug 27 2019	Bog	Wb06	TS


A
570000
580000
6210000
590000
600000
WL221
WL220
WL219
WL222
WL223
WL215
WL216
MWL13
WL218
WL217
MWL14
N
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
600000
615000
630000
6235000
B
600000
Peace River
BR2
PI4
PR
WL203
WL204
WL205
WL206
WL207
WL224
WL225
WL226
WL229
WL228
WL201
WL200
MWL02
WL202
PI2
MWL59
MWL62
MWL72
MWL58
MWL69
PI1
MWL33
MWL13
MWL09
MWL08
WL218
MWL14
MWL12
MWL10
MWL18
MWL19
Pine River
N
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
570000
6220000
580000
590000
600000
6240000
C
570000
610000
WL211
WL213
WL214
WL210
WL212
WL209
Peace River
WL208
N
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
645000
Site C Project
Location of 2019 Sample Sites
Figure 3.1-1
Date: 2019-12-20
Map Number: BCHWL-27
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983
ECOLOGIC
Wetland Plot Type
Baseline
Construction Phase
Groundwater Monitoring Site
0
2
4
6
8
km
1:110,000
C
B
A
Sources: Esri, USGS, NOAA

3.1.2 Construction Phase Wetland Monitoring

All of the construction phase wetlands that were targeted in the 2019 field plan (Native Plant Solutions 2019a) were assessed (Table 3.1-3; Figure 3.1-1): 10 marshes, one fen, one swamp, two bogs, and one open water wetland. Additionally, a site association not previously observed in the PAZ was identified: the Wm15 Bluejoint – Beaked sedge marsh site association within the SE wetland type. The Wm15 was found in two of the construction phase monitoring wetlands (MWL08 and MEL09).

Table 3.1-3. Construction Phase Monitoring Wetlands

Plot ID	Location	Date	Class	Site Association	Wetland Type
MWL02	TL Phase A	July 12 2019	Fen	Wf02	SE
MWL08	TL Phase A	July 16 2019	Marsh	Wm15	SE
MWL09	TL Phase A	July 16 2019	Marsh	Wm15	SE
MWL10	TL Phase A	Aug 26 2019	Marsh	Wm03	SE
MWL12	TL Phase A	Aug 24 2019	Marsh	Wm03	SE
MWL13	TL Phase A	Aug 24 2019	Bog	Wb08	BT
MWL14	TL Phase A	July 16 2019	Marsh	Wm02	SE
MWL18	TL Phase A	Aug 24 2019	Bog	Wb06	TS
MWL19	TL Phase A	Aug 24 2019	Marsh	Wm00	SE/WS
MWL33	TL Phase A	Aug 24 2019	Marsh	Wm03	SE
MWL58	TL Phase A	July 14 2019	Marsh	Wm01	SE
MWL59	TL Phase A	July 15 2019	Open Water	OW	OW
MWL62	TL Phase A	July 15 2019	Marsh	Wm03	SE
MWL69	TL Phase A	July 15 2019	Swamp	Ws03	WS
MWL72	TL Phase A	July 14 2019	Bog	Wb03	BT

3.1.3 Groundwater Monitoring Sites

Five groundwater sites were assessed in 2019, including both fen (Wf01) and marsh (Wm01) site associations (Table 3.1-4; Figure 3.1-1). For the Verified Impact Site, which was assessed during the 2018 field program, only the well layout was completed in 2019.

Table 3.1-4. Groundwater Monitoring Wetlands

Plot ID	Location	Date	Site Association	Wetland Type
BR2	TL Phase A	July 12 2019	Wf01	SE
PI1	TL Phase A	July 15 2019	Wm01	SE
PI2	TL Phase A	July 14 2019	Wm01	SE
PI4	TL Phase A	July 13 2019	Wf01	SE
PR	TL Phase A	July 13 2019	Wf01	SE

3.2 Ecosystem Classification and Mapping

The existing Site C ecosystem mapping for the PAZ includes three distinct but related products: Terrestrial Ecosystem Mapping (TEM); broad habitat mapping; and Detailed Wetland Mapping (DWM). The existing ecosystem classification and mapping is based on *A Field Guide for Identification and Interpretation of Ecosystems of the Northeast Portion of the Prince George Forest Region* (DeLong et al. 1990), *Wetlands of British Columbia* (MacKenzie and Moran 2004), and new units described for the Project (2006 to 2012) by regional forest ecologists (Andrusiak and Simpson 2012). Appendix B contains a crosswalk table that uses a "best fit" process to correlate existing PAZ ecosystem classification and current provincial classification system units.

All of the wetlands assessed in the Reservoir Footprint were delineated in the field with the use of GPS and mapped after the field season in a GIS, as the wetlands were contained within larger ecosystem polygons in the TEM. The DWM layer was used to locate wetlands along transmission lines. For wetlands that had been previously been field-checked in 2016, the DWM layer was used to re-locate them, and the mapped boundaries of the DWM checked for accuracy. The majority (33) of the 2019 wetlands, in both the Reservoir Footprint and transmission line, required the creation of a new polygon or an alteration to an existing DMW polygon (Table 3.2-1). The 33 new polygons were mainly created in areas that did not contain detailed wetland mapping polygons, and where the TEM polygons were too large and generalized to map the often small wetlands. The alterations ranged from improving the polygon delineation to better reflect the wetland boundaries and, more often, limit the boundary to the wetland type that was being assessed (instead of a polygon that complexed other wetland types within it) to making entirely new polygons that often crossed the DWM boundaries, or used portions of multiple DWM polygons.

Of the 16 wetlands where edits to the DWM polygon were not required, the classification was changed from one wetland type to another six times, and five were changed from Field Truth Required (FTR) to a recognized wetland classification. Of the 33 new wetland polygons created in 2019, 13 were entirely new while the other 20 included portions of one or more DWM polygons. Of those 20 that overlapped a portion of one or more DWM polygons, 7 required changes to the DWM classification.

Table 3.2-1. Summary of Ecosystem Classification and Mapping Changes

Mapping Type	Plot ID	DWM Wetland Type(s)	2019 Site Series	2019 Wetland Type	2019 Wetland Type Change
DWM	MWL02	WS	Wf02	SE	Yes
	MWL09	SE	Wm15	SE	No
	MWL08	SE	Wb06	TS	Yes
	MWL18	TS	Wm15	SE	Yes
	MWL19	WS	Wm00	SE	Yes
	MWL58	FTR	Wm01	SE	Yes
	MWL59	FTR	OW	OW	Yes
	MWL62	FTR	Wm03	SE	Yes

Mapping Type	Plot ID	DWM Wetland Type(s)	2019 Site Series	2019 Wetland Type	2019 Wetland Type Change
	MWL72	FTR	Wb03	BT	Yes
	PI1	SE	Wm01	SE	No
	WL200	BT	Wb08	BT	No
	WL215	BT	Wb03	BT	No
	WL216	BT	Wb06	TS	Yes
	WL218	BT	Wb03	BT	No
	WL228	FTR	Wb06	TS	Yes
	WL229	SE	Wb06	TS	Yes
New	BR2	SE	Wf01	SE	No
	MWL10	SE	Wm03	SE	No
	MWL12	SE	Wm03	SE	No
	MWl13	BT SE and unmapped area	Wb08	BT	Yes
	MWL14	SE	Wm02	SE	No
	MWL33	SE	Wm03	SE	No
	MWL69	Portion FTR and unmapped area	Ws03	WS	Yes
	PI2	SE	Wm01	SE	No
	PI4	SE	Wf01	SE	No
	PR	SE	Wf01	SE	No
	WL201	BT - mostly new area	Wb08	BT	No
	WL202	FTR	Wb03	BT	Yes
	WL203	NA	Ws02	WS	NA
	WL204	NA	Fl06	WH	NA
	WL205	NA	Fl00	WH	NA
	WL206	NA	Fl06	WH	NA
	WL207	NA	Fl00	WH	NA
	WL208	NA	Fl00	WH	NA
	WL209	NA	Ws02	WS	NA
	WL210	NA	Fl06	WH	NA
	WL211	NA	Fl06	WH	NA
	WL212	NA	Fl03	WH	NA
	WL213	NA	Fl06	WH	NA
	WL214	NA	Fl06	WH	NA
	WL217	Portion of TS	Wb03	BT	Yes
	WL219	Portion of BT	Wb08	BT	No

Mapping Type	Plot ID	DWM Wetland Type(s)	2019 Site Series	2019 Wetland Type	2019 Wetland Type Change
	WL220	Portion of FTR	Wb06	TS	Yes
	WL221	NA	Wb08	BT	NA
	WL222	Portion of BT	Wb08	BT	No
	WL223	BT SE and unmapped area	Wb08	BT	Yes
	WL224	SE	Wb03	BT	Yes
	WL225	TS - multiple DWM polys some new area	Wb06	TS	No
	WL226	TS - multiple DWM polys some new area	Wb06	TS	No

Adjustments to ecosystem classification and mapping are primarily a result of differences in scale, as the TEM for the study area is a larger scale (1:20,000) product used to map and classify ecosystems across the landscape and assess Project-level impacts. In contrast, wetlands surveyed within the Site C wetland monitoring program were mapped at 1:1,000 scale and ground-truthed to accurately delineate and characterize pure wetland ecosystems. For the most part, these changes resulted in a smaller, pure wetland polygon being created within the larger TEM polygon(s). These spatial adjustments are required to assess site-specific disturbance and change over time, as the TEM polygons typically capture multiple ecosystem types in a single mapped polygon. Further analysis will be needed to quantify how fine-scale spatial data collected within the wetland monitoring program will influence the area of wetlands represented at the Project scale.

3.3 WETLAND SUMMARIES

3.3.1 Overview of Wetlands Sampled in 2019

A total of 106 wetlands have been assessed since 2018 in the PAZ (Appendix C) using the baseline and monitoring methodologies (Native Plant Solutions 2018b). The following sections contain summaries of the wetlands assessed during the 2019 field program. Each section contains representative photographs, along with the number and type of each wetland sampled, and some key physical features (structural stage, successional status[1], and hydrology). Appendix A contains definitions for structural stage and successional status codes used in Tables 3.3-1 to 3.3-6.

[1] Note that while the successional status has been included in the summary tables, it has been loosely applied as the codes used to describe successional status in British Columbia were developed for forested communities and are not directly applicable to non-forested wetlands.

3.3.2 Bog Overview

A total of 20 bogs were assessed in 2019, with baseline wetland data collection occurring at 17 and construction phase monitoring occurring at three (Table 3.3-1). Three site associations were identified among the 20 bogs sampled: Wb03 (Black spruce - Lingonberry - Peat-moss); Wb06 (Tamarack - Water sedge - Fen moss); and Wb08 (Black spruce - Soft-leaved sedge - Peat-moss). Wb03 and Wb08 are included in the BT wetland type, while Wb06 is the only association described by the TS wetland type.

Structural stages of the sampled bogs range from 2b (herbaceous) to 7tC (old growth), representing a wide range of conditions that are a result of current disturbance (clearing in the new transmission line corridor), past disturbance (bogs disturbed by the existing transmission line right-of-way), and natural variability within undisturbed sites. As bogs are adapted to growing in marginal conditions, the resulting forest stand structure has considerable variation, ranging from very nutrient poor sites dominated by stunted irregular trees that are maintained in a shrub to pole-sapling phase, to sites with higher productivity, resulting in a more forest-like stand with larger trees and increased vertical structure. Bogs can be described using a successional status as they are generally forested communities. Sampled sites included Young Climax (disturbed sites that contain expected climax species), Mature Climax (some vertical structure and mature climax tree species) and Old Climax (well developed structure, canopy openings, and old climax tree species).

All of the sampled bogs are located in closed-basin depressions that contain permanently to semi-permanently flooded surfaces. The groundwater table in these wetland types is at or above the surface throughout the growing season, although the presence of large hummocks and deep peat moss accumulations results in a mosaic of elevated drier microsites and lower wet areas.

Table 3.3-1. Summary of Bogs Sampled in 2019

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)	Successional Status(es)	Hydrology
Transmission Line							
Bog	Wb03	BT	Black spruce - Lingonberry - Peat-moss	6	3b, 5oC	YC, OC	Permanently to Semi-permanently Flooded
	Wb06	TS	Tamarack - Water sedge - Fen moss	7	2b, 3a, 4C, 7tC	YS, OC	Permanently to Semi-permanently Flooded
	Wb08	BT	Black spruce - Soft-leaved sedge - Peat-moss	7	4C, 5sC, 5oC, 6mC, 7tC	YC, MC, OC	Permanently to Semi-permanently Flooded
Total				**20**			

All of the bogs sampled in 2019 are located along the transmission line. Plots were placed in the undisturbed portion of the wetland adjacent to the cleared transmission line corridor whenever possible to sample natural pre-disturbance conditions. Plates 3.3-1 to 3.3-5 show the three types of bogs that were sampled, with photos illustrating how the clearing of the transmission line has affected the wetland structure and changed the vegetation composition. Plates 3.3-3 and 3.3-5 also show the products of grubbing that have been left in the wetlands, and a construction road.

Plate 3.3-1. Wb03 Black spruce - Lingonberry - Peat-moss bog at Plot MWL13 looking parallel to the transmission line corridor with intact bog on the left and cleared bog on the right.

Plate 3.3-2. Wb06 Tamarack - Water sedge - Fen moss bog at Plot WL226 from the edge of the cleared transmission line corridor looking towards the un-disturbed portion of the bog.

Plate 3.3-3. Modified portion of a Wb06 Tamarack - Water sedge - Fen moss bog at Plot WL226 showing the cleared transmission line and construction road.

Plate 3.3-4. Wb08 Black spruce - Soft-leaved sedge - Peat-moss bog at Plot WL222.

Plate 3.3-5. Wb08 Black spruce - Soft-leaved sedge - Peat-moss bog at Plot WL222 showing the adjacent intact bog on the left and the cleared and grubbed bog in the transmission line corridor on the right.

3.3.3 Fen Overview

Four fens were assessed in the 2019 field program: one construction phase monitoring wetland and three groundwater monitoring sites (Table 3.3-2). Three Wf01 Water sedge - Beaked sedge fens were sampled in 2019. All of the Wf01 fens (Plate 3.3-6) have a structural stage of 2b (graminoid) and are classified as disclimax communities. They are located in closed-basin depressions that are permanently to semi-permanently flooded throughout the growing season.

One Wf02 Scrub birch- water sedge fen was sampled in 2019. The Wf02 has a structural stage of 3a (low shrub) and was considered to be a young seral community, as it is expected to develop into a forested bog over time (Plate 3.3-7). The Wf02 is located in a closed-basin level site that is permanently to semi-permanently flooded throughout the growing season. This wetland was modified by transmission line construction, including clearing of larger shrubs, and the creation of a construction road though the wetland (Plate 3.3-8).

Table 3.3-2. Summary of Fens Sampled in 2019

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)	Successional Status(es)	Hydrology
Transmission Line							
Fen	Wf01	SE	Water sedge - Beaked sedge	3	2b	DC	Permanently to Semi-permanently Flooded
	Wf02	SE	Scrub birch-water sedge	1	3a	YS	Permanently to Semi-permanently Flooded
Total				**4**			

Plate 3.3-6. Wf01 Water sedge - Beaked sedge fen at Plot PR.

Plate 3.3-7. Modified Wf02 Scrub birch- water sedge fen at Plot MWL02.

Plate 3.3-8. Construction road and rig mats bisecting a Wf02 Scrub birch- water sedge fen at Plot MWL02.

3.3.4 Marsh Overview

A total of 11 marshes were sampled in 2019: eight construction phase monitoring wetlands and three groundwater sites (Table 3.3-3). Five marsh site associations were sampled: Wm00 (unclassified marsh), Wm01 (Beaked sedge - Water sedge), Wm02 (Swamp horsetail - Beaked sedge), Wm03 (Awned sedge) and Wm15 (Bluejoint - Beaked sedge). All of the marshes have a structural stage of 2b (graminoid) and are classified as disclimax communities. They are located in level and depression sites, permanently to semi-permanently flooded throughout the growing season.

Table 3.3-3. Summary of Marshes Sampled in 2019

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)	Successional Status(es)	Hydrology
Transmission Line							
Marsh	Wm00	SE	Marsh (unclassified)	1	2b	DC	Permanently to Semi-permanently Flooded
	Wm01	SE	Beaked sedge - Water sedge	3	2b	DC	Permanently to Semi-permanently Flooded

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)	Successional Status(es)	Hydrology
	Wm02	SE	Swamp horsetail - Beaked sedge	1	2b	DC	Permanently to Semi-permanently Flooded
	Wm03	SE	Awned sedge	4	2b	DC	Permanently to Semi-permanently Flooded
	Wm15	SE	Bluejoint - Beaked sedge	2	2b	DC	Permanently to Semi-permanently Flooded
Total				**11**			

One Wm00 marsh was sampled at wetland MWL19 (Plate 3.3-9). The Wm00 was modified by the old transmission line construction, resulting in a vegetation community that is a mix of the typical Wm03 and Wm15 species, as well as a higher cover of shrubs than expected for a marsh. The three Wm01 marshes sampled (Plate 3.3-10 and 3.3-11) were largely intact, with construction-related impacts limited to clearing and tower construction near the wetland edge. A single Wm02 wetland was sampled at MWL14 in part of a small complex that contained Wm01 on the outside, Wm02 in deeper water, and a shallow open water center (Plate 3.3-12). Four Wm03 marshes were sampled along the new and existing transmission lines. The Wm03 communities are typically small marshes within larger willow swamps (Plate 3.3-13). While the Wm03 marshes were not typically directly disturbed by construction activities, the swamp portions of the complexes were often cleared, and construction roads and tower construction occurred on the marsh edges (Plate 3.3-14). Two Wm15 marshes were sampled in 2019, with this site association not previously observed in the PAZ (Plate 3.3-15). One of the Wm15 marshes at MWL09 was significantly modified from pipeline construction that bisected the transmission line corridor (Plate 3.3-16).

Plate 3.3-9. Wm00 Unclassified marsh at Plot MWL19.

Plate 3.3-10. Wm01 Beaked sedge - Water sedge marsh at Plot MWL58.

Plate 3.3-11. Modified (clearing and tower construction) on the edge of the Wm01 Beaked sedge - Water sedge marsh at Plot PI2.

Plate 3.3-12. Wm02 Swamp horsetail - Beaked sedge marsh at Plot MWL14.

Plate 3.3-13. Wm03 Awned sedge marsh at Plot MWL10.

Plate 3.3-14. Modified edge of a Wm03 Awned sedge marsh at Plot MWL12 showing grubbing debris and a tower anchor in the transmission line corridor.

Plate 3.3-15. Wm15 Bluejoint - Beaked sedge marsh at Plot MWL08.

Plate 3.3-16. Recently disturbed Wm15 Bluejoint - Beaked sedge marsh at Plot MWL09 by a new pipeline that crosses the transmission line corridor.

3.3.5 Shallow Open Water Overview

One construction phase shallow open water (OW) monitoring wetland was assessed in 2019 (Table 3.3-4). The provincial biogeoclimatic ecosystem system does not include site associations for shallow open water wetlands to more precisely classify them. The OW wetland (Plate 3.3-17) had a structural stage of 2c (aquatic plants), with a fringe of emergent species in the transitional area to a Wm05 Cattail Marsh and tall shrub Ws03 Bebb's willow – Bluejoint swamp. The OW is located in a closed basin depression that is permanently flooded. While the OW wetland was not directly disturbed, clearing and soil modifications from a construction road were present at the edge of the Ws03 swamp (Plate 3.3-18).

Table 3.3-4. Summary of Shallow Open Water Sampled in 2019

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)	Successional Status(es)	Hydrology
Transmission Line							
Open Water	OW	OW	Shallow Open Water (unclassified)	1	2c	NA	Permanently Flooded
Total				**1**			

Plate 3.3-17. OW Shallow Open Water at Plot MWL59.

Plate 3.3-18. Construction road at the swamp fringe of Plot WML59.

3.3.6 Swamp Overview

A total of three swamps were assessed in 2019 (Table 3.3-5). Of those, baseline wetland data collection was conducted at two Ws02 (Mountain alder – Pink spirea – Sitka sedge) wetlands, and construction phase monitoring was conducted at one Ws03 (Bebb's willow – Bluejoint) wetland. The Ws02 swamps (Plate 3.3-19) are located in the reservoir footprint, along the edge of the Peace River. They have a structural stage of 3b (tall shrub) and are considered to be young seral communities that may develop into forested swamps over time. The Ws02 associations are located on the active edge of the Peace River, and had evidence of short-duration seasonal flooding, with the groundwater table otherwise remaining below the surface for the growing season. One of the Ws02 sites had evidence of old clearing and soil modifications from a temporary road.

The Ws03 swamp (Plate 3.3-20) is located in the vicinity of the existing transmission line, and was likely modified during construction based on its proximity to the transmission line. The Ws03 swamp has a structural stage of 3b (tall shrub) and is considered to be a young seral community that is expected to develop into a forested swamp over time. It is located in a slight depression, and permanent to semi-permanent flooding occurs throughout the growing season.

Table 3.3-5. Summary of Swamps Sampled in 2019

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)	Successional Status(es)	Hydrology
Reservoir Footprint							
Swamp	Ws02	WS	Mountain alder – Pink spirea – Sitka sedge	2	3b	YS	Seasonally to Intermittently Flooded
Transmission Line							
Swamp	Ws03	WS	Bebb's willow - Bluejoint	1	3b	YS	Permanently to Semi-permanently Flooded
Total				**3**			

Plate 3.3-19. Ws02 Mountain alder – Pink spirea – Sitka sedge swamp at Plot WL209

Plate 3.3-20. Ws03 Bebb's willow – Bluejoint swamp at Plot MWL69.

3.3.7 Floodplain Overview

Baseline wetland data collection was conducted at 10 floodplain sites in 2019 (Table 3.3-6) in the Middle and Eastern Reservoir and Downstream area. Three low-bench floodplain site associations were assessed: Fl00 (Unclassified Low bench floodplain), Fl03 (Pacific willow – Red-osier dogwood – Horsetail), and FL06 (Sandbar willow).

Structural stages of the floodplain communities were limited to low (3a) and tall (3b) shrubs. The Fl00 association (Plate 3.3-21) is dominated by low and tall cottonwood (*Populus balsamifera*), representing a young community that over time is expected to develop into a mature cottonwood mid-bench floodplain. The Fl00 sites are seasonally flooded with low- to moderate-energy water, resulting in a relatively stable substrate. For the flood-maintained Fl03 and Fl06 associations (Plate 3.3-22 and 3.3-23), the shrub cover represents a young seral stage that may either develop into a cottonwood mid-bench floodplain, or one of several types of swamps. These associations are seasonally flooded, likely multiple times during the year, by high-energy water typically resulting in scouring. No human disturbance was observed at any of the floodplain sites.

Table 3.3-6. Summary of Floodplains Sampled in 2019

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)	Successional Status(es)	Hydrology
Reservoir Footprint							
Floodplain	Fl00	WH	Low bench floodplain (unclassified)	3	3a, 3b	YC	Seasonally Flooded
	Fl03	WH	Pacific willow – Red-osier dogwood – Horsetail	1	3b	YS	Seasonally Flooded
	Fl06	WH	Sandbar willow	6	3a, 3b	YS	Seasonally Flooded
Total				**10**			

Plate 3.3-21. Fl00 Unclassified low-bench floodplain at Plot WL207.

Plate 3.3-22. Fl03 Pacific willow – Red-osier dogwood – Horsetail low-bench floodplain at Plot WL212.

Plate 3.3-23. Fl06 Sandbar willow low-bench floodplain at Plot WL204.

4. RECOMMENDATIONS

Based on the 2019 field program, we have three recommendations for future field work:

- Continue to search for additional TS bogs to sample since the target number of TS bogs was not achieved during the 2019 field program.
- Create wetland-specific summaries for each monitoring wetland. The summary could contain the baseline photographs, existing disturbance, the presence (and cover) of invasive species, and any other information that will provide context for an in-field assessment of change.
- Future re-sampling of the 2019 plots for comparison to baseline conditions should occur within wetland polygons in cleared portions of the transmission line. This will also allow for the assessment of construction-related changes relative to the 2019 baseline conditions.

REFERENCES

Andrusiak, L., and Simpson, L. 2012. *Expanded Legend for the Peace River Terrestrial Ecosystem Mapping Project*. Prepared for BC Hydro by Keystone Wildlife Research Ltd.

BC Hydro. 2015. *Vegetation and wildlife mitigation and monitoring plan, Site C Clean Energy Project*. Version 1, June 5, 2015. 629pp.

BC MOE and BC MOF. 2010. *Field Manual for Describing Terrestrial Ecosystems* (2nd Edition). B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of Forests: Victoria, B.C.

Bourdaghs, M., Johnston, C.A., and Regal, R.R. 2006. Properties and performance of the floristic quality index in Great Lakes coastal wetlands. *Wetlands* 26:718-725.

DeLong, C., MacKinnonn, A., and Jang., L. 1990. A Fi*eld Guide for Identification and Interpretation of Ecosystems of the Northeast Portion of the Prince George Forest Region*. Land Management Handbook 22. BC Ministry of Forests.

MacKenzie, W.H., and Moran, J.R. 2004. *Wetlands of British Columbia: A Guide to Identification.* Victoria, BC: BC Ministry of Forests.

Native Plant Solutions (NPS). 2019a. *BC Hydro Site C: 2019 Wetland Monitoring Program Site Selection*. Prepared for BC Hydro: April 26 2019. 6pp.

Native Plant Solutions (NPS). 2019b. *BC Hydro Site C: 2019 wetland groundwater monitoring program*. Prepared for BC Hydro: May 8 2019. 19pp.

Native Plant Solutions (NPS). 2019c. BC Hydro Site C: 2019 Wetland Monitoring Program Recommended Revisions, Technical Memo. Prepared for BC Hydro: May 10 2019. 5pp.

Native Plant Solutions (NPS). 2018a. *Assessment of wetland function for the Site C Clean Energy Project*. Prepared for BC Hydro: April 2018. 207pp.

Native Plant Solutions (NPS). 2018b. BC *Hydro Site C Vegetation and Wildlife Wetland Monitoring Program: Baseline and Construction Phase Wetland Monitoring*. Prepared for BC Hydro: August 2018. 115pp.

Rooney, T.P. and Rogers, D.A. 2002. The modified floristic quality index. *Natural Areas Journal* 22:340–344.

Washington, H. G. 1984. Diversity, biotic, and similarity indices: a review with special relevance to aquatic ecosystems. *Water Resources* 18:653–694.

Wilson, M. J., Forest, A.S., and Bayley, S.E. 2013. Floristic Quality Assessment for Marshes in Alberta's Northern Prairie and Boreal Regions. Aquatic Ecosystems Health and Management. 16:3. 288-299.

APPENDIX A. DEFINITION OF STRUCTUAL STAGES AND SUCCESSIONAL STATUS CODES

Structural stage codes and structural stage modifiers are used to describe the vegetation structure and appearance in each ecosystem unit. Structural stage codes describe the relative age of a given ecosystem (i.e. shrub dominated vs. old growth forest) while the modifiers are used to provide additional descriptions of structural stages (BC MOE and MOF 2010).

Structural Stage

Structural Stage	Description
Post-disturbance stages or environmentally induced structural development	
1 Sparse/bryoid	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance less than 20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover less than 20%; total tree layer cover less than 10%.
1a Sparse	Less than 10% vegetation cover.
Stand initiation stages or environmentally induced structural development	
2 Herb	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover less than 10%, shrub layer cover less than or equal to 20% or less than 1/3 of total cover, herb-layer cover greater than 20%, or greater than or equal to 1/3 of total cover; time since disturbance less than 20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
2a Forb-dominated	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid-dominated	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
3 Shrub/Herb	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover less than 10%, shrub layer cover greater than 20% or greater than or equal to 1/3 of total cover.

Structural Stage	Description
3a Low shrub	Communities dominated by shrub layer vegetation less than 2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 20 years for normal forest succession.
3b Tall shrub	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
Stem exclusion stages	
4 Pole/Sapling	Trees greater than 10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually greater than 10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy - this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually less than 40 years for normal forest succession; up to 100+ years for dense (5,000–15,000+ stems per hectare), stagnant stands.
5 Young Forest	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions.
Understory reinitiation stage	
6 Mature Forest	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80-140 years for biogeoclimatic group A and 80-250 years for group B.
Old-growth stage	
7 Old Forest	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and coarse woody debris in all stages of decomposition typical, as are patchy understories; understories may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally greater than 140 years for biogeoclimatic group A and greater than 250 years for group B.

Structural Stage Modifiers are used to describe the overstorey structure of a forested stand, often related to disturbance history or edaphic conditions (BC MOE and MOF 2010).

Structural Stage Modifiers

Modifier	Description
s single storied	Closed forest stand dominated by the overstory crown class (dominant and co-dominant trees); intermediate and suppressed trees account for less than 20% of all crown classes combined, advance regeneration in the understory is generally sparse.
t two storied	Closed forest stand co-dominated by distinct overstory and intermediate crown classes; the suppressed crown class is lacking or accounts for less than 20% of all crown classes combined, advance regeneration is variable.
m multistoried	Closed forest stand with all crown classes well represented; each of the intermediate and suppressed classes account for greater than 20% of all crown classes combined, advance regeneration is variable.
o open	Forest stand with very open main and intermediate crown classes (totaling less than 25% cover); substantial understorey light levels commonly result in well-developed shrub and/or herb understorey.

Stand composition modifiers are used to provide additional descriptions of structural stages 3 to 7 and indicate the dominance of the stand by broadleaf, conifers or a mixed forest (BC MOE and MOF 2010).

Stand Composition Modifiers

Modifier	Description
C - coniferous	Greater than 3/4 of total tree layer cover is coniferous.
B - broadleaf	Greater than 3/4 of total tree layer cover is broadleaf.
M - mixed	Neither coniferous or broadleaf account for greater than 3/4 of total tree layer cover.

Successional status describes a temporal stage of a given ecosystem type in relation to its expected stable state for a given environment (BC MOE and MOF 2010). It is generally used to describe the development of a community after a large scale disturbance (natural or human). The successional system was developed for forested ecosystems, but can be generally applied to other communities to reflect the current status of the community relative to what is expected to occur on the site (BC MOE and MOF 2010).

Successional Status

Successional Status	Description
NV – Non-vegetated	Due to substrate or disturbance, vegetation cover is absent or less than five percent.
PS – Pioneer Seral	Initial stages of re-vegetation after disturbance.

Successional Status	Description
YS – Young Seral	Early successional community where competition has not created structural complexity. Often a mix of pioneer and early successional species. Forested stands are even aged, and less than 60 years old.
MS – Maturing Seral	Early successional tree species that have gone through natural self-thinning. Overstorey and understory of trees present, with understory species including shade tolerant trees. Trees of mature age, generally 60–140 years old.
OS – Overmature Seral	Overstorey seral tree species are dying, usually older than 140 years.
YC – Young Climax	Young stand with trees species typical of climax expected for site. Composition and structure are underdeveloped.
MC – Maturing Climax	Mature (80–120 years old) stand of climax species that has undergone natural thinning, with few seral species remaining. Vertical structure is developed.
OC – Old Climax	Old (greater than 250 years) and composed of expected climax species. Vertical structure is well developed, including canopy gaps, and large woody debris is common on forest floor.
DC - Disclimax	Persistent community that does not reflect the expected species composition due to disturbance (historic or repeated). Used for species conditions where processes or events are holding natural succession from moving forward.

APPENDIX B. CROSSWALK OF ECOSYSTEM CLASSIFICATION SYSTEMS

In order to achieve the stated goals of the monitoring program and to satisfy the federal and provincial approval conditions for the Project, it is important that the wetland classification used is structured to accommodate the current (i.e., DeLong et al. 2011 and Mackenzie and Moran 2004) provincial classification. Therefore, Table B-1 presents a crosswalk table that uses a "best fit" process to correlate existing PAZ ecosystem classification and current provincial classification system units. The crosswalk table was created by Tetra Tech and refined by EcoLogic for the 2018 wetland field program (Native Plant Solutions 2018b). Additional Site Associations identified during the 2019 field surveys are indicated in **Table B-1** in bold text.

Table B-1. Crosswalk of Existing PAZ Ecosystem Classification and Current Provincial Ecosystem Mapping Codes

	Existing PAZ Ecosystem Units		Current Provincial Ecosystem Units	
Wetland Class	Wetland Type (Map Code)	Vegetation Community Description	Site Association	Vegetation Community Description
Bog	BT	Sb - Labrador tea – Sphagnum	Wb03	Black spruce - Lingonberry - Peat-moss
	BT	Assumed Wb05 included in BT	Wb05	Black spruce - Water sedge - Peat-moss
	TS	Tamarack - Sedge	Wb06	Tamarack - Water sedge - Fen moss
	BT	-	Wb08	Black spruce – Soft-leaved sedge – Peatmoss bog
Fen	SE	Sedge Wetland	Wf00	Fen (unclassified)
	SE	Sedge Wetland	Wf01	Water sedge - Beaked sedge
	-	-	Wf02	Scrub birch- water sedge
Marsh	SE	Sedge Wetland	Wm00	Marsh (unclassified)
	SE	Sedge Wetland	Wm01	Beaked sedge - Water sedge
	SE	Sedge Wetland	Wm02	Swamp horsetail - Beaked Sedge
	SE	Sedge Wetland	Wm03	Awned sedge
	SE	Sedge Wetland	Wm04	Common spike-rush
	SE	Sedge Wetland	Wm05	Cattail
	SE	Sedge Wetland	Wm06	Great bulrush
	SE	Sedge Wetland	Wm15	Bluejoint – Beaked sedge
Swamp	-	-	Ws00	Swamp (unclassified)
	WS	Willow Sedge Wetland	Ws02	Mountain alder – Pink spirea – Sitka sedge

Wetland Class	Existing PAZ Ecosystem Units		Current Provincial Ecosystem Units	
	Wetland Type (Map Code)	Vegetation Community Description	Site Association	Vegetation Community Description
	WS	Willow Sedge Wetland	Ws03 (Ws14)	Bebb's willow - Bluejoint
	WS	Willow Sedge Wetland	Ws04	Drummond's willow - Beaked sedge
	WS	Willow Sedge Wetland	Ws05	MacCalla's willow - Beaker sedge
	WS	Willow Sedge Wetland	Ws06	Sitka willow - Sitka sedge
	-	-	Ws07	Spruce - Common horsetail - Leafy moss
	-	-	Ws15	SwSb - Labrador tea - Glow moss
Open Water	OW	Shallow open water	OW	Shallow Open Water (unclassified)
Floodplain	WH	Willow – Horsetail – Sedge – Riparian Wetland	Fl00	Low bench floodplain (unclassified)
	WH	Willow – Horsetail – Sedge – Riparian Wetland	Fl03	Pacific willow – Red-osier dogwood – Horsetail
	WH	Willow – Horsetail – Sedge – Riparian Wetland	Fl06	Sandbar willow
	-	-	Fm00	Mid bench floodplain (unclassified)
	Fm02 (09)[2]	ActSw - Red-osier dogwood	Fm02 (112)	Cottonwood - Spruce - Red-osier dogwood

[2] Map codes do not exist for the floodplain site associations. The site series associated with the Fm02 changed from 09 to 112 in the updated field guide (DeLong et al. 2011).

APPENDIX C. TALLY OF BASELINE AND CONSTRUCTION MONITORING WETLANDS

Wetland Class	Site Association	Vegetation Community	No. Sampled 2018	No. Sampled 2019
Reservoir Footprint				
Bog	Wb06	Tamarack - Water sedge - Fen moss	1	
Fen	Wf00	Fen (unclassified)	1	
Swamp	Ws00	Swamp (unclassified)	4	
	Ws02	Mountain alder – Pink spirea – Sitka sedge		2
	Ws05	MacCalla's willow - Beaked sedge	1	
	Ws15	SwSb - Labrador tea - Glow moss	1	
Marsh	Wm00	Marsh (unclassified)	1	
	Wm02	Swamp horsetail - Beaked sedge	1	
	Wm03	Awned sedge	2	
	Wm04	Common spike-rush	1	
	Wm05	Cattail	1	
	Wm06	Great bulrush	1	
Open Water	OW	Shallow Open Water (unclassified)	1	
Floodplain	Fl00	Low bench floodplain (unclassified)	8	3
	Fl03	Pacific willow – Red-osier dogwood – Horsetail	1	1
	Fl06	Sandbar willow	4	6
	Fm00	Mid bench floodplain (unclassified)	2	
	Fm02	Cottonwood - Spruce - Red-osier dogwood	5	
Total			***36***	***12***
Transmission Line				
Bog	Wb03	Black spruce - Lingonberry - Peat-moss	1	6
	Wb05	Black spruce - Water sedge - Peat-moss	1	
	Wb06	Tamarack - Water sedge - Fen moss	3	7
	Wb08	Black spruce - Soft-leaved sedge - Peat-moss		7
Fen	Wf01	Water sedge - Beaked sedge		3
	Wf02	Scrub birch – Water sedge	2	1
Swamp	Ws00	Swamp (unclassified)	1	

Wetland Class	Site Association	Vegetation Community	No. Sampled 2018	No. Sampled 2019
	Ws03	Bebb's willow - Bluejoint		1
	Ws04	Drummond's willow - Beaked sedge	1	
	Ws06	Sitka willow - Sitka sedge	1	
	Ws07	Spruce - Common horsetail - Leafy moss	1	
	Ws14	Mountain Alder – Bebb's Willow – Bluejoint	2	
Marsh	Wm00	Marsh (unclassified)		1
	Wm01	Beaked sedge - Water sedge	4	3
	Wm02	Swamp horsetail - Beaked sedge	1	1
	Wm03	Awned sedge	1	4
	Wm05	Cattail	2	
	Wm15	Bluejoint - Beaked sedge		2
Open Water	OW	Shallow Open Water (unclassified)		1
Total			***21***	***37***

Appendix 7. 2019 Preconstruction Rare Plant Surveys

EAGLE CAP CONSULTING
environmental consulting services

2019 Interim Report
Preconstruction Rare Plant Surveys
Site C Clean Energy Project

Prepared by:

Eagle Cap Consulting Ltd.
1103-240 70 Shawville Blvd. SE
Calgary, Alberta T2Y 2Z3

Prepared for:

BC Hydro and Power Authority
Suite 600, 4 Bentall Centre
1055 Dunsmuir Street
PO Box 49260
Vancouver, British Columbia

November 26, 2019

Contents

1. INTRODUCTION

1.1. Background

The Environmental Assessment Certificate (EAC #E14-02) for the Site C Clean Energy Project (the Project) sets out the conditions that BC Hydro must comply with during construction and operation of the Project (BC Environmental Assessment Office 2014). Condition 9 states in part:

- *The EAC Holder must, with the use of a QEP, complete an inventory in areas not already surveyed and use rare plant location information as inputs to final design of access roads and transmission lines. These preconstruction surveys must target rare plants as defined in Section 13.2.2 of the EIS —including vascular plants, mosses, and lichens.*
- *The EAC Holder must create and maintain a spatial database of known rare plant occurrences in the vicinity of Project components that must be searched to avoid effects to rare plants during construction activities. The database must be updated as new information becomes available and any findings of new rare plant species occurrences must be submitted to Environment Canada and MOE using provincial data collection standards.*

In addition, the federal decision statement issued under the Canadian Environmental Assessment Act sets out conditions relating to rare plants (Canadian Environmental Assessment Agency 2014). Condition 16 states in part:

- *16.1 The Proponent shall ensure that potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants are addressed and monitored.*
- *16.2. The Proponent shall develop, in consultation with Environment Canada, a plan setting out measures to address potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants.*
- *16.3. The plan shall include:*
    - *16.3.3. measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants;*
    - *16.3.4. conservation measures to ensure the viability of rare plants, such as seed recovery and plant relocation;*
    - *16.3.6. an approach to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities and rare plants; and*

- *16.3.7. an approach for tracking updates to the status of listed species identified by the Government of British Columbia, Committee on the Status of Endangered Wildlife in Canada, and the Species at Risk Act, and implementation of additional measures, in accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species should the status of a listed species change during the life of the Designated Project.*

To partially fulfill EAC condition 9 and Federal conditions 16.1, 16.2, 16.3.3, 16.3.4, 16.3.6 and 16.3.7, BC Hydro is conducting preconstruction rare plant surveys in previously unsurveyed areas of the proposed transmission line and access roads. By documenting additional occurrences of rare plants within the Project footprint, measures to mitigate effects to these occurrences—including seed recovery and translocation—can be identified.

Data collected during these surveys is added to the Project's environmental features map. This map is used during detailed design and construction to identify opportunities for avoidance, areas where extra care is needed, and areas where losses will occur. The first season of preconstruction surveys was completed in the summer and fall of 2015, and the work has been proceeding every year since. This interim report documents the methods and results of the surveys completed from 2015 through the end of the 2019 field season.

1.2. Scope

The goals of the study are:

- to develop, maintain, and update a spatial database of rare plant occurrences in the vicinity of Project facilities;
- to determine the location of rare plant occurrences in previously unsurveyed areas that are proposed for ground or vegetation disturbance during construction and operation of the Project;
- to determine the location of rare plant occurrences within two mitigation parcels that will be used to compensate for project effects;
- to record detailed element occurrence data in the Project rare plant database on all rare plant populations found, and submit these data to the B.C. Ministry of Environment and—for taxa of federal concern—to Environment Canada; and
- to develop occurrence-specific mitigation measures to eliminate or reduce adverse effects to rare plant populations resulting from the Project.

1.3. Study Area

Preconstruction rare plant surveys are being conducted in:

- the Highway 29 realignment corridors;
- the proposed transmission line corridor;
- the proposed new or upgraded transmission line access road corridors;
- the proposed new or upgraded access road corridors into the reservoir clearing zone—excluding the reservoir footprint;
- the proposed aggregate extraction areas;
- the proposed Project Access Road corridor running from Jackfish Road to the Dam Site;
- the proposed access road extension at the Portage Mountain site;
- the 85th Avenue industrial site;
- the proposed conveyor corridor from the 85th Avenue industrial site to the dam site;
- the 204 hectare Rutledge mitigation parcel along Highway 29 at Dry Creek; and
- the 423 hectare Wilder Creek mitigation parcel located along the Peace River approximately six kilometres downstream from Bear Flat.

Pre-construction rare plant surveys were completed for some of these areas during the 2015 through 2018 field seasons. The 2019 work focussed on access roads on the south side of the Peace River, and on the remaining segments of Highway 29 realignment corridors on the north side of the River.

2. METHODS

2.1. Prefield Review

Each year in the spring the investigation begins with a prefield review designed to collect and analyze existing data. This information is used to create a field study plan and to identify data gaps in order to direct further research.

For the purpose of the investigation, “rare plants” are defined to include the following vascular plants, mosses, and lichens:

- species listed on Schedule 1 of the Canadian Species at Risk Act (SARA) as amended (Government of Canada 2002);
- species assigned a status of Extinct, Extirpated, Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2019); and
- species on the B.C. Ministry of Environment’s provincial Red or Blue lists (BCCDC 2019).

Since 2005, BC Hydro has been conducting rare plant surveys in the Project's Regional Assessment Area (RAA)—as defined in the Site C Environmental Impact Statement (Hilton et al. 2013). As such, much is known about the rare flora of the area, and the prefield review is based heavily on element occurrence data collected over the last 14 years. Currently, 26 different rare plant taxa are reported to occur in the Project area. Consequently, these 20 vascular plants, 3 lichens, and 3 mosses form the basis of the target species list for the work, comprising the rare species with the highest likelihood of occurrence.

In order to identify additional rare plant species that could potentially occur in the Project area, each year the dataset of all B.C. vascular plants, mosses, and lichens is downloaded from the Ministry of Environment's Species and Ecosystem Explorer (BCCDC 2019). Queries are run on the dataset to extract a list of the rare plant species that the Ministry of Environment associates with the Peace River Regional District and the Boreal Black and White Spruce Biogeoclimatic Zone. Each species on this list is further reviewed to determine its potential for occurrence within the areas targeted for survey.

In addition, the Conservation Data Centre's (CDC) occurrence dataset of all species and ecosystems at risk is downloaded from the B.C. Data Catalogue and added to the Project spatial database (Ministry of Environment and Climate Change Strategy 2018). The dataset is queried to investigate historic and verified extant rare plant occurrences within the Project area.

All the above information is compiled to produce a list of target rare plant species potentially occurring within the Project area. This target list includes the 26 taxa currently reported to occur in the Project area, as well as numerous other possible Peace Region species uncovered during the prefield review of data and literature. It should be noted that the target list is used as a working guideline and can never be an exhaustive list of all potential rare plants for a given area. For this reason, the botanists consider all described plant taxa while conducting surveys.

Aerial imagery, contour information, and project maps are reviewed to predict the habitat types present in the survey corridors. General plant communities are determined, and the locations of possible high-suitability rare plant habitat are noted.

In order to refine their search images for the target taxa, the surveyors study photographs, herbarium specimens, and species descriptions in various published references (Hitchcock et al. 1955; Flora of North America Editorial Committee 1993; Goward et al. 1994; McCune et al. 1995; Douglas et al. 1998; Goward 1999; Brodo et al. 2001; Cronquist et al. 2013; Brodo 2016) and online databases (CNALH 2018; Klinkenberg 2019; NatureServe 2019). In addition, they review similar data for species that might be confused with the target taxa. Tables of summary identification characteristics are prepared for field use. The goals are to maximize detectability of the target species and to reduce observer bias during the surveys.

The final field plan each year is designed to guide the methods, coverage, and timing of the rare plant surveys. Seasonal timing is based on the predicted phenologies of the target species.

2.2. Field Survey

The preconstruction surveys began in June of 2015 and have taken place every year since. Over the five field seasons, 197 surveyor-days have been spent surveying a total transect distance of 1,113.3 kilometres (Table 1 and Figure 1).

Table 1: Rare Plant Survey Effort

Year	Start Date	End Date	Surveyor-Days	Total Survey Km
2015	June 30	September 7	42	209.8
2016	June 20	August 23	41	191.8
2017	June 23	August 12	12	51.7
2018	June 13	August 29	56	409.3
2019	May 31	August 15	46	250.7
Totals			**197**	**1,113.3**

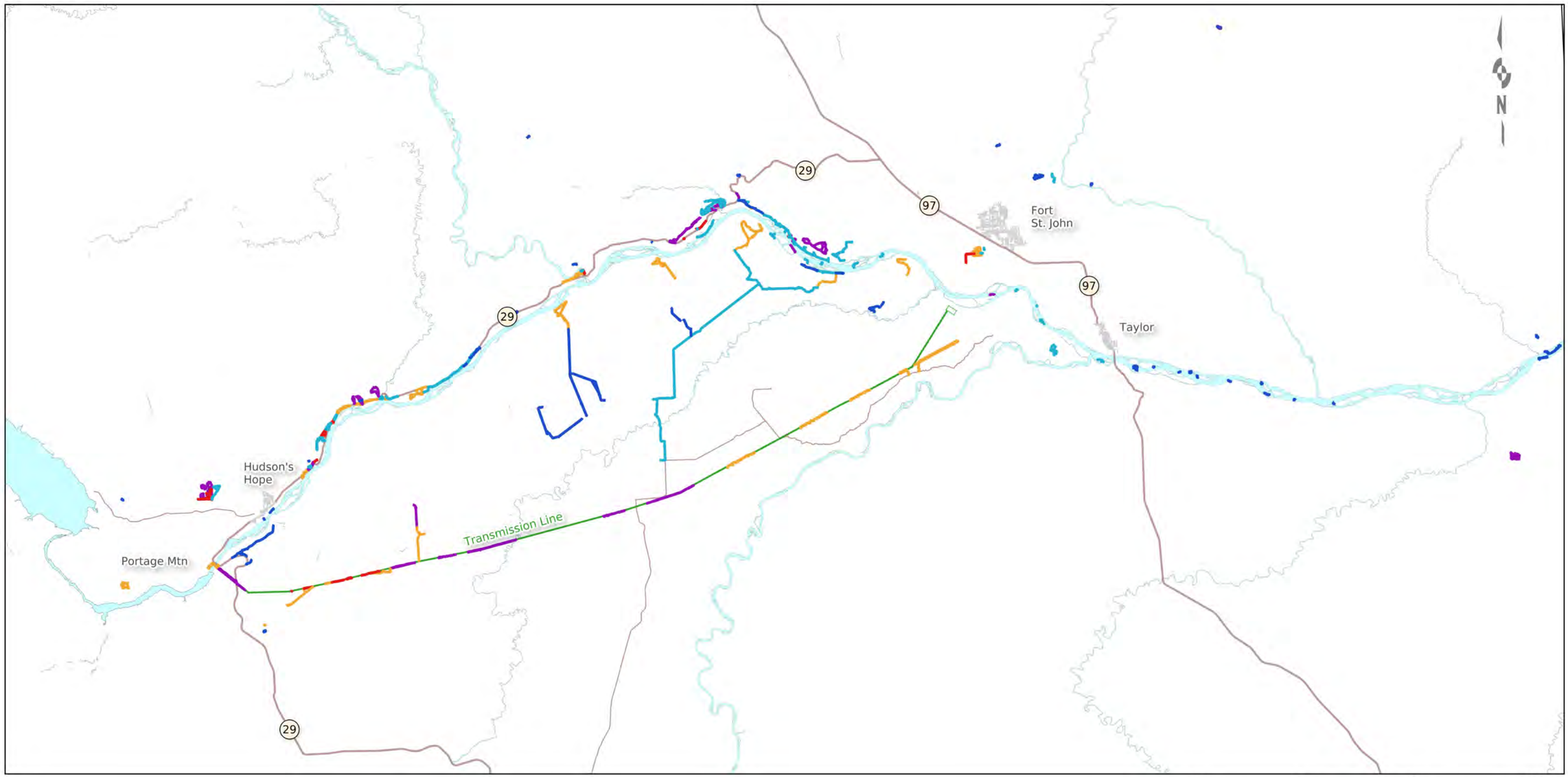
Table notes:

- *Surveyor-Days = days spent surveying x number of botanists*
- *Total Survey Km = total survey transect distance*

For all five years, the surveys were performed by two senior-level rare plant botanists—both of whom have been working with the rare flora of the Project area for the past nine years. The surveyors primarily use a habitat-directed meander search protocol to cover the areas surveyed. This survey technique is based on floristic, intuitive-controlled meander search types outlined in various rare plant survey guidelines (Whiteaker et al. 1998; ANPC 2000; ANPC 2012; Penny & Klinkenberg 2012; Ministry of Environment and Climate Change Strategy Ecosystems Branch 2018). The surveyors, working together or separately, walk the length of the linear corridors, zig-zagging back and forth from one edge of the proposed disturbance area to the other. For non-linear survey areas such as the Industrial 85th Avenue or Portage Mountain sites, the surveyors conduct meander transects to cover the entire area.

When using the habitat-directed meander search protocol:

- surveyors walk variable-width transects that are spaced relatively close together (typically so that the edge of the transect just surveyed is still visible to the surveyor or their partner—this distance varies based on the habitat surveyed and the detectability of the target species);
- surveyors attempt to locate all rare plant occurrences and high-suitability rare plant habitat within a defined unit in a systematic way (e.g., by walking in a zig-zag pattern along linear features, or in a contour pattern when surveying non-linear features); and
- surveyors attempt to traverse a representative cross-section of all low-suitability rare plant habitat within the unit.



Map Notes:

1. Based on surveys completed through September 2019.
2. Map Datum: NAD83
3. Map Projection: UTM Zone 10 N
4. Water Features Base Data from BC FreshwaterAtlas.
5. Road Base Data from the BC Digital Roads Atlas project.
6. Project-specific spatial data supplied by BC Hydro.

Legend

Roads
- Highway
- Secondary Roads
- Urban

Survey Routes
- 2015
- 2016
- 2017
- 2018
- 2019

Map Scale 1:350000

0 10 20 30 km

SITE C CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING environmental consulting services

Figure 1
Preconstruction Rare Plant Survey Routes

Date	November 14, 2019	DWG NO	2019-11-14-0001	Revision 0

The habitat-directed meander search preferentially covers high-suitability ecosystems over the more common low-suitability habitats (MacDougall & Loo 2002). The survey method is also floristic in nature, meaning that all plant taxa encountered are recorded and identified to a level necessary to determine their rarity (ANPC 2012). Furthermore, the habitat-directed meander search pattern is variable-intensity, such that when a rare plant occurrence or high-suitability rare plant habitat is located, the surveyors increase the intensity of their survey by narrowing the spacing of the transect pattern they are walking. Depending on the kind of habitat being surveyed and the detectability of the target rare species, this can require very close, hands-and-knees survey work in some areas.

For certain linear corridors that traverse habitat with a low potential for rare plant occurrence, the botanists drive slowly along the corridor in a Utility Terrain Vehicle (UTV) or truck, scanning both sides for rare plants and pockets of high-suitability rare plant habitat. This procedure is only conducted in corridors where the majority of habitat is low-probability, and at a speed of approximately five kilometres per hour. If high-potential rare plant habitat is encountered—such as wetlands or rock outcrops—the surveyors exit the vehicle and survey the habitat on foot. In 2015, 5.1% of the total 209.8 kilometres traversed was surveyed from UTV—the rest was walked. In 2016 only 0.9% of the total 191.8 kilometres survey distance was covered by UTV. In 2017, none of the transects were surveyed by UTV. In 2018, 14.6% of the total 409.3 kilometres was covered by UTV or truck, and in 2019, 2.3% of the total 250.7 kilometers was covered by UTV.

In 2016, surveys were conducted within the Rutledge and Wilder Creek mitigation parcels. These surveys were designed to provide a general overview of the rare plant populations present within the parcels, in order to inform mitigation planning. As such, these areas were surveyed at a lower intensity level, covering a smaller percentage of the suitable habitats, than in the areas proposed for disturbance. Although the habitat-directed meander survey technique described above was used in the mitigation parcels, certain areas of suitable habitat were not covered.

During the fieldwork, the surveyors constantly monitor all areas traversed for changes in habitat and plant association, as well as for previously unrecorded plant species (common and rare). Lists are kept of all plants and plant communities observed; unknown species are collected for later identification in the lab; Global Positioning System (GPS) units are used to mark location points as appropriate; and notes and photographs are taken to record plants of interest, landforms and unique features, habitat quality and disturbance, and areas requiring further survey.

When target rare plants are found during the fieldwork, element occurrence information is entered into custom-built digital forms or recorded on printed CDC rare plant survey forms (BCCDC 2012). Where paper forms are used, the information is later transcribed into digital format to facilitate analysis of the sites. Photographs are taken of both the individual plants and the surrounding habitat. Consistent with the B.C. Resource Information Standards Committee guidelines and the rare plant survey guidelines on the B.C. E‑Flora website a voucher specimen is collected where permitted by the landowner, and when doing so would not compromise the viability of the population (RIC 1999; Penny & Klinkenberg 2012; Ministry of Environment and Climate Change Strategy Ecosystems Branch 2018). At each vascular rare plant site, GPS units are used to record the boundary of the occurrence to facilitate mitigation planning.

Delimitation of occurrences is based on *A Habitat-Based Strategy for Delimiting Plant Element Occurrences* (NatureServe 2004). The Element Occurrence (EO) is a fundamental unit of information in the CDC system, and is defined as "an area of land and/or water in which a species or natural community is, or was present." (NatureServe 2002). Based on the NatureServe guidance, rare plants are typically grouped into a single occurrence when they are located closer than one kilometre from another individual of the same species. In some cases, occurrences are composed of two or more discrete patches—also referred to as "sites" in this report—spread out over a large area. These patches are mapped separately to facilitate mitigation planning, but are recorded as a single occurrence when the patches are closer than one kilometre to each other.

The botanists conducting the 2019 preconstruction surveys were also working on the Site C Experimental Rare Plant Translocation program at the time, selecting and documenting potential recipient sites for translocation outplanting. When new rare plant sites were found during potential recipient site selection work, they were documented using the same methods as described above. All of the new rare plant sites found during the survey work for either project are reported here to provide a single document that contains all the new rare plant sites.

2.3. Analysis

As field data are collected, they are imported into the Project rare plant database on a daily basis. This includes rare plant occurrence information, survey transect routes, and field notes. Collected data are encrypted and secured with multi-factor authentication protocols. The information and field photos are backed up nightly to secure off-site servers.

Following the field season, the collected rare plant information is compiled and analyzed in the Project rare plant Geographic Information System (GIS). Voucher specimens are examined and sent to outside experts when additional verification is required. New rare plant locations are compared with CDC data to determine if the newly discovered sites can be combined as extensions of previously recorded occurrences.

Every year, once the data have been compiled, verified, and cleaned, a submission package is prepared for the CDC. This dataset contains all the new rare plant occurrences found during the previous field season, as well as any updates and extensions to previously reported occurrences. The data are provided in a spatial format compatible with CDC submission requirements. Voucher specimens are prepared based on Ministry of Environment (MOE) guidelines (Ministry of Environment and Climate Change Strategy Ecosystems Branch 2018) and submitted to the appropriate herbarium.

The updated rare plant dataset is imported into the BC Hydro Site C GIS and used to populate the rare plant environmental features layer. This spatial information is made available to Project engineers for use in mitigation planning.

The following quality assurance and quality control measures are applied to promote accurate data collection and analysis:

- All project rare plant data are stored in a custom-built spatial database (PostgreSQL 9.6 spatially enabled with PostGIS 2.3). The database server software is regularly updated to the latest stable versions and all security patches are applied soon after issue.
- The tables in the database have been normalized to reduce data redundancy and improve integrity.
- Primary key constraints are enforced for all relational tables to improve database integrity and allow complex queries to be run.
- Data fields are constrained at the database level to ensure type-consistency. Electronic input forms also constrain entered data to provide front-end validation and user guidance.
- Regular updates are pulled from the MOE's Ecosystem Explorer and are added to the database to ensure that analyses are performed using the latest CDC rare plant statuses and nomenclature.
- The data fields *UTM northing*, *UTM easting*, and *occurrence area* are calculated programmatically from the rare plant polygons, ensuring accuracy of the derived fields. Point data are also derived programmatically from the rare plant polygons to ensure locational consistency between the spatial fields.
- Multipolygons—a GIS feature class that allows one or more closed plane figures to be recorded for each occurrence—are used as the basic spatial descriptor for the rare plant occurrences recorded after 2008 to enable more precise avoidance mitigation than would be possible using single polygons or points.
- Custom-built electronic forms are used by the botanists to enter rare plant data in the field while at the occurrence. Paper versions of the forms are also used in cases where there are difficulties with the electronic entry devices. In these cases, the paper forms are transcribed onto the electronic forms as soon as possible to allow for data validation.
- Every record is reviewed for typographical and transcription errors at the end of the field season.
- Associated species lists are reviewed by a second botanist to ensure identification accuracy.
- Rare plant polygons are reviewed on aerial imagery and ecosystem layers in the GIS to check boundary accuracy by the botanist(s) who recorded the occurrence.
- Voucher specimens are collected where appropriate and verified in the lab and herbarium, or are sent to species experts for further verification when taxonomic questions still exist.

3. RESULTS

3.1. Prefield Review

The 2019 prefield review identified 110 rare plant taxa with potential for occurrence in the overall Project area (Appendix 1). The list is comprised of 41 vascular plant species, 51 bryophytes, and 18 lichens. As noted previously, this list was used for planning purposes and was not considered to be an exhaustive listing of all possible rare plant taxa in the project area. The surveyors considered all rare taxa during the surveys, whether they were on the target list or not.

It should also be noted that the CDC regularly reviews the statuses of the plant taxa in the province to determine if new information warrants a change in the rarity rankings. As the Site C rare plant work proceeds, the numerous new occurrences that have been found during the surveys have allowed the CDC to reassess many of the plant taxa in the RAA. These reassessments are typically published by the CDC in May of the year, allowing Project botanists to incorporate the updates into the field plan for the upcoming season.

However, in 2019 the CDC status update was not published until July 5, after several weeks of field work had been completed. The update removed 10 RAA plant taxa from the Red or Blue lists, meaning that they no longer meet the definition of "rare plants" for the Project (see Section 2.1). This reduced the number of rare plant sites within the RAA by more than half, from 261 occurrences before the update, to 124 after the update.

3.2. Field Survey

The 2015 field surveys found 34 new sites of 14 different rare plant species—11 vascular plants and 3 lichens. Some of these new sites were within one kilometre of other occurrences of the same species found in previous years, and so were considered to be extensions of these previously reported occurrences. Of the 14 rare species, 5 were on the MOE's Red list, with the remaining 9 being on the Blue list. None of the taxa were listed on Schedule 1 of the Species at Risk Act, or were considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2019). Some of the rare taxa found in 2015 have since had their statuses revised and are no longer Red- or Blue-listed by the B.C. Ministry of Environment.

In 2016, 88 new sites of 13 different rare plant species were found—10 vascular plants and 3 lichens. As in 2015, some of the new sites were considered to be extensions of occurrences found in previous years. Of the 13 rare species found in 2016, 5 were on the B.C. Red list, while the remaining 8 were on the Blue list. None of the 2016 taxa were listed on Schedule 1 of the Species at Risk Act, or were considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2019). As with the 2015 rare plant taxa, some of the 13 rare plant species found in 2016 are no longer Red- or Blue-listed by the B.C. Ministry of Environment.

In 2017, three new sites of two different lichen species were found. One of the sites was considered to be an extension of a previously reported occurrence, and two were new occurrences. Both taxa found in 2017 were on the B.C. Blue list, however they have both since been removed. Neither was listed on Schedule 1 of the Species at Risk Act, or was considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2019).

For the 2018 field season, 46 rare plant sites were found. Several of these were extensions of previously known occurrences. Fourteen different rare plant taxa were found: 4 B.C. Red list, and 10 Blue list. None of the 14 were listed on Schedule 1 of the Species at Risk Act, or were considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2019). Several of the taxa documented in 2018 have since been removed from the B.C. Red/Blue lists.

In 2019, 21 occurrences of 9 rare or formerly rare taxa were found or expanded. These 21 occurrences contain 47 separate patches. One of the taxa is Red-listed by the CDC, six are Blue-listed, and two are currently Yellow-listed (*i.e.*, apparently secure) after being revised in July when the CDC status changes were published (BCCDC 2019). None of the nine taxa is listed on Schedule 1 of the Species at Risk Act, or is considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2019).

In total, 140 occurrences containing 287 patches of 27 currently or formerly listed rare plant taxa were discovered or expanded during the preconstruction surveys (Table 2 and Figure 2). Over the course of the five survey years, the investigators recorded 638 vascular plant, bryophyte, and lichen taxa (Appendix 2).

Table 2: Rare plants found during the Site C Preconstruction surveys

Taxon	Common Name	Current BC List	Occurrences	Patches
Vascular Plants				
Artemisia herriotii	Herriot's Sage	Yellow	7	24
Atriplex gardneri var. gardneri	Gardner's Sagebrush	Red	1	1
Avenula hookeri	Spike-oat	Yellow	1	1
Calamagrostis montanensis	Plains Reedgrass	Yellow	5	14
Carex backii	Back's Sedge	Yellow	3	10
Carex sprengelii	Sprengel's Sedge	Blue	3	4
Carex torreyi	Torrey's Sedge	Blue	6	10
Carex xerantica	Dry-land Sedge	Blue	8	16
Castilleja miniata var. fulva	Tawny Paintbrush	Yellow	1	1
Cirsium drummondii	Drummond's Thistle	Yellow	4	13
Geum triflorum var. triflorum	Old Man's Whiskers	Yellow	7	28
Juncus stygius var. americanus	Bog Rush	Yellow	1	1

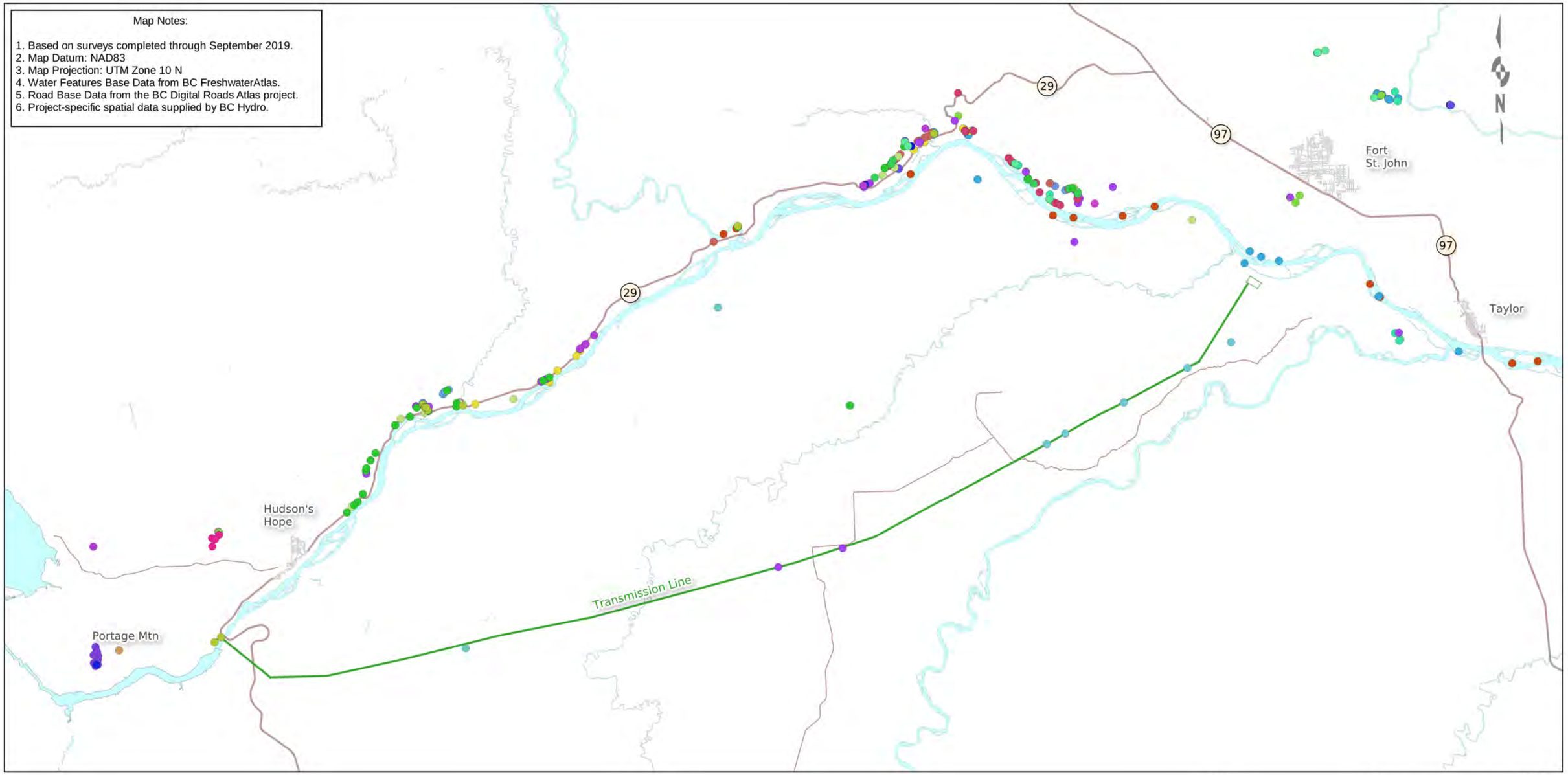
Oxytropis campestris var. davisii	Davis' Locoweed	Blue	12	15
Pedicularis parviflora	Small-flowered Lousewort	Yellow	1	2
Penstemon gracilis	Slender Penstemon	Blue	7	18
Piptatheropsis canadensis	Canada Ryegrass	Red	1	1
Polypodium sibiricum	Siberian Polypody	Yellow	1	12
Potentilla pulcherrima	Pretty Cinquefoil	Yellow	4	9
Ranunculus rhomboideus	Prairie Buttercup	Blue	7	9
Selaginella rupestris	Rock Selaginella	Red	4	7
Silene drummondii var. drummondii	Drummond's Campion	Yellow	3	3
Sphenopholis intermedia	Slender Wedgegrass	Yellow	7	13
Symphyotrichum puniceum var. puniceum	Purple-stemmed Aster	Yellow	7	7
Lichens				
Physcia biziana	Frosted rosette	Yellow	16	28
Physcia stellaris	Immaculate rosette	Yellow	8	11
Ramalina sinensis	Threadbare ribbon	Yellow	14	25
Usnea cavernosa	Pitted beard	Yellow	1	4
TOTAL			**140**	**287**

Table notes:

- *BC List (B.C. Ministry of Environment): Red = Endangered, Threatened, or Extirpated; Blue = Special Concern; Yellow = Apparently Secure*
- *Occurrences: Includes newly discovered occurrences as well as occurrences expanded during the preconstruction surveys*

Map Notes:

1. Based on surveys completed through September 2019.
2. Map Datum: NAD83
3. Map Projection: UTM Zone 10 N
4. Water Features Base Data from BC FreshwaterAtlas.
5. Road Base Data from the BC Digital Roads Atlas project.
6. Project-specific spatial data supplied by BC Hydro.



Legend

- *Artemisia herriotii*
- *Atriplex gardneri var. gardneri*
- *Avenula hookeri*
- *Calamagrostis montanensis*
- *Carex backii*
- *Carex sprengelii*
- *Carex torreyi*
- *Carex xerantica*
- *Castilleja miniata var. fulva*
- *Cirsium drummondii*
- *Geum triflorum var. triflorum*
- *Juncus stygius var. americanus*
- *Oxytropis campestris var. davisii*
- *Pedicularis parviflora*
- *Penstemon gracilis*
- *Physcia biziana*
- *Physcia stellaris*
- *Piptatheropsis canadensis*
- *Polypodium sibiricum*
- *Potentilla pulcherrima*
- *Ramalina sinensis*
- *Ranunculus rhomboideus*
- *Selaginella rupestris*
- *Silene drummondii var. drummondii*
- *Sphenopholis intermedia*
- *Symphyotrichum puniceum var. puniceum*
- *Usnea cavernosa*

Map Scale 1:250000

0 10 20 km

SITE C CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING
environmental consulting services

Figure 2
Rare Plant Sites Found During Preconstruction Surveys

Date	November 14, 2019	DWG NO	2019-11-14-0002	Revision 0

Many of the rare plant taxa found during the preconstruction surveys had been documented previously in other occurrences during the baseline surveys performed for the Project environmental impact assessment. Species descriptions for the nine currently rare-listed taxa recorded during the 2015–2019 preconstruction surveys are presented in Appendix 3. Each section also contains an overview of the new sites documented in 2019, and to-date summary information on all reported occurrences for each of these taxa in the RAA.

In this report all of the rare plant taxa discussed in Appendix 3 are currently Red- or Blue-listed by the CDC. For clarity, rare species found in previous years that have subsequently been removed from the Red or Blue lists are not included. Although not currently of conservation concern, the occurrence data for these taxa have been retained in the Project rare plant database for future reference if needed.

Information on additional taxa and occurrences documented in the RAA prior to 2015 can be found in the following references:

- Site C Project Environmental Impact Statement, Volume 2, Appendix R, Part 1 (Hilton et al. 2013);
- Report: Site C Clean Energy Project: Pre-disturbance Rare Plant Assessment #1: Rolling Work Plan 10 (Eagle Cap Consulting Ltd 2014);
- Report: Site C Clean Energy Project: Wildlife, Vegetation and Mapping Inventory for the Marl Fen Property (Simpson et al. 2014); and
- B.C. Ecosystem Explorer website (BCCDC 2019).

4. Discussion

4.1. Coverage

Survey coverage of the areas proposed for construction disturbance—both the linear corridors and non-linear areas—was considered sufficient to locate the majority of identifiable target rare plant species. The field crew used a habitat-directed search protocol, employing a variable-intensity survey pattern that focussed time and effort on the habitats most likely to contain rare plant occurrences. Transects were spaced so that the majority of rare plant occurrences and high-suitability rare plant habitat would have been visible during the surveys. See Section 2.2 above for a complete description of the survey methods.

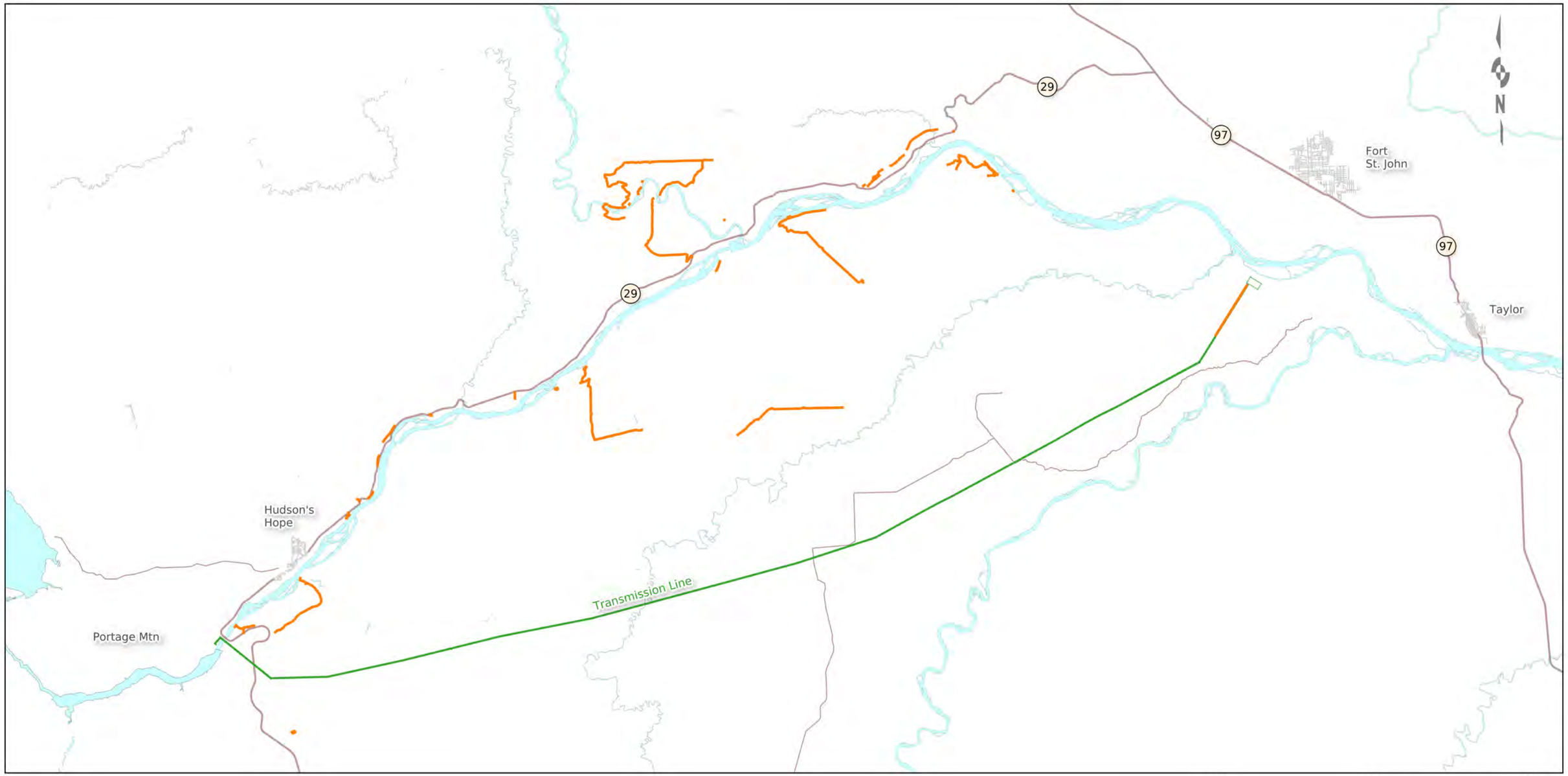
For the mitigation parcels—where the goal was to provide only a general overview of the rare plant populations present—the lower intensity meander surveys sampled most of the important habitats at both parcels. Although there are likely additional rare plant occurrences to be found at the mitigation parcels, the surveys provided a general picture of the rare plant resources present.

4.2. Timing

Based on the observed phenology of the plants in the areas surveyed and data gathered during previous years' survey work, the timing of the surveys was sufficient to identify all the target rare plants. The June and early July work typically focussed on sites north of the Peace River, where floodplain and grassland habitats make up the majority of the high-potential rare plant habitats present. Target species in these habitats often bloom early in the season, and then wither by later in the summer. The late summer and early fall surveys mainly focussed on areas south of the Peace River, where wetlands are the primary high-potential rare plant habitats. Many of these wetland-associated target rare plants bloom later in the season, and persist longer into the fall than those found in the upland areas.

4.3. Remaining Areas to Survey

At the beginning of the 2019 field season, 32.1 kilometres of preconstruction corridor remained to be surveyed. Field work began on those 32.1 kilometres in early June and progressed well. On June 13, BC Hydro provided an update to the project facilities spatial layers, significantly increasing the amount of required survey corridor to 145.0 kilometres. This increase was primarily a result of continuing refinements to the proposed access routes, and some additional layout changes to the Highway 29 realignment routes. By the end of the 2019 field season, 86.1 kilometres of corridor remained to be surveyed (Figure 3). Rare plant surveys of these corridors are scheduled to begin during the 2020 field season.



Map Notes:

1. Based on surveys completed through September 2019.
2. Map Datum: NAD83
3. Map Projection: UTM Zone 10 N
4. Water Features Base Data from BC FreshwaterAtlas.
5. Road Base Data from the BC Digital Roads Atlas project.
6. Project-specific spatial data supplied by BC Hydro.

Legend

Roads

- *Highway*
- *Secondary A*
- *Urban*

Preconstruction Corridors

- *To Be Surveyed*

Map Scale 1:250000

0 10 20 km

SITE C CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING
environmental consulting services

Figure 3
Remaining Preconstruction Survey Areas

Date	November 14, 2019	DWG NO	2019-11-14-0003	Revision 0

5. REFERENCES

Alberta Native Plant Council (ANPC). 2000. Guidelines For Rare Plant Surveys. Edmonton, Alberta: Alberta Native Plant Council.

Alberta Native Plant Council (ANPC). 2012. ANPC Guidelines for Rare Vascular Plant Surveys in Alberta – 2012 Update. Edmonton, Alberta: Alberta Native Plant Council.

Ball PW, Reznicek AA. 2002. *Carex*. In: Flora of North America Editorial Committee, editor. Flora of North America North of Mexico. Vol. 23. New York, New York: Oxford University Press; p. 252–333.

Barkworth ME. 2007. *Piptatherum*. In: Flora of North America Editorial Committee, editor. Flora of North America North of Mexico. Vol. 24. New York, New York: Oxford University Press.

BC Conservation Data Centre (BCCDC). 2012. Field survey form (plants) [Internet]. [cited 2017 Jan 1]. Available from: http://www.env.gov.bc.ca/cdc/contribute.html

BC Conservation Data Centre (BCCDC). 2019. BC Species and Ecosystems Explorer [Internet]. [cited 2019 Nov 4]. Available from: http://a100.gov.bc.ca/pub/eswp

BC Environmental Assessment Office. 2014. Environmental Assessment Certificate #E14-02: Site C Clean Energy Project. Victoria, BC: BC Environmental Assessment Office.

Brodo IM. 2016. Keys to Lichens of North America: Revised and Expanded. New Haven, Connecticut, USA: Yale University Press.

Brodo IM, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. New Haven, Connecticut, USA: Yale University Press.

Canadian Environmental Assessment Agency. 2014. Decision Statement Issued under Section 54 of the Canadian Environmental Assessment Act, 2012, for the Site C Clean Energy Project. Ottawa, Ontario: Canadian Environmental Assessment Agency.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2019. Species at Risk Public Registry [Internet]. [cited 2019 Jun 27]. Available from: http://www.registrelep-sararegistry.gc.ca/sar/index/default_e.cfm

Consortium of North American Lichen Herbaria (CNALH). 2018. CNALH Data Portal [Internet]. [cited 2018 Sep 22]. Available from: http://lichenportal.org/portal/index.php

Cronquist A, Holmgren AH, Holmgren NH, Reveal JL, Holmgren PK. 2013. Intermountain flora: vascular plants of the Intermountain West, USA: Volumes One through Seven. New York, New York: NYBG Press.

Douglas GW, Straley GB, Meidinger DV, Pojar J, editors. 1998. Illustrated flora of British Columbia: 8 volume set. Victoria, BC: British Columbia, Ministry of Environment, Lands and Parks.

Eagle Cap Consulting Ltd. 2014. Site C Clean Energy Project: Pre-disturbance Rare Plant Assessment #1: Rolling Work Plan 10. Vancouver, BC: BC Hydro.

Elisens WJ, Packer JG. 1980. A contribution to the taxonomy of the *Oxytropis campestris* complex in northwestern North America. Can J Bot. 58:1820–1831.

Flora of North America Editorial Committee, editor. 1993. Flora of North America North of Mexico. New York, New York: Oxford University Press.

Freeman CC, Rabeler RK. 2016. *Plantaginaceae*. Flora of North America North of Mexico [Internet]. [cited 2016 Nov 30]. Available from: http://floranorthamerica.org/Review/under-prod-17

Government of Canada. 2002. Species at Risk Act [as amended through May 14, 2012]. SC 2002, c 29. Ottawa, Ontario, Canada: Government of Canada.

Goward T. 1999. The Lichens of British Columbia: Part 2: Fruticose Species. Victoria, British Columbia: BC Ministry of Forests, Research Branch.

Goward T, McCune B, Meidinger D. 1994. The Lichens of British Columbia: Part 1: Foliose and Squamulose Species. Victoria, British Columbia: BC Ministry of Forests, Research Branch.

Hilton S, Andrusiak L, Krichbaum RS, Björk CR. 2013. Site C Clean Energy Project: Environmental Impact Statement: Volume 2: Appendix R: Terrestrial Vegetation and Wildlife Report, Part 1: Vegetation and Ecological Communities (amended). Vancouver, BC: BC Hydro.

Hitchcock CL, Cronquist A, Ownbey M, Thompson JW. 1955. Vascular plants of the Pacific Northwest. Seattle, Washington: University of Washington Press.

Hitchcock CL, Cronquist A, Ownbey M, Thompson JW. 1959. Vascular plants of the Pacific Northwest: Part 4: Ericaceae through Campanulaceae. Seattle, Washington: University of Washington Press.

Klinkenberg B. 2019. E-Flora BC: Electronic Atlas of the Plants of British Columbia [Internet]. [cited 2019 Nov 11]. Available from: http://eflora.bc.ca

Lapin M. 2004. *Piptatherum canadense* (Poiret) Dorn (Canada Ricegrass) Conservation and Research Plan for New England. Framingham, Massachusetts, USA: New England Wild Flower Society.

MacDougall AS, Loo JA. 2002. Predicting occurrences of geographically restricted rare floral elements with qualitative habitat data. Canadian Forest Service Environmental Reviews. 10:167–190.

McCune B, Goward T, Mikulin AG, Stone DF, Taylor L. 1995. Macrolichens of the northern Rocky Mountains. Eureka, California: Mad River Press.

Ministry of Environment and Climate Change Strategy. 2018. Dataset of Species and Ecosystems at Risk - Publicly Available Occurrences - CDC. Victoria, BC: Government of British Columbia.

Ministry of Environment and Climate Change Strategy Ecosystems Branch. 2018. Inventory and Survey Methods for Rare Plants and Lichens. Victoria, BC: Resources Information Standards Committee.

NatureServe. 2002. Element Occurrence Data Standard. Arlington, Virginia.

NatureServe. 2004. A Habitat-Based Strategy for Delimiting Plant Element Occurrences: Guidance from the 2004 Working Group. Arlington, Virginia: Natureserve.

NatureServe. 2019. NatureServe Explorer: An online encyclopedia of life: Version 7.1 [Internet]. [cited 2019 Nov 11]. Available from: http://explorer.natureserve.org/

Penny J, Klinkenberg R. 2012. Rare plant inventory methods [Internet]. [cited 2017 Dec 26]. Available from: http://www.geog.ubc.ca/biodiversity/eflora/ProtocolsforRarePlantSurveys.html

Resources Inventory Committee (RIC). 1999. Voucher Specimen Collection, Preparation, Identification and Storage Protocol: Plants & Fungi: Standards for components of British Columbia's biodiversity No. 4b. Victoria, British Columbia: Government of British Columbia.

Romaschenko K, Peterson PM, Soreng RJ, Futorna O, Susanna A. 2011. Phylogenetics of *Piptatherum* s.l. (Poaceae: Stipeae): Evidence for a new genus, *Piptatheropsis*, and resurrection of *Patis*. Taxon. 60:1703–1716.

Simpson L, Churchland C, Jones T, Simpson TK. 2014. Site C Clean Energy Project: Wildlife, Vegetation and Mapping Inventory for the Marl Fen Property. Vancouver, BC: BC Hydro.

Valdespino IA. 1993. *Selaginella*. In: Flora of North America Editorial Committee, editor. Flora of North America North of Mexico. Vol. 2. New York, New York: Oxford University Press.

Welsh SL. 1991. *Oxytropis* DC. - Names, basionyms, types, and synonyms - Flora North America Project. Great Basin Naturalist. 51:377–396.

Welsh SL. 2003. *Atriplex*. In: Flora of North America Editorial Committee, editor. Flora of North America North of Mexico. Vol. 4. New York, New York: Oxford University Press.

Whiteaker L, Henderson J, Holmes R, Hoover L, Lesher R, Lippert J, Olson E, Potash L, Seevers J, Stein M, Wogen N. 1998. Survey Protocols for Survey & Manage Strategy 2 Vascular Plants: V 2.0. Oregon: US Bureau of Land Management.

Whittemore AT, Parfitt BD. 1997. *Ranunculus*. In: Flora of North America Editorial Committee, editor. Flora of North America North of Mexico. Vol. 3. New York and Oxford.

6. APPENDICES

Appendix 1: Rare plant taxa with potential for occurrence in the Site C Project area

Scientific Name	Common Name	BC List	COSEWIC	SARA
VASCULAR PLANTS				
Acorus americanus	American Sweet-flag	Blue		
Alopecurus magellanicus	Alpine Meadow-foxtail	Red		
Arctophila fulva	Pendantgrass	Blue		
Artemisia alaskana	Alaskan Sagebrush	Blue		
Atriplex gardneri var. gardneri	Gardner's Sagebrush	Red		
Botrychium montanum	Mountain Moonwort	Blue		
Botrychium paradoxum	Two-spiked Moonwort	Blue		
Carex bicolor	Two-coloured Sedge	Blue		
Carex lapponica	Lapland Sedge	Blue		
Carex sprengelii	Sprengel's Sedge	Blue		
Carex torreyi	Torrey's Sedge	Blue		
Carex xerantica	Dry-land Sedge	Blue		
Drosera linearis	Slender-leaf Sundew	Blue		
Elymus lanceolatus ssp. psammophilus	Sand-dune Wheatgrass	Blue		
Epilobium hornemannii ssp. behringianum	Hornemann's Willowherb	Red		
Epilobium saximontanum	Rocky Mountain Willowherb	Blue		
Lomatium foeniculaceum var. foeniculaceum	Fennel-leaved Desert-parsley	Blue		
Oxytropis campestris var. davisii	Davis' Locoweed	Blue		
Packera ogotorukensis	Ogotoruk Creek Butterweed	Red		
Penstemon gormanii	Gorman's Penstemon	Blue		
Penstemon gracilis	Slender Penstemon	Blue		
Piptatheropsis canadensis	Canada Ricegrass	Red		
Polemonium boreale	Northern Jacob's-ladder	Blue		
Polygala senega	Seneca-snakeroot	Red		
Polygonum ramosissimum ssp. prolificum	Proliferous Knotweed	Red		
Potentilla arenosa ssp. arenosa	Scree Cinquefoil	Red		
Potentilla furcata	Forked Cinquefoil	Red		
Prenanthes racemosa	Purple Rattlesnake-root	Red		
Ranunculus cardiophyllus	Heart-leaved Buttercup	Red		

Ranunculus rhomboideus	Prairie Buttercup	Blue		
Rosa arkansana	Arkansas Rose	Blue		
Salix petiolaris	Meadow Willow	Blue		
Salix raupii	Raup's Willow	Red		
Sarracenia purpurea ssp. purpurea	Common Pitcher-plant	Red		
Saussurea angustifolia var. angustifolia	Northern Sawwort	Red		
Selaginella rupestris	Rock Selaginella	Red		
Silene repens	Pink Campion	Blue		
Symphyotrichum falcatum var. commutatum	White Prairie Aster	Red		
Tephroseris palustris	Marsh Fleabane	Blue		
Thalictrum dasycarpum	Purple Meadowrue	Blue		
Utricularia ochroleuca	Ochroleucous Bladderwort	Blue		
BRYOPHYTES				
Acaulon muticum var. rufescens	[no common name]	Red		
Amblyodon dealbatus	[no common name]	Blue		
Atrichum tenellum	[no common name]	Red		
Aulacomnium acuminatum	[no common name]	Blue		
Barbula convoluta var. gallinula	[no common name]	Red		
Bartramia halleriana	Haller's Apple Moss	Red	T (Nov 2011)	1-T (Jun 2003)
Brachythecium trachypodium	[no common name]	Blue		
Bryobrittonia longipes	[no common name]	Blue		
Bryum uliginosum	[no common name]	Blue		
Cynodontium glaucescens	[no common name]	Blue		
Dicranum majus var. orthophyllum	[no common name]	Red		
Didymodon rigidulus var. icmadophilus	[no common name]	Blue		
Didymodon subandreaeoides	[no common name]	Red		
Encalypta brevicollis	[no common name]	Blue		
Encalypta intermedia	[no common name]	Blue		
Encalypta longicolla	[no common name]	Blue		
Encalypta mutica	[no common name]	Blue		
Encalypta spathulata	[no common name]	Blue		
Grimmia teretinervis	[no common name]	Red		
Haplodontium macrocarpum	Porsild's Bryum	Red	T (Dec 2017)	1-T (Feb 2011)
Hygrohypnum alpestre	[no common name]	Blue		

Hygrohypnum alpinum	[no common name]	Blue		
Lescuraea saxicola	[no common name]	Blue		
Meesia longiseta	[no common name]	Blue		
Myurella sibirica	[no common name]	Red		
Orthothecium strictum	[no common name]	Blue		
Orthotrichum speciosum var. elegans	[no common name]	Blue		
Philonotis yezoana	[no common name]	Blue		
Plagiobryum demissum	[no common name]	Red		
Pohlia bulbifera	[no common name]	Blue		
Pseudocalliergon turgescens	[no common name]	Blue		
Schistidium boreale	[no common name]	Blue		
Schistidium confertum	[no common name]	Red		
Schistidium pulchrum	[no common name]	Blue		
Schistidium robustum	[no common name]	Blue		
Schistidium trichodon	[no common name]	Blue		
Seligeria subimmersa	[no common name]	Red		
Seligeria tristichoides	[no common name]	Blue		
Sphagnum balticum	[no common name]	Blue		
Sphagnum contortum	[no common name]	Blue		
Sphagnum wulfianum	[no common name]	Blue		
Splachnum vasculosum	[no common name]	Blue		
Tayloria froelichiana	[no common name]	Blue		
Tayloria splachnoides	[no common name]	Red		
Tetraplodon urceolatus	[no common name]	Red		
Timmia norvegica	[no common name]	Blue		
Timmia sibirica	[no common name]	Red		
Tortella humilis	[no common name]	Red		
Trichostomum crispulum	[no common name]	Blue		
Warnstorfia pseudostraminea	[no common name]	Blue		
Weissia brachycarpa	[no common name]	Blue		
LICHENS				
Anaptychia crinalis	Electrified millepede	Red		
Anaptychia ulotrichoides	Amputated millepede	Blue		
Cladonia parasitica	Fence-rail pixie	Red		
Collema bachmanianum	Caesar's tarpaper	Blue		
Collema coniophilum	Crumpled tarpaper	Red	T (Nov 2010)	1-T (Feb 2017)

Fulgensia desertorum	Desert sulphur	Blue		
Fulgensia subbracteata	Creeping Sulphur	Blue		
Heterodermia speciosa	Smiling centipede	Red		
Leptogium schraderi	Collapsing vinyl	Red		
Phaeophyscia adiastola	Granulating shadow	Blue		
Phaeophyscia hispidula	Whiskered shadow	Red		
Physcia dimidiata	Exuberant rosette	Blue		
Physcia tribacia	Beaded rosette	Red		
Physciella chloantha	Downside shade	Blue		
Squamarina cartilaginea	Pea-green dimple	Red		
Squamarina lentigera	Snow-white dimple	Red		
Thyrea confusa	Candied gummybear	Blue		
Xanthoparmelia camtschadalis	Rockfrog	Red		

Table notes:

- *B.C. List (B.C. Ministry of Environment): Red = Endangered, Threatened, or Extirpated; Blue = Special Concern*
- *COSEWIC (Committee on the Status of Endangered Wildlife in Canada): E = Endangered; T = Threatened; SC = Special Concern; DD = Data Deficient*
- *SARA (Species at Risk Act): 1-E = Schedule 1 Endangered; 1-T = Schedule 1 Threatened; 1-SC = Schedule 1 Special Concern*

Appendix 2: Plant and lichen species recorded during the 2015–2019 surveys

Vascular Plants

Acer glabrum var. douglasii
Acer negundo
Achillea alpina
Achillea borealis
Achillea millefolium var. lanulosa
Achnatherum nelsonii ssp. dorei
Achnatherum richardsonii
Aconitum delphiniifolium
Actaea rubra
Agropyron cristatum ssp. pectinatum
Agrostis capillaris
Agrostis exarata
Agrostis gigantea
Agrostis scabra
Alisma triviale
Allium cernuum var. cernuum
Allium schoenoprasum var. sibiricum
Alnus incana ssp. tenuifolia
Alnus viridis ssp. crispa
Alnus viridis ssp. sinuata
Alopecurus aequalis
Amelanchier alnifolia
Amerorchis rotundifolia
Anaphalis margaritacea
Androsace septentrionalis
Anemone cylindrica
Anemone multifida var. multifida
Anemone patens ssp. multifida
Anemone virginiana var. cylindroidea
Angelica genuflexa
Antennaria howellii ssp. canadensis
Antennaria howellii ssp. petaloidea
Antennaria microphylla
Antennaria neglecta
Antennaria parvifolia
Antennaria pulcherrima ssp. pulcherrima
Antennaria racemosa
Antennaria rosea
Anthoxanthum hirtum
Apocynum androsaemifolium var. androsaemifolium
Aquilegia brevistyla
Aralia nudicaulis
Arctium minus
Arctium sp.
Arctostaphylos uva-ursi
Arnica chamissonis
Arnica cordifolia
Artemisia biennis
Artemisia campestris ssp. pacifica
Artemisia dracunculus
Artemisia frigida
Artemisia herriotii
Asparagus officinalis
Astragalus agrestis
Astragalus alpinus var. alpinus
Astragalus americanus
Astragalus australis
Astragalus canadensis
Astragalus cicer
Astragalus eucosmus
Astragalus laxmannii var. robustior
Astragalus tenellus
Athyrium filix-femina ssp. cyclosorum
Atriplex gardneri var. gardneri
Avena sativa
Avenula hookeri
Axyris amaranthoides
Beckmannia syzigachne
Betula neoalaskana
Betula papyrifera
Betula pumila
Betula pumila var. glandulifera
Bidens cernua
Blitum capitatum ssp. capitatum
Boechera divaricarpa
Boechera grahamii
Boechera pendulocarpa
Boechera retrofracta
Boechera stricta
Botrypus virginianus
Brassica rapa var. rapa
Bromus ciliatus
Bromus inermis
Bromus pumpellianus ssp. pumpellianus

Calamagrostis canadensis
Calamagrostis canadensis var. langsdorfii
Calamagrostis montanensis
Calamagrostis purpurascens var. purpurascens
Calamagrostis stricta ssp. inexpansa
Calla palustris
Callitriche palustris
Caltha natans
Campanula rotundifolia
Capsella bursa-pastoris
Caragana arborescens
Cardamine oligosperma var. oligosperma
Carex aquatilis
Carex aquatilis var. aquatilis
Carex arcta
Carex atherodes
Carex atratiformis
Carex aurea
Carex backii
Carex bebbii
Carex brunnescens
Carex brunnescens ssp. brunnescens
Carex canescens ssp. canescens
Carex capillaris
Carex chordorrhiza
Carex concinna
Carex crawfordii
Carex cusickii
Carex deweyana var. deweyana
Carex diandra
Carex disperma
Carex duriuscula
Carex eburnea
Carex filifolia
Carex foenea
Carex gynocrates
Carex inops ssp. heliophila
Carex interior
Carex lasiocarpa
Carex limosa
Carex livida var. radicaulis
Carex magellanica ssp. irrigua
Carex microptera
Carex obtusata
Carex peckii
Carex pellita
Carex praticola
Carex retrorsa
Carex richardsonii
Carex rossii
Carex sartwellii
Carex sartwellii var. sartwellii
Carex siccata
Carex sprengelii
Carex tenera
Carex tenuiflora
Carex torreyi
Carex utriculata
Carex vaginata
Carex xerantica
Castilleja miniata
Castilleja miniata var. fulva
Cerastium arvense
Cerastium fontanum
Cerastium nutans
Chamerion angustifolium
Chenopodiastrum simplex
Chenopodium album
Chenopodium album ssp. album
Chenopodium album ssp. striatum
Chenopodium desiccatum
Chenopodium pratericola
Chrysosplenium tetrandrum
Cicuta bulbifera
Cicuta douglasii
Cicuta virosa
Cinna latifolia
Circaea alpina ssp. alpina
Cirsium arvense
Cirsium drummondii
Cirsium foliosum
Cirsium vulgare
Clematis occidentalis ssp. grosseserrata
Coeloglossum viride var. virescens
Collomia linearis
Comandra umbellata var. umbellata

Comarum palustre
Conyza canadensis
Corallorhiza maculata
Corallorhiza striata var. striata
Corallorhiza trifida
Cornus canadensis
Cornus stolonifera
Corydalis aurea ssp. aurea
Corylus cornuta
Crepis tectorum
Cypripedium passerinum
Cystopteris fragilis
Dactylis glomerata
Danthonia intermedia ssp. intermedia
Danthonia spicata
Dasiphora fruticosa
Delphinium glaucum
Deschampsia cespitosa ssp. cespitosa
Descurainia sophia
Diphasiastrum complanatum
Dracocephalum parviflorum
Drosera linearis
Drosera rotundifolia
Drosera rotundifolia var. rotundifolia
Dryas drummondii
Drymocallis convallaria
Dryopteris carthusiana
Dryopteris expansa
Elaeagnus commutata
Eleocharis mamillata ssp. mamillata
Eleocharis palustris
Elymus canadensis
Elymus glaucus
Elymus glaucus ssp. glaucus
Elymus lanceolatus ssp. lanceolatus
Elymus repens
Elymus trachycaulus
Elymus trachycaulus ssp. subsecundus
Elymus trachycaulus ssp. trachycaulus
Epilobium angustifolium
Epilobium ciliatum
Epilobium ciliatum ssp. ciliatum
Epilobium ciliatum ssp. glandulosum
Epilobium halleanum
Epilobium hornemannii ssp. hornemannii
Epilobium palustre
Equisetum arvense
Equisetum fluviatile
Equisetum hyemale
Equisetum hyemale ssp. affine
Equisetum laevigatum
Equisetum palustre
Equisetum pratense
Equisetum scirpoides
Equisetum sylvaticum
Equisetum variegatum ssp. variegatum
Erigeron caespitosus
Erigeron glabellus var. pubescens
Erigeron philadelphicus
Erigeron philadelphicus var. philadelphicus
Eriophorum angustifolium
Eriophorum chamissonis
Eriophorum gracile
Eriophorum sp.
Eriophorum viridicarinatum
Erysimum cheiranthoides
Euphrasia nemorosa
Eurybia conspicua
Eurybia sibirica
Fallopia convolvulus
Festuca rubra ssp. rubra
Festuca saximontana
Festuca trachyphylla
Fragaria vesca var. bracteata
Fragaria virginiana
Fragaria virginiana var. platypetala
Galeopsis bifida
Galium boreale
Galium labradoricum
Galium trifidum
Galium trifidum ssp. trifidum
Galium triflorum
Gentianella amarella ssp. acuta
Geocaulon lividum
Geranium bicknellii
Geum aleppicum

Geum macrophyllum
Geum macrophyllum ssp. macrophyllum
Geum macrophyllum var. perincisum
Geum triflorum var. triflorum
Glyceria borealis
Glyceria grandis var. grandis
Glyceria striata
Gnaphalium uliginosum
Goodyera repens
Grindelia squarrosa var. quasiperennis
Gymnocarpium dryopteris
Halenia deflexa ssp. deflexa
Halerpestes cymbalaria
Hedysarum alpinum
Hedysarum boreale
Heracleum maximum
Hesperostipa comata ssp. comata
Hesperostipa curtiseta
Heuchera richardsonii
Hieracium aurantiacum
Hieracium canadense
Hieracium umbellatum ssp. umbellatum
Hierochloë hirta ssp. arctica
Hippuris vulgaris
Hordeum jubatum ssp. jubatum
Hypopitys monotropa
Impatiens noli-tangere
Juncus alpinoarticulatus ssp. americanus
Juncus balticus ssp. ater
Juncus bufonius
Juncus dudleyi
Juncus nodosus
Juncus stygius ssp. americanus
Juncus vaseyi
Juniperus communis
Koeleria macrantha
Lactuca serriola
Lappula occidentalis var. occidentalis
Lappula squarrosa
Larix laricina
Lathyrus ochroleucus
Lemna minor
Lepidium densiflorum
Leucanthemum vulgare
Leymus cinereus
Leymus innovatus ssp. innovatus
Limosella aquatica
Linaria genistifolia ssp. dalmatica
Linaria vulgaris
Linnaea borealis
Linum lewisii ssp. lewisii
Listera borealis
Listera cordata
Lithospermum incisum
Lonicera dioica var. glaucescens
Lonicera involucrata
Lotus corniculatus
Lycopodium dendroideum
Madia glomerata
Maianthemum canadense
Maianthemum racemosum ssp. amplexicaule
Maianthemum stellatum
Maianthemum trifolium
Matricaria discoidea
Medicago lupulina
Medicago sativa
Medicago sativa ssp. falcata
Melampyrum lineare var. lineare
Melica smithii
Melilotus albus
Melilotus officinalis
Mentha arvensis
Menyanthes trifoliata
Mertensia paniculata var. paniculata
Mitella nuda
Moehringia lateriflora
Monarda fistulosa var. menthaefolia
Moneses uniflora
Monotropa uniflora
Muhlenbergia glomerata
Mulgedium pulchellum
Myriophyllum sibiricum
Nassella viridula
Neslia paniculata
Nuphar sp.
Oplopanax horridus

Opuntia fragilis
Orobanche fasciculata
Orthilia secunda
Orthilia secunda var. secunda
Orthocarpus luteus
Oryzopsis asperifolia
Osmorhiza berteroi
Osmorhiza sp.
Oxybasis glauca
Oxytropis campestris var. davisii
Oxytropis deflexa var. sericea
Oxytropis sericea var. speciosa
Oxytropis splendens
Packera paupercula
Packera plattensis
Packera streptanthifolia
Parnassia palustris
Pascopyrum smithii
Pedicularis groenlandica
Pedicularis labradorica
Pedicularis parviflora
Penstemon gracilis
Penstemon procerus var. procerus
Persicaria amphibia
Persicaria amphibia var. emersa
Persicaria amphibia var. stipulacea
Persicaria hydropiper
Persicaria lapathifolia
Persicaria sp.
Petasites frigidus var. palmatus
Petasites frigidus var. sagittatus
Phalaris arundinacea var. arundinacea
Phleum pratense ssp. pratense
Picea glauca
Picea mariana
Pinus contorta var. latifolia
Piptatheropsis canadensis
Piptatheropsis pungens
Piptatherum pungens
Plantago major
Platanthera aquilonis
Platanthera huronensis
Platanthera obtusata ssp. obtusata
Platanthera orbiculata
Platanthera sp.
Poa alpina ssp. alpina
Poa compressa
Poa glauca
Poa glauca ssp. glauca
Poa nemoralis ssp. interior
Poa palustris
Poa pratensis
Poa pratensis ssp. pratensis
Poa secunda
Polygonum achoreum
Polygonum aviculare
Polygonum douglasii
Polygonum fowleri
Polygonum ramosissimum
Polypodium sibiricum
Populus balsamifera
Populus tremuloides
Potamogeton alpinus
Potamogeton gramineus
Potamogeton pusillus ssp. tenuissimus
Potentilla anserina
Potentilla gracilis var. fastigiata
Potentilla hippiana
Potentilla norvegica
Potentilla pensylvanica
Potentilla pensylvanica var. pensylvanica
Potentilla pulcherrima
Prosartes trachycarpa
Prunus pensylvanica
Prunus virginiana ssp. melanocarpa
Prunus virginiana var. demissa
Pseudoroegneria spicata
Puccinellia distans
Puccinellia nuttalliana
Pyrola asarifolia
Pyrola chlorantha
Pyrola minor
Ranunculus acris
Ranunculus aquatilis var. aquatilis
Ranunculus aquatilis var. diffusus
Ranunculus cymbalaria

Ranunculus gmelinii
Ranunculus macounii
Ranunculus rhomboideus
Ranunculus sceleratus
Ranunculus sceleratus var. multifidus
Rhinanthus minor
Rhododendron groenlandicum
Ribes hudsonianum var. hudsonianum
Ribes lacustre
Ribes oxyacanthoides ssp. oxyacanthoides
Rorippa palustris
Rorippa palustris ssp. palustris
Rosa acicularis ssp. sayi
Rosa woodsii ssp. woodsii
Rubus arcticus ssp. acaulis
Rubus chamaemorus
Rubus idaeus ssp. strigosus
Rubus parviflorus var. parviflorus
Rubus pedatus
Rubus pubescens
Rumex britannica
Rumex crispus
Rumex fueginus
Rumex occidentalis
Rumex triangulivalvis
Salix arbusculoides
Salix bebbiana
Salix candida
Salix discolor
Salix drummondiana
Salix interior
Salix lasiandra var. lasiandra
Salix maccalliana
Salix myrtillifolia
Salix pedicellaris
Salix planifolia
Salix prolixa
Salix pseudomonticola
Salix pseudomyrsinites
Salix pyrifolia
Salix scouleriana
Salix serissima
Salsola tragus
Sanicula marilandica
Saxifraga tricuspidata
Schizachne purpurascens
Schoenoplectus tabernaemontani
Scirpus microcarpus
Scutellaria galericulata
Selaginella rupestris
Senecio vulgaris
Shepherdia canadensis
Silene drummondii var. drummondii
Silene latifolia
Sisymbrium altissimum
Sisyrinchium montanum var. montanum
Sium suave
Solidago altissima ssp. gilvocanescens
Solidago bellidifolia
Solidago lepida var. salebrosa
Solidago multiradiata
Solidago simplex var. simplex
Sonchus arvensis
Sonchus arvensis ssp. uliginosus
Sorbus scopulina var. scopulina
Sparganium emersum
Sparganium natans
Sparganium sp.
Sphenopholis intermedia
Spiraea betulifolia ssp. lucida
Spiraea lucida
Spiranthes romanzoffiana
Stachys palustris ssp. pilosa
Stellaria borealis
Stellaria borealis ssp. borealis
Stellaria longifolia
Stellaria longipes var. longipes
Stellaria media
Stuckenia pectinata
Symphoricarpos albus
Symphoricarpos occidentalis
Symphyotrichum boreale
Symphyotrichum ciliolatum
Symphyotrichum ericoides var. pansum
Symphyotrichum laeve var. geyeri
Symphyotrichum lanceolatum var. hesperium

Symphyotrichum puniceum var. puniceum
Tanacetum vulgare
Taraxacum officinale
Thalictrum venulosum
Thinopyrum intermedium
Thlaspi arvense
Tofieldia pusilla
Tragopogon dubius
Triantha glutinosa
Trifolium hybridum
Trifolium pratense
Trifolium repens
Triglochin maritima
Triglochin palustris
Tripleurospermum inodorum
Triticum aestivum
Turritis glabra
Typha latifolia
Urtica dioica ssp. gracilis
Utricularia intermedia
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium myrtilloides
Vaccinium oxycoccos
Vaccinium vitis-idaea ssp. minus
Valeriana dioica ssp. sylvatica
Verbascum thapsus
Veronica beccabunga ssp. americana
Veronica peregrina var. xalapensis
Veronica scutellata
Viburnum edule
Vicia americana
Viola adunca var. adunca
Viola canadensis var. rugulosa
Woodsia scopulina
Zizia aptera

Bryophytes

Aulacomnium palustre
Ceratodon purpureus
Funaria hygrometrica
Hylocomium splendens
Marchantia polymorpha
Pleurozium schreberi
Polytrichum commune
Preissia quadrata
Ptilium crista-castrensis
Sphagnum magellanicum
Sphagnum sp.

Lichens

Bryoria capillaris
Bryoria fuscescens
Bryoria lanestris
Bryoria sp.
Caloplaca cerina
Caloplaca holocarpa
Cetraria ericetorum
Cladina rangiferina
Cladina sp.
Cladonia carneola
Cladonia pocillum
Cladonia sp.
Collema furfuraceum
Diploschistes muscorum
Enchylium tenax
Endocarpon pusillum
Evernia mesomorpha
Flavocetraria cucullata
Hypogymnia occidentalis
Hypogymnia physodes
Icmadophila ericetorum
Lathagrium undulatum var. granulosum
Lecanora impudens
Leptogium saturninum
Leptogium teretiusculum
Lobaria pulmonaria
Melanelixia subaurifera
Melanohalea exasperatula
Melanohalea septentrionalis
Melanohalea subolivacea
Nephroma resupinatum
Parmelia fraudans
Parmelia sulcata
Parmeliopsis ambigua
Parmeliopsis hyperopta
Peltigera aphthosa
Peltigera britannica

Peltigera didactyla
Peltigera elisabethae
Peltigera extenuata
Peltigera lepidophora
Peltigera leucophlebia
Peltigera malacea
Peltigera neckeri
Peltigera sp.
Phaeophyscia orbicularis
Phaeophyscia sciastra
Phaeophyscia sp.
Physcia adscendens
Physcia aipolia
Physcia alnophila
Physcia biziana
Physcia caesia
Physcia phaea
Physcia stellaris
Physcia tenella
Physconia muscigena
Physconia perisidiosa
Platismatia glauca
Ramalina dilacerata
Ramalina obtusata
Ramalina sinensis
Rinodina sp.
Stereocaulon tomentosum
Tuckermannopsis americana
Tuckermannopsis sp.
Umbilicaria americana
Usnea cavernosa
Usnea filipendula
Usnea lapponica
Usnea scabrata
Usnea sp.
Usnea substerilis
Vulpicida pinastri
Xanthomendoza fallax
Xanthoparmelia wyomingica
Xanthoria candelaria

Appendix 3: Species Accounts for Rare Plant Taxa Found During Preconstruction Surveys

Atriplex gardneri var. gardneri (Gardner's sagebrush)

Gardner's sagebrush (Figure 4), a small perennial sub-shrub with a woody base, is a member of the Chenopodiaceae (goosefoot family). Variety *gardneri* is found on fine-textured saline soils and dry grassy slopes in the Great Plains and Intermountain regions of central North America (Douglas et al. 1998; Welsh 2003). In B.C., Gardner's sagebrush is known only from the Peace River region (BCCDC 2019). Variety *gardneri* can be found as far east in Canada as southern Manitoba, and as far south as Utah and Colorado in the United States (Welsh 2003; NatureServe 2019).

Gardner's sagebrush has a rank of S2 (Imperilled) in B.C. and is on the province's Red list (BCCDC 2019). The taxon has a global classification of G5TNR (*Atriplex gardneri* as a species is ranked globally Secure, but variety *gardneri* has not yet been given a global rank). Five other sub-national jurisdictions provide a rank for Gardner's sagebrush: Saskatchewan, Montana, and Wyoming class the species as S5 (Secure), and Utah and Nebraska class the species as S1 (Critically Imperilled) (NatureServe 2019).

Figure 4: *Atriplex gardneri* var. *gardneri* (Gardner's sagebrush)

No new occurrences of Gardner's sagebrush were found in the study area in 2019.

There are currently four reported occurrences of Gardner's sagebrush in the RAA. The most-recently discovered of these consists of an estimated 150 individuals in an area of 618 square metres, along and above a road cut east of Wilder Creek. In addition, there are three older records from 60 kilometres east near the Alberta border. No information on number of individuals or areal coverage is available for these three sites. All four of the Gardner's sagebrush occurrences are situated on open, dry, south-facing

grassland slopes. The dominant associated species include native grasses such as wildrye (*Elymus* spp.), junegrass (*Koeleria macrantha*), and green needlegrass (*Nassella viridula*), and native forbs such as prairie sagewort (*Artemisia frigida*) and aster (*Symphyotrichum* spp.).

Carex sprengelii (Sprengel's sedge)

Sprengel's sedge (Figure 6) is a perennial herb belonging to the Cyperaceae (sedge family); plants have tall stems with fibrous bases and bear achenes in drooping heads. The species forms loose clumps in a variety of dry to wet habitats, including openings, slopes, and alluvial woodlands, often on calcareous substrates (Douglas et al. 1998; Ball & Reznicek 2002). Sprengel's sedge was only known from three locations in B.C. prior to the Site C rare plant survey work: two near Williams Lake, and one in the Peace River region (BCCDC 2019). The taxon ranges across North America as far east as New Brunswick, and as far south as Colorado, Missouri, and New Jersey. It is also reported from Alaska (Ball & Reznicek 2002; NatureServe 2019).

Figure 6: *Carex sprengelii* (Sprengel's sedge)

Sprengel's sedge has a rank of S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2019). Globally, the taxon is classed G5 (Secure). Across much of North America the taxon is classed as Secure (S5) or Apparently Secure (S4), but is considered rare on the western, southern, and eastern edges of its range: S3 (Vulnerable) in Québec, Pennsylvania, Illinois, Montana and Wyoming; S2 (Imperilled) in New Brunswick, Maine, Ohio, Missouri, and Colorado; S1 (Critically Imperilled) in Alaska, and SH (Possibly Extirpated) in Delaware (NatureServe 2019).

No new sites of Sprengel's sedge were found in the study area in 2019. However, one occurrence first reported in 2015 east of Bear Flat was resurveyed and a few new plants were counted, increasing the number from two to six.

In total, there are five reported occurrences (comprising seven patches) of Sprengel's sedge in the RAA. Three of these occurrences (four patches)—found during survey work for the Site C project—are situated between Bear Flat and Wilder Creek, on south-facing shrubby slopes above the Peace River. An estimated 33 plants have been observed growing in a total approximate area of 14 square metres. All of these sites are moist to mesic, and the Sprengel's sedge plants are generally found in relatively shaded microhabitats. Associated species are similar, including prairie saskatoon (*Amelanchier alnifolia*), prickly rose (*Rosa acicularis*), chokecherry (*Prunus virginiana*), aspen (*Populus tremuloides*), and native and weedy herbs such as smooth brome (*Bromus inermis*), northern bedstraw (*Galium boreale*), and American vetch (*Vicia americana*).

The remaining two sites of Sprengel's sedge in the RAA are derived from CDC records which lack certain population data. An occurrence of 20 plants in two patches was discovered between a hay field and a shrubby south-facing escarpment above the Pine River in 2016; areal extent, associated species, and other details of this EO were not documented. Additionally, a fifth occurrence of Sprengel's sedge, first observed in 2010, is reported from over 80 kilometres southwest, in moist balsam poplar (*Populus balsamifera*) woods north of the Moberly River. No clear information is available on the number of individuals or areal coverage (BCCDC 2019).

Carex torreyi (Torrey's sedge)

Torrey's sedge (Figure 7) is a soft-hairy perennial in the Cyperaceae (sedge family) found growing in montane meadows, shrublands, and moist woods (Douglas et al. 1998; Ball & Reznicek 2002). In B.C. the species is found only in the Peace River region (BCCDC 2019). Globally, Torrey's sedge is distributed east across Canada to Ontario, and south in the U.S. as far as Colorado, South Dakota, Minnesota, and Wisconsin (NatureServe 2019).

Torrey's sedge is ranked S3? (Vulnerable?) in B.C. and is on the province's Blue list (BCCDC 2019). The species is ranked G4G5 (Apparently Secure or Secure) globally. Sub-national ranks vary—Torrey's sedge is classed as S4 (Apparently Secure) in Alberta and Saskatchewan, S3 (Vulnerable) in Manitoba and Montana, S2 (Imperilled) in Ontario and Wyoming, and S1 (Critically Imperilled) in Colorado and Wisconsin (NatureServe 2019).

Figure 7: *Carex torreyi* (Torrey's sedge)

Three new occurrences of Torrey's sedge were discovered in the study area in 2019. The largest of these is situated on a slope above Fish Creek, approximately four kilometres northeast of Fort St. John. Here, an estimated 150 Torrey's sedge plants were found in two patches totalling approximately 77 square metres. A smaller occurrence was also observed some five kilometres north of Fort St. John on a slope above Montney Creek; roughly 25 plants were recorded in an area of about 20 square metres. The third new occurrence of Torry's sedge consists of one plant discovered approximately 50 kilometres to the southeast, on a slope above the Peace River near the Alberta border.

There are currently a total of eleven reported occurrences (comprising 17 patches) of Torrey's sedge in the RAA. An estimated 535 plants have been observed growing in a total area of approximately 425 square metres. Ten of the occurrences are situated north of the Peace River; the eleventh occurrence (not reconfirmed since the 1960 report) is located more than 45 kilometres south, near Dawson Creek, B.C. All of the occurrences were found on mesic to xeric south-facing slopes in open shrub grassland complexes. Associated species are similar at the sites and include native shrubs such as prickly rose, prairie saskatoon, and snowberry (*Symphoricarpos* spp.); native and non-native graminoids such as smooth brome, bluegrasses (*Poa* spp.), and sedges (*Carex* spp.); and a diverse mix of native and weedy forbs.

Carex xerantica (dry-land sedge)

Dry-land sedge (Figure 8), a perennial herb with silvery-gold heads of the Cyperaceae (sedge family), is found in xeric steppe and montane habitats such as dry grasslands and hillsides, open forests, and rock outcrops (Douglas et al. 1998; Ball & Reznicek 2002). Dry-land sedge has been collected in the Peace River area in B.C., as well as scattered locations in the central interior and central Rocky Mountains (BCCDC 2019; Klinkenberg 2019). There is some disagreement on the taxon's global range. Douglas et al. (1998) note that dry-land sedge extends east from B.C. to Manitoba, and south to Minnesota and Nebraska; Ball & Reznicek (2002) show the species occurring as far east as Ontario and also in Wyoming; and Natureserve (2019) reports the sedge from as far north as Yukon and Alaska, and as far south as Arizona and New Mexico.

Figure 8: *Carex xerantica* (dry-land sedge)

Dry-land sedge is classed as S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2019). Although globally the taxon is considered Secure (G5), most jurisdictions that provide a rank for the species indicate some degree of rarity: S1 (Critically Imperilled) in Alaska, Yukon and Wyoming; S2 (Imperilled) in Manitoba, Ontario, Nebraska, and New Mexico; and S3 (Vulnerable) in Minnesota. Alberta and Saskatchewan rank the species S4 (Apparently Secure) (NatureServe 2019).

Two new occurrences of dry-land sedge were documented in the study area in 2019. The first comprised four plants in three patches on a slope above Montney Creek, approximately five kilometres north of Fort St. John. The second new occurrence, found on a slope above the Peace river near the Alberta

border, contained an estimated 150 dry-land sedge plants in an area of about 127 square metres. In both cases, the plants were growing in grassland openings within a shrubby woodland mosaic.

For the entire RAA, there are currently 15 reported occurrences of dry-land sedge (comprising 33 patches). An estimated 8,890 plants have been observed growing in an approximate total area of 12.6 ha. Thirteen of the occurrences were found on south-facing slopes north of the Peace River, and one on a bench above the south bank of the Peace. Dry-land sedge has also been collected on a slope above the Pouce Coupe River, over 25 kilometres to the south. The dry-land sedge sites are invariably located in xeric grassland habitat, generally in the vicinity of low shrub thickets. The dominant associated species include native shrubs such as prairie saskatoon, prickly rose, and snowberry; native sedges; and native grasses such as needlegrasses (*Achnatherum* spp. and *Nassella viridula*), needle-and-thread grass (*Hesperostipa comata*), and short-awned porcupinegrass (*Hesperostipa curtiseta*). A diverse mix of native and non-native forbs are also present at dry-land sedge occurrences.

Oxytropis campestris var. davisii (Davis' locoweed)

Davis' locoweed (Figure 10) is a small perennial in the Fabaceae (pea family) that grows on stream gravels and in mesic to dry meadows and forest openings in the montane zone (Elisens & Packer 1980; Welsh 1991; Douglas et al. 1998). Variety *davisii* is found in northeast B.C. where it can be locally abundant, and is also reported from Alberta (Welsh 1991; BCCDC 2019; NatureServe 2019). Davis' locoweed is classed S3? (Vulnerable?) by the BCCDC, and is on the provincial Blue list (BCCDC 2019). Globally, the variety is also ranked as Vulnerable (T3), due to its limited range. Alberta lists Davis' locoweed as S2? (Imperilled?), and the Northwest Territories has not yet ranked the taxon (NatureServe 2019).

Five new occurrences (comprising six patches) of Davis' locoweed were documented in the study area in 2019. All five were discovered on islands or shoreline along the Peace River between Taylor, B.C. and the Beatton River. An estimated 1,000 individuals were found in an approximate total area of three hectares. The Davis' locoweed plants were growing on open cobble floodplains with young balsam poplar saplings and scattered native and weedy herbs.

For the entire RAA, there are currently 20 reported occurrences of Davis' locoweed (comprising 23 patches). An estimated 66,000 plants have been recorded in an approximate total area of 13.3 hectares. Sixteen of the occurrences have been documented from along the Peace River, and many of these sites contain hundreds or thousands of individuals and cover relatively large areas of ground. Three occurrences have been observed along the Halfway River, and there is one historical record of Davis' locoweed on the Pine River, over 50 kilometres to the south (not reconfirmed since the 1954 report).

All Peace and Halfway River occurrences have been mapped within 400 metres of current river shorelines, on non-active cobble bars, floodplains or river benches which have begun to revegetate. Habitat at all the sites is similar, consisting of open, often bare cobble-silt substrates and young to medium-aged balsam poplar. Other associated species include a relatively sparse cover of native and

weedy herbs such as yellow mountain-avens (*Dryas drummondii*), sweet-clover (*Melilotus* spp.), quackgrass and slender wheatgrass (*Elymus* spp.).

Figure 10: *Oxytropis campestris* var. *davisii* (Davis' locoweed)

Penstemon gracilis (slender penstemon)

Slender penstemon (Figure 11) is a perennial herb of the Plantaginaceae (plantain family)—formerly of the Scrophulariaceae (figwort family)—that inhabits mesic to dry plains and grasslands (Hitchcock et al. 1959; Douglas et al. 1998; Freeman & Rabeler 2016). The species is commonly found throughout much of the Great Plains and Midwestern regions of Canada and the U.S., but in B.C. is restricted to the Peace River area (Hitchcock et al. 1959; BCCDC 2019; NatureServe 2019).

Slender penstemon is ranked S3 (Vulnerable) in B.C., and is on the province's Blue list (BCCDC 2019). The species' global status is G5 (Secure) (NatureServe 2019). Of the remaining 17 jurisdictions where it is known to occur, only four rank slender penstemon with any degree of rarity—Manitoba and Wyoming as S3 (Vulnerable), and Iowa and Michigan as S1 (Critically Imperilled) (NatureServe 2019).

Two new sites of slender penstemon were discovered in the study area in 2019. A small occurrence was recorded on a south-facing slope above Highway 29 east of Cache Creek, in a steep grassland opening within upland woodland. Here, a patch of 15 slender penstemon plants were found growing in an area of approximately 223 square meters. Associated species included low native shrubs such as prairie saskatoon and common snowberry (*Symphoricarpos albus*), and a variety of native herbs including junegrass, sedges, anemones (*Anemone* spp.) and wild bergamot (*Monarda fistulosa*). The second new

site was determined to be an extension of an occurrence first reported in 2005, east of Bear Flat. One small patch of slender penstemon was observed on a dry grassland slope above an old road track. The surrounding somewhat degraded plant community is composed of native shrubs and a mix of native and non-native herbs.

In total, there are currently 26 reported occurrences of slender penstemon in the RAA (comprising 50 patches). An estimated 3,900 plants have been documented in an approximate total area of 4.2 hectares. All of the occurrences were found on south-facing slopes and invariably located in xeric grassland habitat, generally in the vicinity of low shrub thickets. Dominant associated species include the native shrub prairie saskatoon, native graminoids such as junegrass and wildryes, and a diverse mix of native and non-native forbs.

Figure 11: *Penstemon gracilis* (slender penstemon)

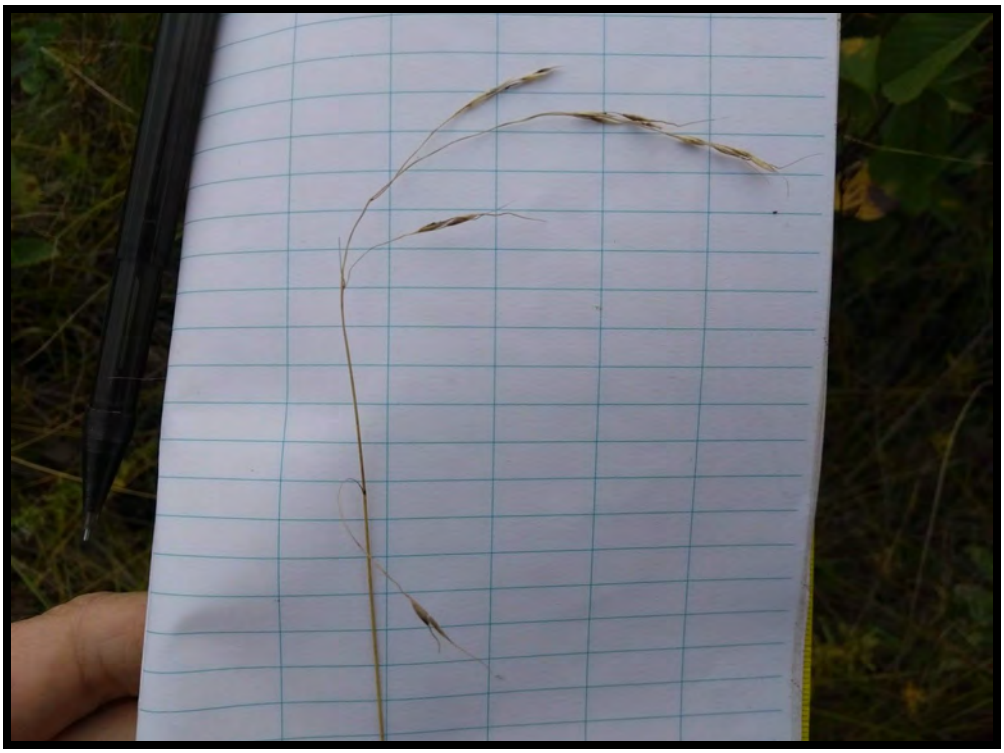
Piptatheropsis canadensis (Canada ricegrass)

Canada ricegrass (Figure 14) is a delicate perennial bunchgrass of the Poaceae (grass family). The species grows in grasslands and open woods on dry to moist, sparsely-vegetated soils which are usually sandy or rocky. Canada ricegrass ranges from Alberta east across Canada to Newfoundland, and south into the U.S. Northeast and Great Lakes regions (Lapin 2004; Barkworth 2007). Prior to 2018, no verified extant occurrences of Canada ricegrass were known from B.C. (BCCDC 2019). Of note: the genus *Piptatheropsis* was only recently described (Romaschenko et al. 2011), therefore Canada ricegrass is still referred to by

the name *Piptatherum canadense* in some important literature (Lapin 2004; Barkworth 2007; NatureServe 2019).

Canada ricegrass is ranked S1 (Critically Imperilled) in B.C., and is on the province's Red list (BCCDC 2019). The taxon's global classification is G4G5 (Apparently Secure or Secure) (NatureServe 2019). However, although Canada ricegrass is widely distributed across North America, the species has few reported occurrences and most of these are small (frequently less than 100 individuals at a site) (Lapin 2004). Accordingly, Canada ricegrass is generally classed as rare sub-nationally: SH (Possibly Extirpated) in Prince Edward Island; S1 (Critically Imperilled) in Manitoba, Wisconsin, West Virginia, and New Hampshire; S2 (Imperilled) in Alberta, Saskatchewan, New Brunswick, Nova Scotia, Newfoundland, Minnesota, Michigan, New York, and Maine; and S4 (Apparently Secure) in Ontario and Québec (NatureServe 2019).

Figure 14: *Piptatheropsis canadensis* (Canada ricegrass)



No new occurrences of Canada ricegrass were found in the study area in 2019. There is only one verified record of the taxon in B.C., which is in the RAA west of Wilder Creek between a road track and a plowed field. Eight plants were recorded scattered over an estimated area of 41 square metres in a small segment of remnant shrub-grassland. Dominant associated species included the native shrubs prairie saskatoon and soopolallie (*Shepherdia canadensis*), and native and non-native grasses such as spreading needlegrass (*Achnatherum richardsonii*), false melic (*Schizachne purpurascens*), and Kentucky bluegrass.

Ranunculus rhomboideus (prairie buttercup)

Prairie buttercup (Figure 17) is a soft-hairy perennial of the Ranunculaceae (buttercup family). The species grows in grasslands, prairies, open woods and thickets across north-central North America (Whittemore & Parfitt 1997; Douglas et al. 1998). In B.C., prairie buttercup is only known from the Peace River region (BCCDC 2019). The taxon's current range extends north to Northwest Territories and southeast through the Canadian prairie provinces and the northern U.S. Great Plains into southern Ontario (Whittemore & Parfitt 1997; NatureServe 2019).

Prairie buttercup has a ranking of S2S3 (Imperilled and Vulnerable) in B.C., and is on the provence's Blue list (BCCDC 2019). Globally, the taxon is ranked G5 (Secure). Only sporadic sub-national ranks are provided for prairie buttercup: Alberta, Saskatchewan, Manitoba, and Ontario class the species as S4 (Apparently Secure); Iowa as S3 (Vulnerable); Illinois and Michigan as S2 (Imperilled); Nebraska as S1 (Critically Imperilled); and Québec as SX (Presumed Extirpated) (NatureServe 2019).

Figure 17: Ranunculus rhomboideus (prairie buttercup)

Four new sites of prairie buttercup were documented in the study area in 2019. A new occurrence, of just one flowering plant, was discovered in a swale on a south-facing slope above Fish Creek, approximately four kilometres northeast of Fort St. John. Associated species included prickly rose and smooth brome. A second new occurrence was recorded to the west of Wilder Creek, along an old road track next to a cultivated field. Here, three prairie buttercup plants in early fruit were observed in an

approximate area of five square metres, growing in disturbed shrub-grassland with prairie saskatoon, smooth brome, and other native and non-native herbs.

The remaining new sites were determined to be extensions to occurrences first reported in 2017. In a grassland opening north of Fort St. John, a patch of five vigorous prairie buttercup plants were discovered scattered along a small trail on a slope above Montney Creek, about half a kilometre west of the previously-recorded occurrence. The plant community at the site consists of low shrubs such as prairie saskatoon and prickly rose, and a variety of herbs including northern bedstraw and woolly yarrow (*Achillea borealis*). The second occurrence extension was located at Watson Slough, where a new patch of two blooming prairie buttercup plants was found on a small trail to the east of the main patch. Associated species include prickly rose, smooth brome, and a variety of native and non-native herbs.

In the entire RAA, there are currently eleven reported occurrences of prairie buttercup (comprising thirteen patches). Eight of the occurrences—discovered during the Site C rare plant survey work—contain an estimated 202 plants in an approximate total area of 357 square metres. The remaining three occurrences are historical records not recently verified and with no information available on number of individuals or area. The habitat for prairie buttercup is somewhat variable: soils can range from moist to dry, shrub cover can be dense to sparse, and occurrence microsite can be flat to sloped. Dominant associated species include a wide variety of native forbs such as northern bedstraw and American vetch as well as native and weedy grasses. Native shrub species are also present, the most commonly reported being rose (*Rosa* spp.) and prairie saskatoon.

Selaginella rupestris (rock selaginella)

Rock selaginella (Figure 18) is a small, mat-forming evergreen perennial in the Selaginellaceae (spike-moss family). The taxon is found in a variety of open, dry, rocky or gravelly habitats in eastern and central North America (Valdespino 1993; Douglas et al. 1998). In B.C., rock selaginella is known only from the Peace River region (BCCDC 2019; Klinkenberg 2019). The taxon ranges east across Canada to Nova Scotia and southeast in the U.S. to southern Georgia (Valdespino 1993; NatureServe 2019).

Rock selaginella is ranked S2 (Imperilled) in B.C., and is on the Red list for the province (BCCDC 2019). The taxon is classed as G5 (Secure) globally, but sub-national rankings vary. Of the jurisdictions providing a rank, rock selaginella is listed as S5 (Secure) in Ontario, Arkansas, Georgia, and Virginia; as S4 (Apparently Secure) in Saskatchewan, Manitoba, Québec, and New York; as S3 (Vulnerable) in Alberta, Illinois, North Carolina, West Virginia, Vermont, and Massachusetts; as S2 (Imperilled) in Iowa, Indiana, Alabama, and New Jersey; as S1 (Critically Imperilled) in New Brunswick, Nova Scotia, Ohio, Wyoming, and North Dakota; and SX (Presumed Extirpated) in Delaware (NatureServe 2019).

Figure 18: *Selaginella rupestris* (rock selaginella)

Two new sites of rock selaginella were discovered in the study area in 2019. Two patches were observed along a steep grassland opening between Highway 29 and the Peace River, about midway between Farrell Creek and the Halfway River. Each patch was approximately 25 square metres in area and contained hundreds of clumps. These sites were determined to be extensions to a large occurrence reported in 2018, which is located to the southwest across the highway. Associated species included low shrubs such as prairie saskatoon and kinnikinnick (*Arctostaphylos uva-ursi*), and native and non-native herbs including prairie sagewort, junegrass, and smooth brome.

In addition, one previously-reported occurrence from 2012 was resurveyed in 2019, and both the areal coverage and the estimated number of rock selaginella plants were substantially increased. This occurrence is situated on a very steep grassland opening west of Hudson's Hope, B.C. Here, an estimated 1,000 to 2,500 clumps are growing in an approximate area of 4,700 square metres. Associated species consist of a diverse assemblage of native shrubs and herbs.

In total, there are currently five reported occurrences of rock selaginella in the RAA (comprising eight patches). An estimated 4,200 individuals have been recorded in an approximate area of 7,255 square metres. All of the occurrences are in open shrub-grassland habitat on south-facing dry hillsides. Associated species include native shrubs such as kinnikinnick and prairie saskatoon; native and non-native graminoids including junegrass, short-awned porcupinegrass, smooth brome, and various dryland sedge species; and native forbs such as prairie sagewort, northern wormwood (*Artemisia campestris*), and bastard toad-flax (*Comandra umbellata*).

Appendix 8. Downstream Western Toad and Gartersnake Monitoring Program – 2019

Site C Vegetation and Wildlife, Downstream Western Toad and Gartersnake Monitoring Program – 2019

Prepared for:

BC Hydro
Site C Clean Energy Project
1055 Dunsmuir Street
PO Box 49260, BC V7X 1V5

Project No. 989619-09

January 29, 2020

Prepared by:

Hemmera Envirochem Inc.
18th Floor, 4730 Kingsway
Burnaby, BC V5H 0C6
T: 604.669.0424
F: 604.669.0430
hemmera.com

EXECUTIVE SUMMARY

Surveys for western toad (*Anaxyrus boreas*), common gartersnake (*Thamnophis sirtalis*), and terrestrial gartersnake (*Thamnophis elegans*) were conducted downstream of the Site C Clean Energy Project in 2019, as part of an on-going study initiated in 2018. The study was designed to assess Project-related changes in suitable habitat and the distribution and relative abundance of western toad and gartersnake. Area of suitable habitat was previously assessed in 2018 (pre-operations) and will be reassessed during operations in 2030 and 2035. Surveys for presence and relative abundance are being conducted using a before-after, control-impact (BACI) study design framework and targeting all available suitable habitat within the area of potential impact.

Transect surveys of western toad in 2019 were conducted at six sites in the impact study area and 11 in the control study area. A relatively dry spring in 2019 resulted in 66% of sites in the impact study area and 55% of sites in the control study area containing water during the month of May. All statistics excluded dry sites. Western toads occupied 100% of sites in the impact study area and 83% of sites in the control study area. The average relative abundance of western toad eggs in the in the impact study was 1,750 eggs per survey, and in the control was 4,167 eggs per survey. The average relative abundance of tadpoles was estimated to be 2,500,001 tadpoles per survey in the impact study area, and 1,753,334 tadpoles per survey in the control area. The average relative abundance of juvenile toads in the impact study area was 32.9 toads per survey, and in the control was 14.0 toads per survey. Lastly, the relative abundance of adult western toads in the impact study area was 0.4 toads per survey, and in the control was 0.2 toads per survey.

Artificial covered object (ACO) surveys of gartersnakes in 2019 were conducted at seven sites in the impact study area, comprised of 69 ACOs, and nine sites in the control study area, with 104 ACOs. Gartersnakes were observed at 14% of survey sites in the impact study area and 22% of survey sites in the control study area. A total of four gartersnakes were observed over three survey periods; three incidentally and one under an ACO. The relative abundance of gartersnakes in the impact study area was 0.014 snakes per ACO. No snakes were seen under ACOs in the control study area.

Recommendations for the gartersnake monitoring program in 2020 are to move ACOs in forested habitat to more open areas and to place woody debris under all coverboards to create more space and airflow. Additionally, to increase the probability of encountering a gartersnake, transect surveys throughout habitat that appears to be high quality will occur within each survey area.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

This report describes the results of the Downstream Western Toad and Gartersnake Monitoring Program in 2019. This program is being conducted to evaluate whether there will be a change in the distribution and relative abundance of western toads and gartersnakes downstream of the dam site in areas where surface water hydrology will be most affected by the Site C Clean Energy Project (the Project).

2.0 METHODS

The program is based on a BACI (before-after-control-impact) study design where monitoring is to be conducted in the control and treatment (i.e., impact) areas during the pre-operations (2018 thru 2020) and operations periods (2025 to 2034). Sample sites in suitable habitat within the impact study area (i.e., from the Project downstream to the Pine River) and the control study area (i.e., from the Pine River downstream to the Beatton River) were established in 2018 for monitoring of western toads and gartersnakes as per the workplan (BC Hydro 2018).

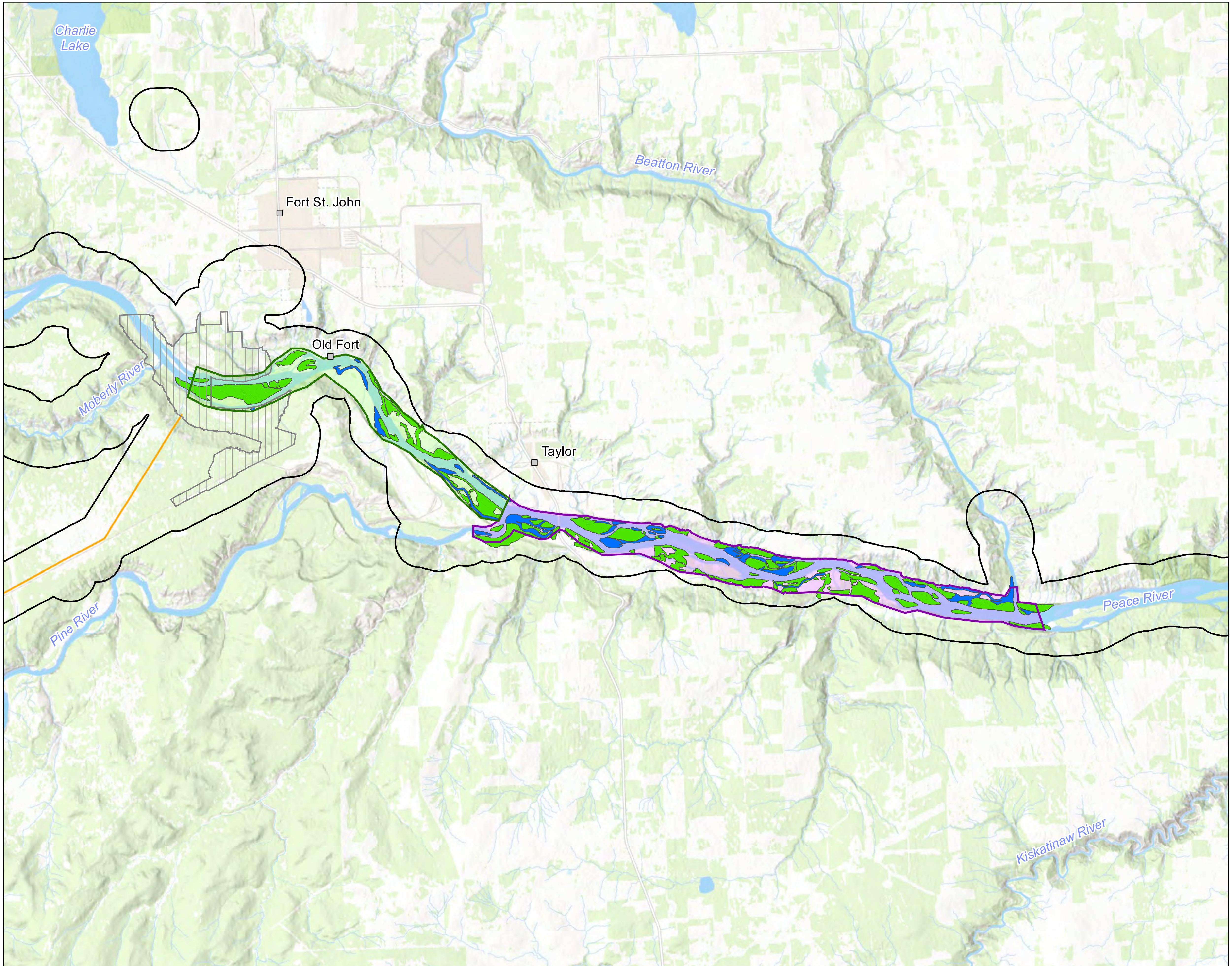
In accordance with best management practices (BC MWLAP 2004), all surveys incorporated standard hygiene protocols (BC MoE 2017) to minimize the potential for spreading amphibian and other aquatic diseases as well as non-native plants and animals.

2.1 Study Area

The study area includes wetlands adjacent to the Peace River from the Site C dam to the Beatton River (**Figure 2-1**). The wetlands between the Site C dam and the Pine River confluence represent the impact study area and the wetlands adjacent to the Peace River downstream of the Pine River to the Beatton River represent the control study area.

Downstream Western Toad and Gartersnake Monitoring 2019
Site C, Peace River, BC

Western Toad and Gartersnake Study Area and Habitat Availability



Legend

- Site C Local Assessment Area (LAA)
- Proposed Dam Site
- Transmission Line Right-of-Way

Study Zones

- Pine River east to Beatton River
- West of Pine River

Habitat Type (TEM)

- Wetland
- Wet Forest

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

1:150,000

0 2 4 6 8 10

Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-09	Production Date: Jan 28, 2020	Figure 2-1

Hemmera An Ausenco Company   BC hydro

Path: S:\Geomatics\Projects\989619\09_ganake_wtoad\mxd\Fig2-1_989619_09_WT_GS_StudyArea_Habitat_200128.mxd

2.2 Habitat Suitability Assessment

In 2018, using Terrestrial Ecosystem Maps (TEM) of the study area provided by BC Hydro and iMap imagery, suitable wetlands were mapped within the bounds of the study area (see **Appendix A** for habitat details). The area of each habitat type was calculated prior to the field habitat assessment (**Table 2-1**). Each wetland area was visited to verify the classification, and to assess the habitat suitability and its extent. Sites were selected based on habitat suitability for each of the target species (**Table 2-1**). During field surveys in 2018, few suitable sites were identified based on accessibility and habitat, and the study became a census of all suitable habitat in both the impact and control areas. The total area of suitable habitat will be reassessed in 2030 and 2035 and analyzed for change as per the workplan (BC Hydro 2018). Surveys were focussed in suitable western toad breeding habitat and gartersnake foraging habitat.

Table 2-1 Wetland habitat based on TEM data in the downstream impact and control study area

Habitat Type (TEM Map Code)	Impact Area (ha): Dam Site to Pine River	Impact Area (ha): Accessible	Control Area (ha): Pine River to Beatton River	Control Area (ha) Accessible
Shallow open water	7.9	7.3	19.3	15.9
Willow sedge	7.2	6.4	0.7	0.2
Sedge	1.2	-	0.0	2.4
Vegetated floodplain	466.0	-	923.8	-
Non-forested floodplain wetlands	60.8	3.7	248.3	4.0
Total	**543.1**	**17.4**	**1,192.0**	**22.5**

Note: " - " indicates not accessible or used

During the breeding season (i.e. early-May to early-June), western toads congregate in shallow water zones or vegetated habitat in proximity to wetland edges. After breeding is complete, they disperse widely to foraging and over-wintering habitats. Suitable habitat for breeding western toad was considered to be small ponds in shallow open water, willow sedge, and sedge habitats (**Figure 2-1**).

Gartersnake habitat selection was related to the location of its dominant prey species of amphibians and earthworms, and to a lesser degree, freshwater fish and leeches (Matsuda et al. 2006). Their suitable foraging habitat was considered to be shallow open water, willow sedge, sedge habitats, vegetated floodplain, and non-forested floodplain wetland (**Figure 2-1**). Foraging occurs near gartersnake hibernation sites, the locations of which can vary annually.

2.3 Western Toad Distribution and Relative Abundance

2.3.1 Systematic Visual Searches

Survey methods followed the protocol for systematic visual searches described in Inventory Methods for Pond-Breeding Amphibians and Painted Turtle (RIC 1998a), and were conducted by qualified biologists with experience in amphibian surveys. Adjacent transects, approximately 10 m apart, at three different depths/habitats were conducted in suitable habitat (as described in **Section 2.2**) for western toad. The three habitats were waist deep water, ankle to knee deep water, and terrestrial shoreline. Transects were 100 m in length and were linear unless the wetland was less than 100 m long, in which case transects

were curvilinear following the riparian edge (**Figure 2-2**). The three 100 m long transects per sampling site are a standardized sampling unit. All amphibian species development stage (i.e., eggs, tadpole, juvenile, adult), and species abundance (i.e., numbers observed during sampling) were recorded at each site. Abundance was estimated either by direct count or extrapolation (i.e. count the number of eggs in 10 cm of egg mass and extrapolate to the estimated length of the egg mass). Sites were visited up to three times in May, as recommended after the first year of surveys (Hemmera 2019), when adults are congregating and eggs are being laid (Kinsey 2009).

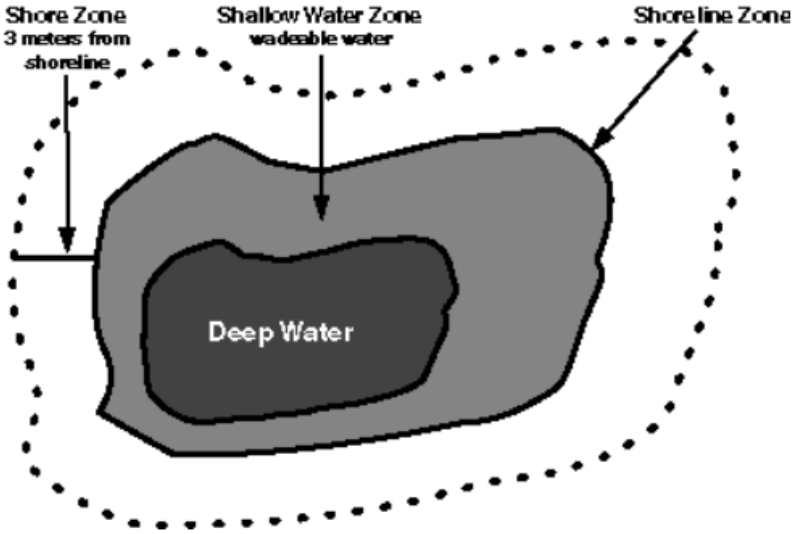


Figure 2-2 Water depth for western toad standardized transects. Adapted from RIC1998a

2.3.2 Environmental DNA

Per the workplan (BC Hydro 2018) environmental DNA (eDNA) was used in 2018 to determine the presence / not detected status for western toads at suitable sites where no toads were observed during visual encounter surveys or where there was low density. This method was not used in 2019 because the one pond (OW8) which had no observed western toads was dry during the last round of surveys, which is when eDNA samples would have been taken.

2.4 Gartersnake Distribution and Abundance

2.4.1 Artificial Cover Objects

Surveys for gartersnakes were conducted using Artificial Cover Objects (ACO), following methods by Halliday and Blouin-Demers (2015) and Joppa et al. (2009). Gartersnakes spend most of their time hidden under logs, rocks, and dead vegetation (Matsuda et al. 2006). ACOs were deployed at pre-determined sampling sites deemed suitable for gartersnake foraging in 2018 to allow sufficient time for gartersnakes to find and become accustomed to the ACOs prior to 2019 surveys (Grant et al. 1992, Joppa et al. 2009, Eekhout 2010). ACOs were placed at intervals along a meandering transect adjacent to foraging habitat. The number of ACOs placed at a site was determined by the size of the suitable habitat. ACOs were placed using the following guidelines: three adjacent to wetlands <0.1 ha, six at wetlands between 0.1 and 1.0 ha, and from ten to twenty at wetlands >1.0 ha. ACOs were also placed at a reference site, known by local residents to have snake presence.

In the Downstream Western Toad and Gartersnake Monitoring Program plan, gartersnake surveys were to be conducted during two periods: late-May (corresponding with western toad surveys), and early September, to provide a sample of early and late season habitat use. Three ACO checks per survey period were planned for presence / not detected analysis. The time needed to complete a survey was longer than expected due to challenges in finding ACOs from overgrown vegetation. To accommodate the unexpected long survey time and fulfill other field schedules, surveys were instead conducted during three periods: mid-June, mid-July, and mid-August. Surveys were completed over two days and were split to morning and evening shifts, by surveying control sites in the morning and impact sites in the evening, and vice versa on the second day. This was done to avoid the hottest time of the day when snakes are least likely to be under an ACO (Joppa 2009).

Surveys consisted of lifting the ACOs and counting and classifying any gartersnakes present by size and species. ACOs were checked in the mornings and evenings, the cooler time of day, because they provide refuge that is warmer than the surrounding environment, resulting in a higher likelihood of use/detection (Joppa 2009). ACOs were not checked during precipitation events. Atmospheric temperature and precipitation observations were collected at every station on every survey day to verify that surveys were conducted under appropriate weather conditions (see **Section 4.2**).

2.5 Environmental Monitoring

Suitable habitat for western toad and gartersnake share similar characteristics, so during western toad surveys environmental factors that may affect distribution and abundance of both target species were collected. During each site visit for western toad monitoring, field crews collected wetland characteristic information, such as water depth from a fixed location, and water quality (i.e., water temperature, air temperature, pH, dissolved oxygen, and conductivity) using an Oakton PCSTestr 35, to understand intra-seasonal changes that might be affecting presence or relative abundance. Turbidity estimates were recorded using a LaMotte 2020we turbidity meter.

2.6 Data Analysis

Western toad and gartersnake observations from all surveys were collected via electronic (iPad) forms and compiled in a database. Data were reviewed to check for anomalous records (i.e., quality control), and questionable species identification or count data were queried with field staff.

The total number of western toads per life stage detected by each survey method was recorded for each of the three survey periods. Totals are presented in terms of relative abundance, which represents the number of western toads detected. In contrast, true abundance would require either a complete census or an estimate of the individuals not detected during surveys to provide a total count of all toads that were present. To control for variation in abundance due to the size of a suitable habitat, data are summarized in terms of abundance per survey unit as per RISC standards (RIC 1998b).

Until multiple years of data are available, and while awaiting the collection of before and after treatment data, simple statistical analyses will be presented.

Analysis will, in future years, follow a single site BACI design to assess the project-related changes while accounting for background variation. The BACI effect is the differential change in the study area means that occur between the before and after periods (Swartz 2015). A general linear model will be used to determine if the number of western toad and gartersnake detections in the treatment area differ significantly between the pre-construction and operations periods relative to the same periods at the control site:

$$Abundance = Treatment\ (control|impact) + Period(before|after) + Treatment * Period + Site + Year + env\ variables$$

Random effects parameters will include Site, Year, and other relevant environmental variables, such as temperature and precipitation as measured at BC Hydro meteorological station 11 (Taylor or 7B (North Camp) to evaluate the influence of weather conditions may be affecting observations. The interaction term "*Treatment * Period*" is the BACI effect, the non-parallel response where magnitude of change between treatment areas and time is estimated. Using an analysis of variance (ANOVA), the model will determine the level of significance (p-value) of the interaction of Treatment and Period. The BACI contrast estimates the magnitude of differences using least square means. This will indicate the magnitude and direction of the differences. Additionally, variation can be estimated within sites (sub-samples), between sites within a treatment, between treatments, and between periods.

3.0 RESULTS

Downstream Western Toad and Gartersnake Monitoring Program plan included sampling at 30 sites in the impact area and 30 sites in the control area for both western toads and gartersnakes to achieve sufficient statistical power. However, field assessments in 2018 found that access to and availability of suitable and discrete wetland habitat (**Table 2-1**) limited the application of that study design. In 2019, sites available for survey were further reduced due to construction activities to prevent fish stranding in ephemeral ponds, such that only six sites in the impact study area and 11 sites in the control study area were available for western toad surveys. Due to annual variation in precipitation only four sites in the impact area and six in the control area had water and were surveyed **(Table 3-1, Figure 3-1**).

Table 3-1 Summary of 2019 western toad survey locations

Study Area	Site
IMPACT	OW1
	OW4a
	OW11
	OW14
	OW4
	WS1
CONTROL	OW6
	OW7
	OW7a
	OW12
	OW15
	OW8
	OW5
	OW7b
	OW13a
	OW13b
	WS2

Note: Grey rows indicate site with no water.

For gartersnake surveys, eight sites in the impact study area and nine sites in the control study area were surveyed in 2019 (excluding PRP and WH6, see below) with 69 and 104 ACOs, respectively (**Table 3-2**, **Figure 3-1**). Additional sites were not available because of private property access limitations or construction activities.

Table 3-2 ACO survey locations for gartersnake monitoring 2018 to 2019

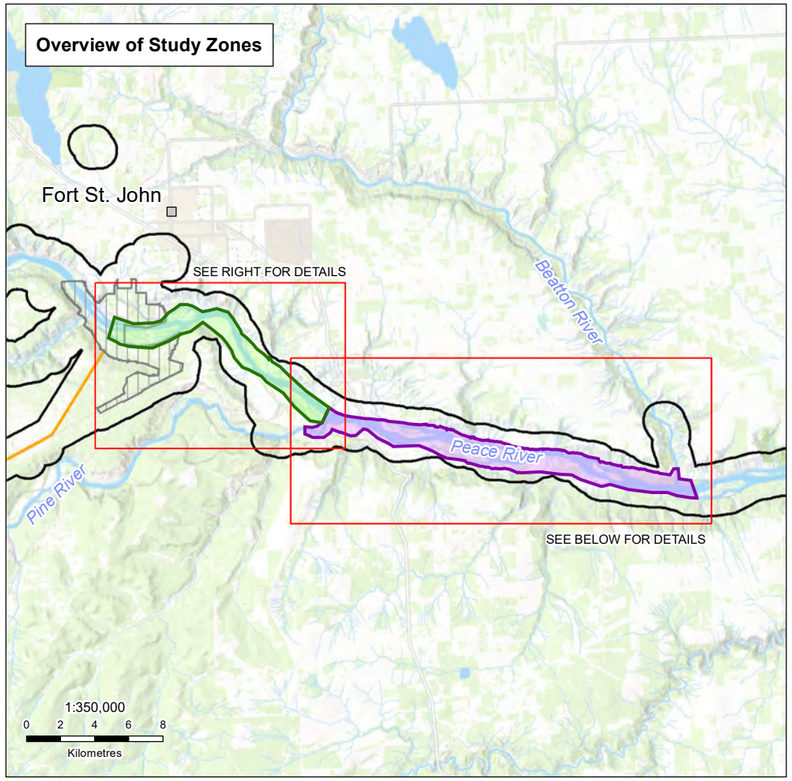
Site Names	Number ACOs	
	Impact	Control
Back Channel	**7**	**0**
WOF	7	-
Non-forested floodplain	**18**	**32**
WH2	7	-
WH5	11	-
VF2	10	-
TS	-	10
WH3	-	11
WH4	-	11
WH6	-	14
Shallow open water	**33**	**66**
OW1	12	-
OW11	10	-
OW4	12	-
OW10	13	-
OW2	20	-
OW3	12	-
OW20	10	-
OW5	-	10
OW6	-	11
OW7	-	20
OW8	-	12
OW9	-	13
PRP	-	18
Willow sedge	**11**	**6**
WS1	11	-
WS2	-	6
Total	**80**	**104**

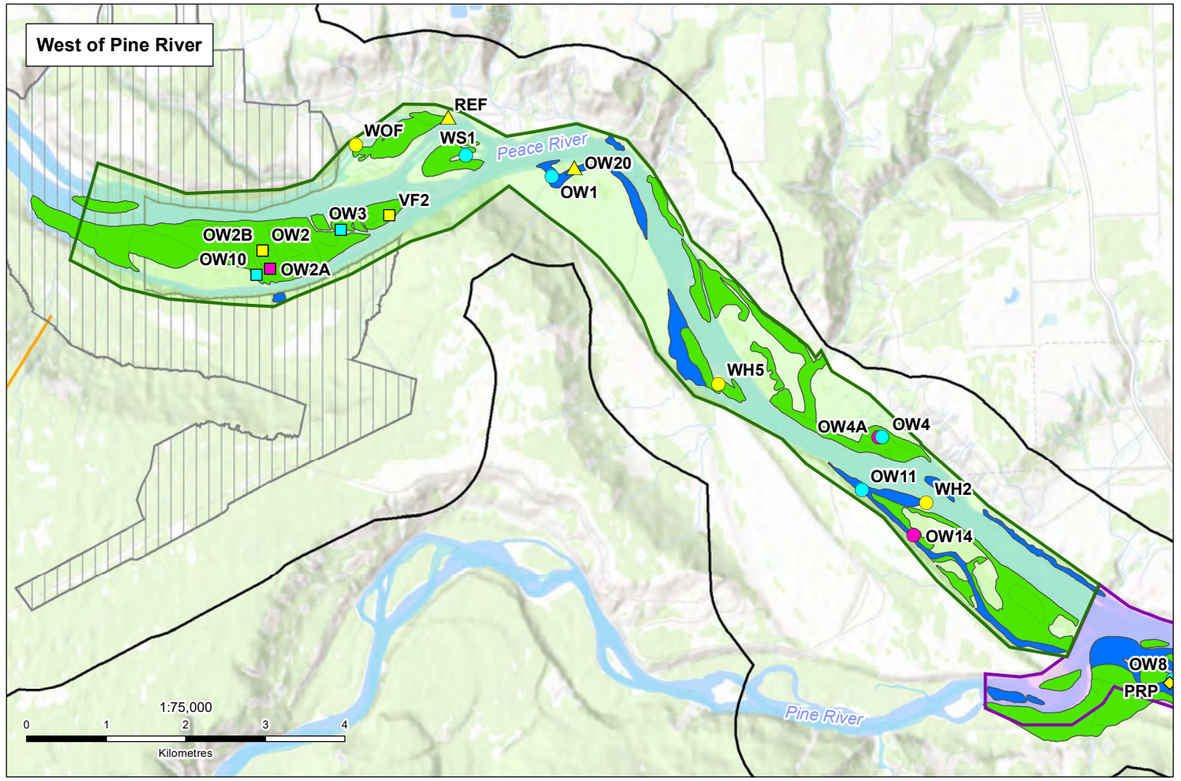
Note: Dark grey are sites removed due to property access limitations or to construction activities; blue are sites added in 2019. ACO habitat and overall totals based on 2019 deployment

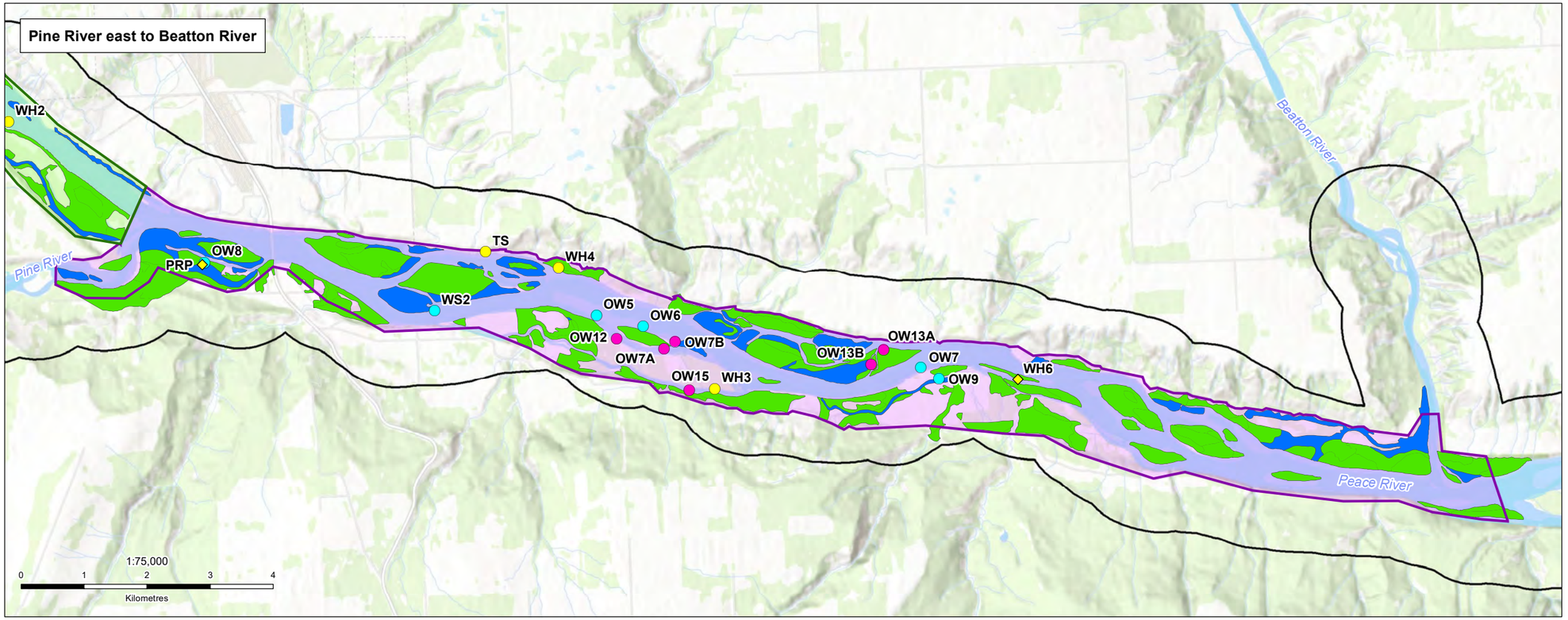
Sites WH6 and PRP were surveyed prior to removing the ACO and were included in the results. An additional 18 ACOs in the impact study area and four in the control study area could not be found. To balance the number of impact and control sites, a new site in the impact area, OW12 with 10 ACOs was created, and one additional ACO was added to OW1 (**Figure 3-1**). This resulted in a total of 80 ACOs in the impact study area and 104 in the control study area (**Table 3-2**). A reference site in non-forested floodplain habitat, chosen based on local knowledge of gartersnake presence, was established on July 21 with nine ACOs in the impact area for comparison.

Downstream Western Toad and Gartersnake Monitoring 2019
Site C, Peace River, BC

Western Toad and Gartersnake Monitoring Sites







Legend

- Site C Local Assessment Area (LAA)
- Proposed Dam Site
- Transmission Line Right-of-Way

Monitoring Sites

Site Status

- Active since 2018
- Added in 2019
- Removed (Construction)
- Removed (Private Property)

Species Surveyed

- Snakes
- Toads
- Snakes and Toads

Study Zones

- Pine River east to Beatton River
- West of Pine River

Habitat Type (TEM)

- Wetland
- Wet Forest

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-09	Production Date: 29-Jan-2020	Figure 3-1

Hemmera An Ausenco Company

BC hydro

Path: S:\Geomatics\Projects\989619\00_gismaps_wtoad\mxd\Fig3-1_989619_00_WT_GS_MonitoringSites_20012.mxd

3.1 Western Toad Distribution and Relative Abundance

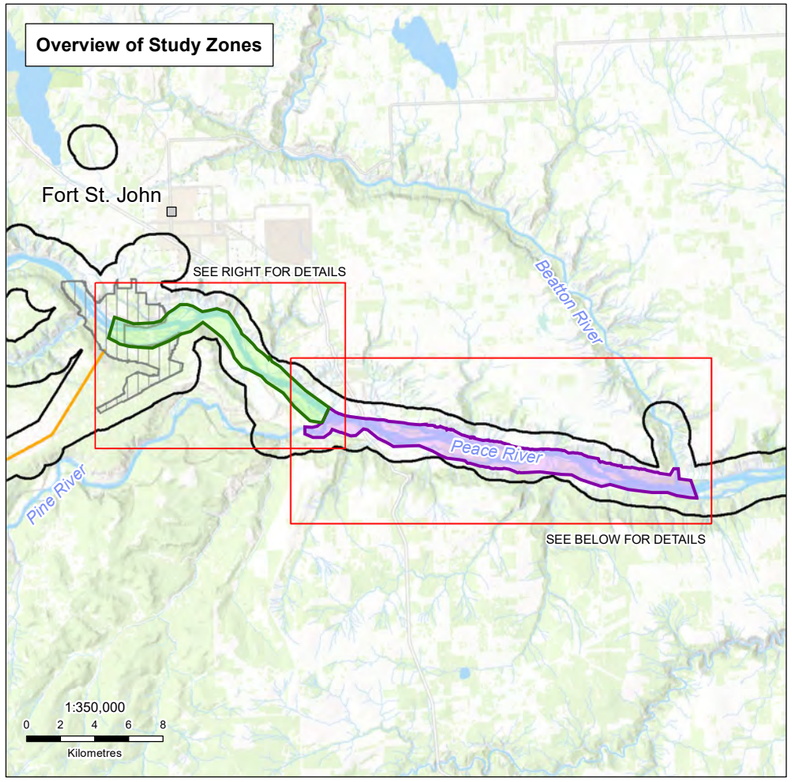
Field crews visited the six sites in the impact study area and 11 sites in the control study area to conduct transect surveys. Only four out of six (66%) sites in the impact area and six out of 11 (55%) sites in the control area contained water during the surveys (**Table 3-3**). Surveys took place during three time periods: 1) May 14 and 15; 2) May 19 and 20; and 3) May 25 and 26.

Of the sites available to survey, western toads occupied four out of four (100%) sites in the impact study area and five out of six (83%) sites in the control study area (**Figure 3-2**).

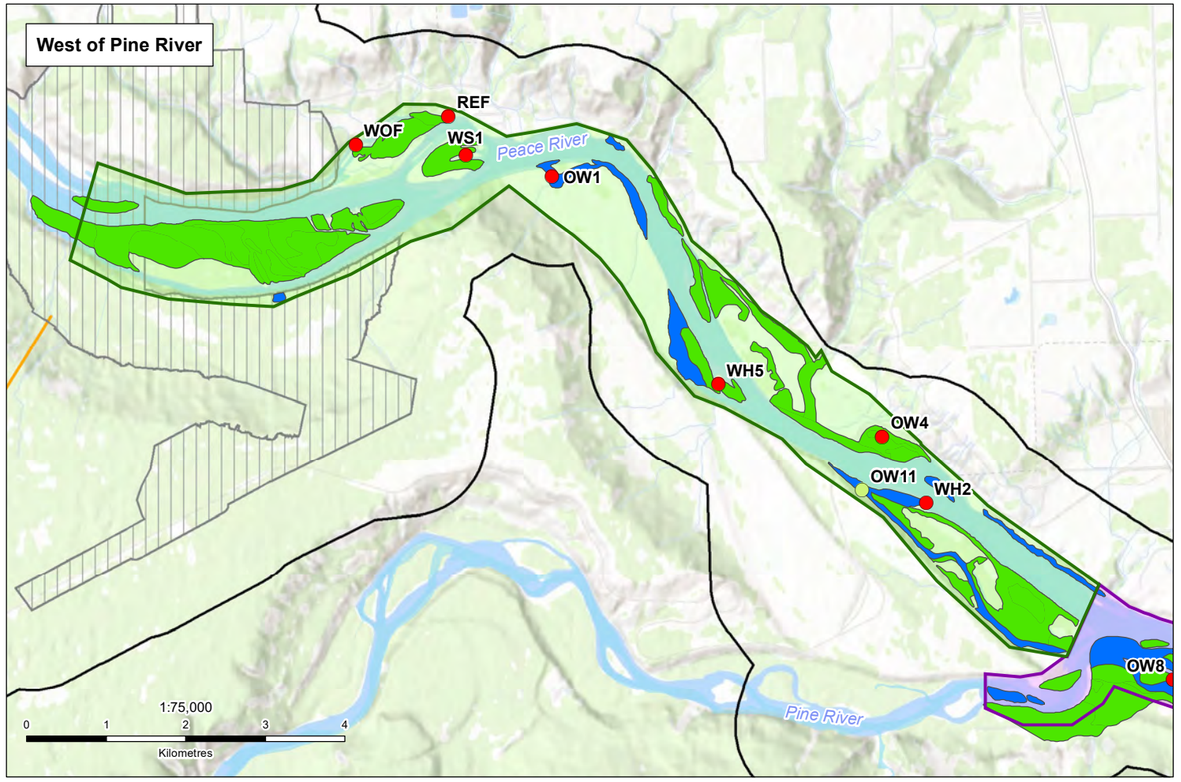
Downstream Western Toad and Gartersnake Monitoring 2019
Site C, Peace River, BC

Western Toad Presence / Not Detected

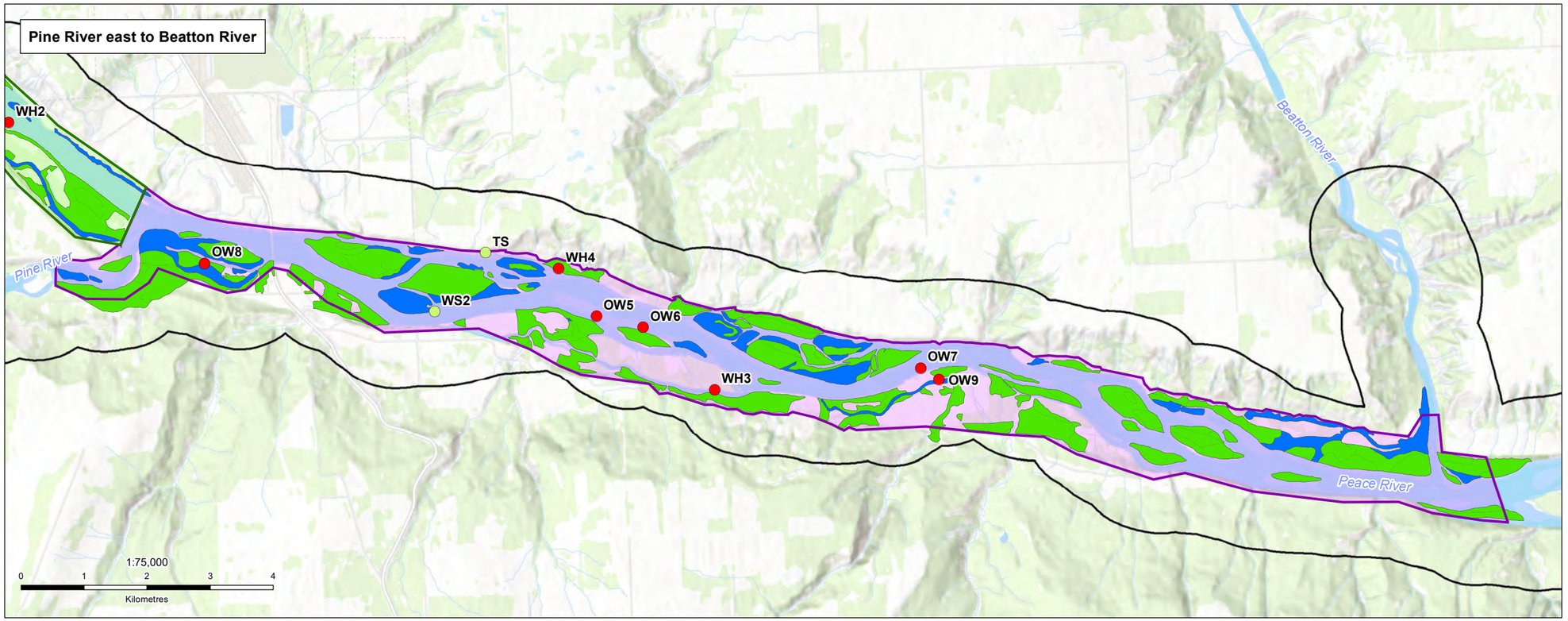
Overview of Study Zones



West of Pine River



Pine River east to Beatton River



Legend

- Site C Local Assessment Area (LAA)
- Proposed Dam Site
- Transmission Line Right-of-Way
- Gartersnake Present
- Gartersnake Not Detected

Study Zones

- Pine River east to Beatton River
- West of Pine River

Habitat Type (TEM)

- Wetland
- Wet Forest

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-09	Production Date: 29-Jan-2020	Figure 3-2

Hemmera An Ausenco Company

BC hydro

Path: S:\Geomatics\Projects\989619\03_gis\arcgis_wtoad\mxd\Fig3-2_989619_03_WT_Presence_230129.mxd

Surveys in 2019 resulted in more robust data on western toad abundances (**Table 3-3**). The distribution of the data is skewed and so the median of the site averages is the best measure of central tendency (data will be transformed prior to doing inferential statistics). The median relative abundance in the control study area of eggs and tadpoles was greater than in the impact study area (2,000 vs. 0 eggs per 100 m; and 10,001 vs. 3 tadpoles per 100 m). In the impact area, the median of juveniles was 3 juvenile toads per 100 m, which was only slightly higher than the control area median of 1 juvenile toad per 100 m. The median relative abundance of western toad adults was zero for both impact and control survey areas (**Table 3-3**).

In 2019, western toad surveys were condensed to the month of May resulting in more observations of all life stages in 2019 than in 2018. Only tadpoles and adult western toads were observed in 2018, while a maximum of 11,000 eggs and 126 juveniles were observed in 2019. Of the life stages observed in both 2018 and 2019, the median relative abundance of tadpoles was zero in the impact area and 1 in the control area in 2018, and three tadpoles in the impact area and 10,001 in the control area in 2019 (**Table 3-3**).

Table 3-3 Relative abundance for western toad in the impact and control study area 2018 and 2019

Year	Study Area	Summary	Life Stage			
			Eggs	Tadpole	Juvenile	Adult
2018	IMPACT (n = 8)	Avg Relative Abundance	0	25.20	0	1.00
		Median Relative Abundance	0	0	0	1
		SE	0	25.20	0	0.55
		SD	0	56.35	0	1.22
		Min	0	0	0	0
		Max	0	126	0	3
	CONTROL (n = 7)	Avg Relative Abundance	0	616	0	0
		Median Relative Abundance	0	1	0	0
		SE	0	596	0	0
		SD	0	1,333	0	1
		Min	0	0	0	0
		Max	0	3,000	0	1
2019	IMPACT (n = 4)	Avg Relative Abundance	1,750	2,500,001	32.88	0.38
		Median Relative Abundance	0	3	3	0
		SE	1,750	2,500,000	31.06	0.38
		SD	3,500	4,999,999	62.11	0.75
		Min	0	0	0	0
		Max	7,000	10,000,000	126	2
	CONTROL (n = 6)	Avg Relative Abundance	4,167	1,753,334	14	0
		Median Relative Abundance	2,000	10,001	1	0
		SE	2,041	1,651,316	13	0
		SD	4,998	4,044,881	32	0
		Min	0	0	0	0
		Max	11,000	10,000,000	80	1

3.2 Gartersnake Distribution and Relative Abundance

Field crews visited eight sites in the impact area and nine sites in the control area. ACO checks took place over three periods: 1) June 15, 16, 17, and 18; 2) July 17, 18 and 19; and 3) August 13 and 14. Two replicates were completed during the first two periods and only one replicate in the third period. The last survey round during the third period was cancelled due to weather conditions and the associated low likelihood of detections.

There were four gartersnakes observed; one under an ACO in the impact study area and three incidental observations recorded during transect surveys in the control study area (**Table 3-4, Figure 3-3**). Gartersnakes were observed at 13% of sites (i.e., one out of eight) in the impact study area and 22% of sites (i.e., two out of nine) in the control study area. The relative abundance of gartersnakes in the impact study area was 0.008 snakes per ACO (1/118). No snakes were seen under ACOs in the control study area (0/80).

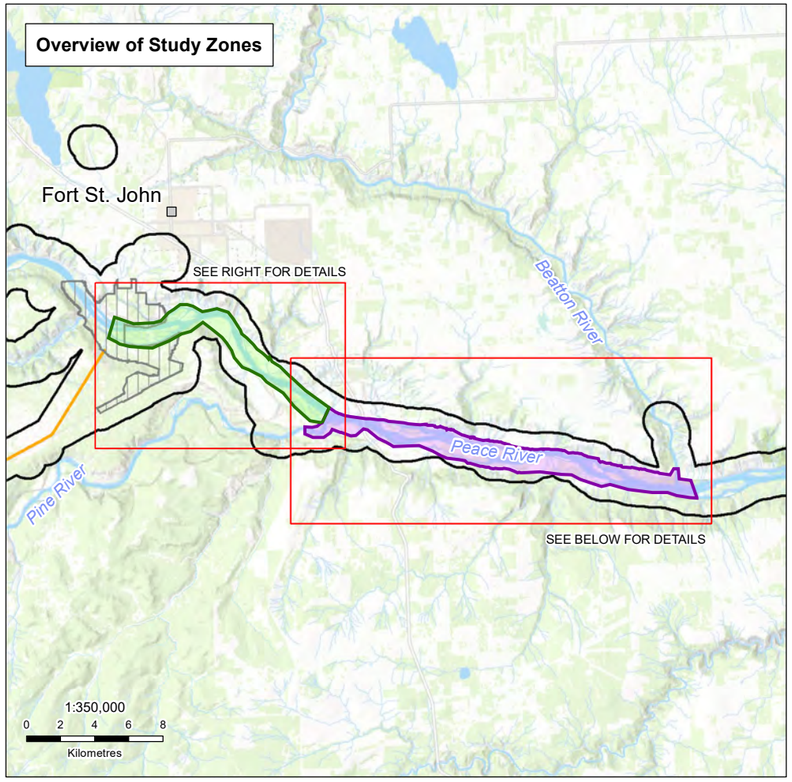
Table 3-4 2019 Gartersnake observations

Study Area	ACO Location	Survey Type	Species	Count
Impact	OW11	ACO Check	Common gartersnake	1
Control	WS2	Incidental observation	Terrestrial gartersnake	1
			Unknown snake	1
	TS		Common gartersnake	1

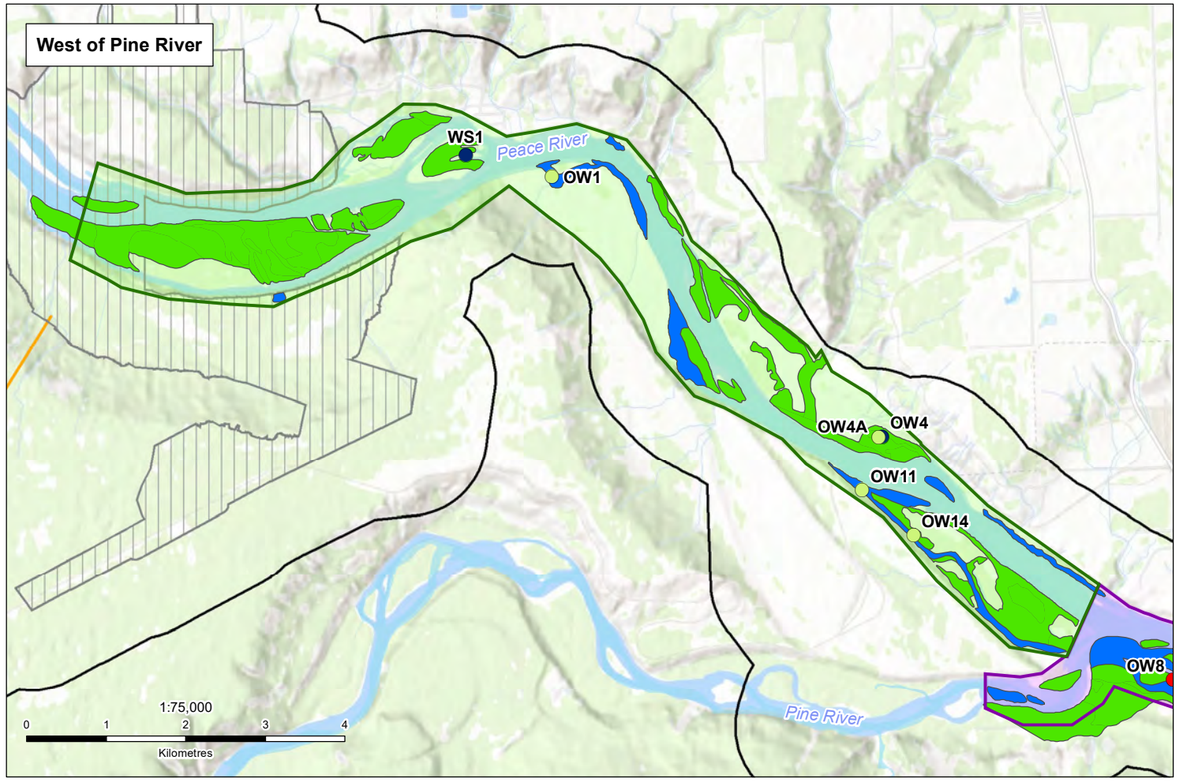
Downstream Western Toad and Gartersnake Monitoring 2019
Site C, Peace River, BC

Gartersnake Presence / Not Detected

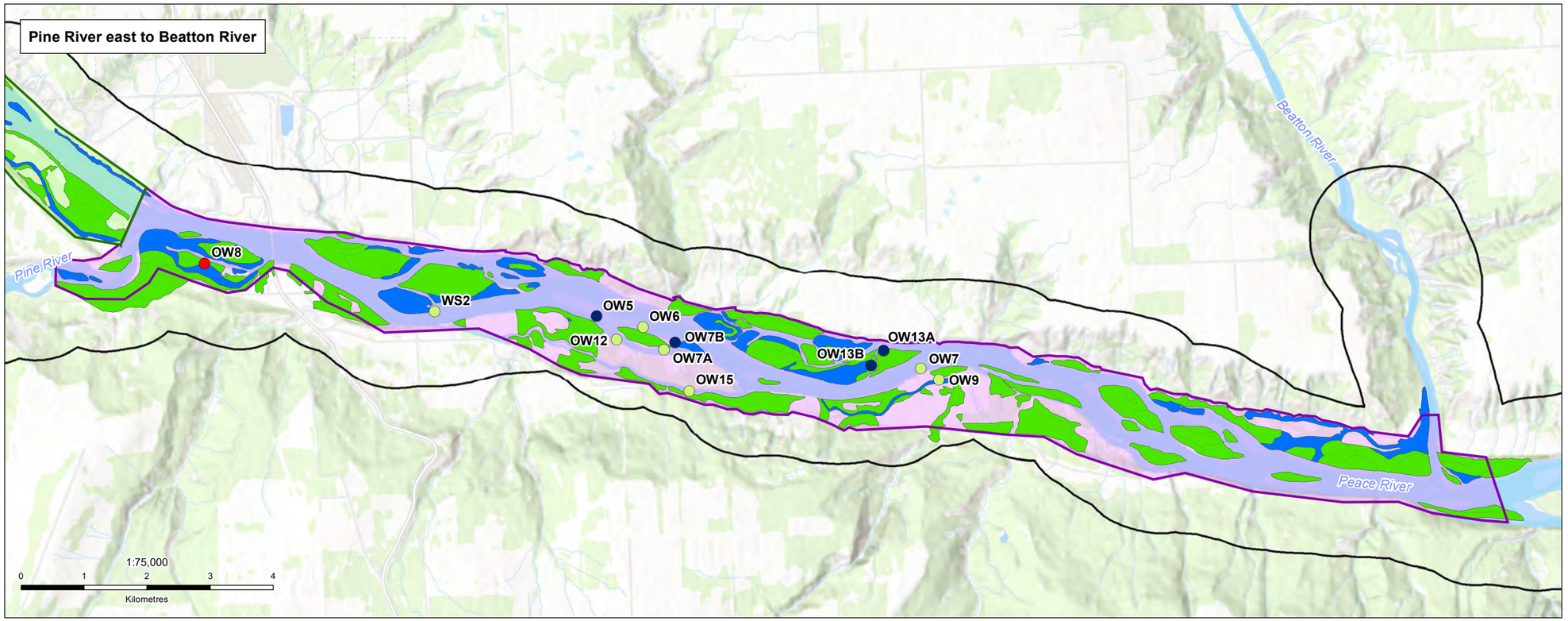
Overview of Study Zones



West of Pine River



Pine River east to Beatton River



Legend

- Site C Local Assessment Area (LAA)
- Proposed Dam Site
- Transmission Line Right-of-Way
- Western Toad Present
- Western Toad Not Detected
- Dry Site

Study Zones

- Pine River east to Beatton River
- West of Pine River

Habitat Type (TEM)

- Wetland
- Wet Forest

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-09	Production Date: 29-Jan-2020	Figure 3-3

Hemmera An Ausenco Company

BC hydro

Path: S:\Geomatics\Projects\989619\00_gismaps_wrkspc\mxd\Fig3-3_989619_00_GS_Presence_200129.mxd

3.3 Environmental Monitoring

Aligned with western toad surveys, water quality parameters that the four sites in the impact study area and six sites in the control study area were recorded (**Table 3-5**).

Table 3-5 Average water temperature, air temperature, pH, conductivity and turbidity 2018 and 2019

Study Area	2018		2019	
	Impact (n=9)	Control (n=13)	Impact (n=4)	Control (n=6)
Average Water Temp (°C) (SE)	20.33 (3.35)	19.6 (3.15)	12.25 (0.96)	13.50 (1.11)
Average pH (SE)	8.68 (0.89)	7.85 (0.28)	8.34 (0.13)	8.61 (0.16)
Average Conductivity (s/cm)(SE)	300.4 (140)	399.8 (157)	388 (78.8)	526 (184)
Average Turbidity (NTU) (SE)	14.74* (5.62)	66.35* (22.83)	25.7 (3.55)	41.4 (6.92)
Dissolved Oxygen (mg/L) (SE)	NA	NA	13.7 (1.15)	13.7 (1.52)
Water Depth (cm) (SE)	NA	NA	21.7 (9.63)	12.5 (4.71)

Note: SE = standard error; NA = Not applicable: dissolved oxygen not collected, and water depth not standardized for comparison
* turbidity taken with LaMotte 2020we, or similar, were Impact = 5 and Control = 4 and are comparable

In 2019, the average water temperature for the impact sites was slightly lower than the control. The average water temperature was likely lower in 2019 than in 2018 because surveys in 2018 took place later in the spring, giving ponds more time to heat up. The average pH at the impact sites was slightly more acidic than the average pH at the control sites, although the pH between 2018 and 2019 is relatively similar. The average conductivity (dissolved ions / salinity) at the impact sites was lower than at the control sites. Conductivity was higher in 2019 compared to 2018, which may be due to the ponds being shallower in 2019, with several them drying up. The average turbidity at the impact sites was lower than at the control sites in both 2018 and 2019. Again, this is likely due to the depths of the ponds, with more shallow ponds located in the control sites in 2019. The average dissolved oxygen was the same at the impact and control sites. The average depth for impact sites was greater than the average depth found at control sites.

4.0 DISCUSSION AND RECOMMENDATIONS

Construction activity in the vicinity of the Project decreased the total number of impact survey sites for both western toad and gartersnakes (see **Section 3.0**). The area west of the Site C dam is being managed to prevent fish strandings. These mitigations resulted in the loss of ephemeral ponds, and the removal of four western toad survey sites (OW10, OW2A, OW2B, and OW3) and four gartersnake survey sites (OW10, OW2, OW3, VF2) with 77 ACOs removed from the study.

In 2018 more survey sites were sampled because although some ponds dried up in late June, all were suitable for western toad breeding and gartersnake foraging. During the months of March, April, and May 2019, there was a 42% decrease in rain in Fort St. John, BC compared to overall average rain for the same time period (34 mm in 2019 vs 84 mm overall average; Potenteau 2019). The drier conditions in 2019 resulted in a reduction of suitable sites (four in the impact area, and six in the control area).

4.1 Western Toad Abundance

Survey efforts in 2019 were focused on the early spring (month of May) to capture peak congregation of adult western toads. Although there were few observations of adult western toads, the shift in timing was advantageous because all life stages were observed with large numbers of egg masses and tadpoles. Estimates of tadpole abundance in 2019 are far higher than 2018, based on statistical extrapolation and western toad breeding capabilities. One western toad female can lay upwards of 16,500 eggs during the breeding season (COSEWIC, 2012) and through communication with local residents (Brunet, J., biologist, pers. comm.), there have been up to 40 western toads observed at one time in small ponds (i.e., 660,000 eggs). Further, the tadpole data were collected from the same field crew in 2019 which suggests consistency of the estimates.

In 2018 there was a limited number of possible western toad breeding sites in the impact study area. As mentioned, in 2019 this has further been reduced from nine sites to six sites due to construction activities to eliminate possible fish stranding in the vicinity of the Site C dam. This reduction of impact sites limits the statistical power of this study. In 2019 only one site in the impact area was suitable for western toads, with only one individual detected.

4.2 Gartersnake Abundance

In 2019, field crews surveyed the 250 ACOs placed in 2018 in the control and impact areas. Four gartersnakes were observed, one under an ACO and three incidentally during transect surveys. After the first survey period (June 15 to 18) it was apparent that there would be few detections. As a result, local knowledge (Brunet, J., biologist, pers. comm) was used to select a reference site with known snake occurrences to confirm the effectiveness of the ACOs. In late July, a reference site at the recommended location in the impact study area was created with nine ACOs. The reference site was checked every other week until the end of August with no gartersnakes observed.

Gartersnake in the Peace River valley may occur in population densities too low to find a statistical difference between impact and control areas. In the baseline study conducted by Hilton et al. (2013) for the Project, only eight gartersnakes were observed during spring over 42 km of transect and spot-checks upstream and downstream of the Site C dam, emphasizing the low population density of gartersnakes in the Project area. The small population size and localized ranges of gartersnakes in the Peace River valley make it likely that random sample plots will miss gartersnakes (Sarell, M., reptile expert, pers. comm.). This low population density also limits the statistical power of this study.

Using ACOs is a tested method for estimating gartersnake presence / not detected (Hobbs, J., reptile expert, pers. comm., Joppa 2009) and there may be several factors that have contributed to the lack of snake detections. Such factors include ACO material (asphalt shingles vs plywood vs corrugated plastic), ACO placement (an estimated 40-50% had ant colonies under them, 20% had overgrown vegetation covering them), inadequate ACO size, insufficient airflow under the ACO (i.e. too hot), and/or not enough time for snakes to find and acclimatize to the ACOs.

It is recommended that 2020 gartersnake surveys continue to be conducted as they were in 2019, with two surveys in each of three survey periods. This method was more manageable and still achieves the same survey effort stated in the Monitoring Plan (BC Hydro 2018). It is also recommended that each ACO will have some woody debris placed under it to allow more airflow and space for snake movement. The ACOs are recommended to stay in place through the construction period, rather than being removed, to allow snakes time to acclimatize to them (Hobbs, J., reptile expert, pers. comm.). Additionally, since three of four snakes observed in 2019 occurred incidentally, it is recommended that time constrained visual encounter surveys throughout suitable habitat surrounding the ACO survey sites be conducted. This method is likely to increase the probability of encountering a gartersnake (Joppa 2009, RIC 1998b). Each gartersnake site will be searched thoroughly with natural cover objects being investigated in addition to the ACOs. Each observer's time will be recorded, and relative abundance will be calculated as the number of snakes per person hour.

4.3 Environmental Monitoring

At the sites with water, there was no apparent meaningful differences in the water quality or environmental variables except with the turbidity measurements (**Table 3-5**). The difference between turbidity in the impact and control study areas (25.7 and 41.4, respectively) can likely be explained by the difference in water depth levels (21.7 cm and 12.5 cm, respectively), as shallower water tends to be more turbid.

5.0 CLOSING

This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

Report prepared by:
Hemmera Envirochem Inc.

ORIGINAL SIGNED

Jason Brogan, M.Sc., R.P.Bio.
Biologist
604.669.0424 ext. 181
Jason.brogan@hemmera.com

Report reviewed by:
Hemmera Envirochem Inc.

ORIGINAL SIGNED

Ryan Gill, R.P.Bio.
Biologist
250.837.1870
ryan.gill@hemmera.com

6.0 REFERENCES

BC Conservation Data Centre (BC CDC). 2018. BC Species and Ecosystems Explorer. B.C. Ministry of Environment, Victoria B.C. Available: http://a100.gov.bc.ca/pub/eswp/ (2018/11/20)

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Prepared for BC Hydro by Keystone Wildlife Research Ltd. <http://a100.gov.bc.ca/appsdata/epic/documents/p371/d35994/1377196616722_0263c53e020fe5f023732f6213a2332790dcad7d2650fa0f8279feaa86fff482.pdf>.

BC Hydro. 2018. Site C Clean Energy Project Vegetation and Wildlife Mitigation and Monitoring Program Downstream Western Toad and Gartersnake Monitoring. Prepared for BC Hydro

BC MoE. 2017. Environmental DNA Protocol for Freshwater Aquatic Systems, version 2.1. Prepared for the BC Ministry of Environment by J. Hobbs, K. Goldberg, C. Helbing and N. Veldhoen.. Victoria, BC. 48 pp.

BC MWLAP. 2004. Best Management Practices for Reptiles and Amphibians in Rural and Urban Environments in British Columbia. Ministry of Water Land and Air Protection. Victoria.

COSEWIC. 2012. COSEWIC assessment and status report on the Western Toad Anaxyrus boreas in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiv + 71 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm)

Eekhout, X. 2010. Sampling reptiles and amphibians. J. Eymann, J. Degreef, C. L. Häuser, J. C. Monje, Y. Samyn, and D. VandenSpiegel, editors. Manual on field recording techniques and protocols for All Taxa Biodiversity Inventories and Monitoring. Volume Vol. 8. ABC Taxa. <https://issuu.com/ysamyn/docs/abctaxa_vol_8_part1_lr?reader3=1>. Accessed 18 Nov 2016.

Grant, B. W., A. D. Tucker, J. E. Lovich, A. M. Mills, P. M. Dixon, and J. W. Gibbons. 1992. The use of coverboards in estimating patterns of reptile and amphibian biodiversity. ResearchGate 379–403.

Halliday, W. D., and G. Blouin-Demers. 2015. Efficacy of coverboards for sampling small northern snakes. Herpetology Notes 8:309–314.

Hemmera 2019. Site C Vegetation and Wildlife, Downstream Western Toad and Gartersnake Monitoring Program - 2018. Prepared for BC Hydro

Hilton, S., L. Andrusiak, L. Simpson, and M. Sarell. 2013. Part 3 Amphibians and Reptiles. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC.

Joppa, L. N., C. K. Williams, S. A. Temple, and G. S. Casper. 2009. Environmental factors affecting sampling success of artificial cover objects. Herpetological Conservation and Biology 51:143–148.

Kinsey, S. 2009. Amphibian Surveys in the Dawson Creek TSA 2009. Prepared for Louisiana-Pacific Canada Ltd

Matsuda, B.M., Green, D.M. and Gregory, P.T., 2006. Amphibians and reptiles of British Columbia. Royal BC Museum.

Potenteau, D. 2019. 'Spring in B.C. was much warmer and drier than normal: Environment Canada'. *Global News*. 07 June 2019. <globalnews.ca/news/5366127/warm-spring-drier-than-normal-bc>. Accessed 04 September 2019.

RIC (Resources Inventory Committee). 1998a. Inventory Methods for Pond-breeding Amphibians and Painted Turtle. Standards for Components of British Columbia's Biodiversity No. 37, Version 2.0, Prepared for the Terrestrial Ecosystems Task Force, Resources Inventory Committee, Victoria.

RIC. 1998b. Inventory methods for snakes. Standards for Components of British Columbia's Biodiversity No. 38, Prepared by the B.C. Ministry of Environment, Lands and Parks, Resources Inventory Branch, Victoria.

Swartz, C. 2015. Analysis of BACI experiments. <http://people.stat.sfu.ca/~cschwarz/Stat-650/Notes/PDFbigbook-R/R-part013.pdf>. Accessed 30 Dec 2017.

APPENDIX A
Habitat Characteristics

Site Name	Study Area	Date	Wetland Habitat Type	Wetland Feature Class	Emergent Vegetation (%)	Submerged Vegetation (%)	Substrate	Water temp (°C)	Air temp (°C)	pH	Conductivity (s/cm)	Turbidity (NTU)	Turbidity (cm)
OW8	Control	05/14/2018	Shallow open water (PD, OW)	Temporary	10	50	Silt	19.1	26	7.67	346	1.52	
OW8	Control	06/07/2018	Shallow open water (PD, OW)	Temporary	2	0	Silt	16.9	20.6	7.6	455		25
OW8	Control	06/21/2018	Shallow open water (PD, OW)	Permanent	10	50	Silt	20.6	21.7	7.6	510		20
OW11	Impact	05/14/2018	Shallow open water (PD, OW)	Semi-permanent	15	80	Muck	17.5	24.5	7.85	689	1.45	
OW11	Impact	06/07/2018	Willow sedge (WS)	Semi-permanent	20	80	Muck	19.4	21.5	8.25	590		
OW11	Impact	06/21/2018	Shallow open water (PD, OW)	Temporary	100		Organic						
OW10	Impact	05/13/2018	Shallow open water (PD, OW)	Seasonal	15	70	Silt	20	25.8	8.4	273	1.65	
OW3	Impact	05/13/2018	Shallow open water (PD, OW)	Seasonal	15	85	Silt	20	22	8.9	200	1.25	
OW1	Impact	05/13/2018	Shallow open water (PD, OW)	Seasonal	2	40	Silt	19	22	7.85	238	1.2	
OW4	Impact	05/14/2018	Shallow open water (PD, OW)	Seasonal	30	50	Silt	14.3	18	7.7	297	4.24	
OW4	Impact	06/06/2018	Shallow open water (PD, OW)	Temporary	80		Silt						
OW7	Control	05/13/2018	Shallow open water (PD, OW)	Semi-permanent	20	70	Silt	17.5	16.6	7.85	473	2.15	
OW7	Control	06/06/2018	Sedge (SE)	Semi-permanent	65	25	Muck	16.2	18.5	7.8	519		5
OW6	Control	05/13/2018	Shallow open water (PD, OW)	Seasonal	20	15	Silt	17.8	17.4	7.87	319	3.4	
OW9	Control	05/13/2018	Shallow open water (PD, OW)	Semi-permanent	20	0	Silt	16.4	15.9	7.86	301	2.11	
OW9	Control	06/07/2018	Shallow open water (PD, OW)	Permanent	5			18	18.3	8.2	338		20
OW4a	Impact	06/06/2018	Shallow open water (PD, OW)	Temporary	10	80	Silt	22.1	21.2	8.85	266		30
WS1	Impact	06/06/2018	Willow sedge (WS)	Temporary	80	0	Silt						
WS1	Impact	06/21/2018	Sedge (SE)	Seasonal	95		Organic						
OW2b	Impact	06/06/2018	Sedge (SE)	Temporary	1	10	Silt	23.9	25	9.29	270		20
OW2b	Impact	06/21/2018	Shallow open water (PD, OW)	Semi-permanent	20	90	Muck	27.1	22.8	9.5	111		15
OW2a	Impact	06/06/2018	Shallow open water (PD, OW)	Temporary	1	1	Silt	24.9	23	10.4	220		20
OW2a	Impact	06/21/2018	Sedge (SE)	Semi-permanent			Muck						
WS2	Control	06/06/2018	Willow sedge (WS)	Seasonal	25		Silt						
WS2	Control	06/21/2018	Shallow open water (PD, OW)	Permanent	5	0	Silt	19.6	19.9	7.6	369		8
OW7b	Control	06/06/2018	Sedge (SE)	Seasonal	70	20	Silt	16.3	17	7.63	716		20
OW7b	Control	06/21/2018	Willow sedge (WS)	Semi-permanent	90		Silt						
OW7a	Control	06/06/2018	Shallow open water (PD, OW)	Seasonal	10	70	Muck	17.4	18.5	8.57	259		5
OW14	Control	06/21/2018	Shallow open water (PD, OW)	Permanent	30	50	Organic	22.6	21.1	8	326		30
OW12	Control	06/21/2018	Shallow open water (PD, OW)	Permanent	10		Muck	20.7	18.3	8.1	171		10
OW5	Control	06/21/2018	Shallow open water (PD, OW)	Semi-permanent	40		Silt	22.3	21	7.9	264		15
OW13a	Control	06/21/2018	Shallow open water (PD, OW)	Temporary	90		Muck						
OW15	Control	06/21/2018	Shallow open water (PD, OW)	Permanent	20	40	Silt	27.4	19.9	7.6	647		15

* See based on Stewart and Kantrud classification (Stewart and Kanatrud 1971). See Appendix B for definitions

APPENDIX B
Wetland Class Definitions

WETLAND CLASS DEFINITIONS

Temporary Wetlands are periodically covered by standing or slow moving water. They typically have open water for only a few weeks after snowmelt or several days after heavy storm events. Water seepage is fairly rapid, but surface water usually lingers for a few weeks after spring snowmelt and for several days after heavy rainstorms at other times of the year. Water is retained long enough to establish wetland or aquatic processes. They are dominated by wet meadow vegetation such as fine-stemmed grasses, sedges and associated forbs

Seasonal Ponds and Lakes are characterized by shallow marsh vegetation, which generally occurs in the deepest zone (usually dry by midsummer). These wetlands are typically dominated by emergent wetland grasses, sedges and rushes.

Semi-permanent Ponds and Lakes are characterized by marsh vegetation, which dominates the central zone of the wetland, as well as coarse emergent plants or submerged aquatics, including cattails, bulrushes and pondweeds. These wetlands frequently maintain surface water throughout the growing season, i.e., from May to September.

Permanent Ponds and Lakes have permanent open water in central zone that is generally devoid of vegetation. Submerged plants may be present in the deepest zone, while emergent plants are found along the edges. These wetlands maintain surface water year round. Plants commonly present in these wetlands include cattails, red swampfire and spiral ditchgrass.

Reference:

MacKenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia; a guide to identification. Ministry of Forests Forest Science Program. 287pp.

APPENDIX C

2019 Western Toad Average Relative Abundance per Site

Study Area	Site	Life Stage			
		Eggs	Tadpole	Juvenile	Adult
IMPACT	OW1	7,000	10,000,000	1	0
	OW4a	0	0	126	0
	OW11	0	5	0	0
	OW14	0	0	5	2
	OW4	0	0	0	0
	WS1	0	0	0	0
CONTROL	OW6	11,000	0	1	0
	OW7	2,200	10,000,000	2	0
	OW7a	10,000	20,000	80	1
	OW12	1,800	500,001	0	0
	OW15	0	2	1	0
	OW8	0	0	0	0
	OW5	0	0	0	0
	OW7b	0	0	0	0
	OW13a	0	0	0	0
	OW13b	0	0	0	0
	WS2	0	0	0	0

Note: **G**rey rows indicate site with no water.

APPENDIX D

Western Toad and Gartersnake Site and Habitat Area

Site Name	Study Area	Habitat Type	Site Area (ha)	Species
OW1	impact	Shallow-open Water	3.13	toad and snake
OW11	impact	Shallow-open Water	0.39	toad and snake
OW4	impact	Shallow-open Water	1.51	toad and snake
OW4a	impact	Shallow-open Water	1.44	toad
OW20	impact	Shallow-open Water	0.81	snake
WH2	impact	Non-forested Floodplain	1.77	snake
WH5	impact	Non-forested Floodplain	1.46	snake
WS1	impact	Willow-Sedge	6.41	toad and snake
WOF	impact	Non-forested Floodplain	0.47	snake
OW12	control	Shallow-open Water	1.55	toad
OW13a	control	Shallow-open Water	1.60	toad
OW13b	control	Shallow-open Water	2.21	toad
OW14	control	Shallow-open Water	1.24	toad
OW15	control	Shallow-open Water	2.15	toad
OW5	control	Shallow-open Water	0.75	toad and snake
OW6	control	Shallow-open Water	0.53	toad and snake
OW7	control	Shallow-open Water	2.98	toad and snake
OW7a	control	Shallow-open Water	0.54	toad
OW7b	control	Sedge	2.44	toad
OW8	control	Shallow-open Water	0.86	toad and snake
OW9	control	Shallow-open Water	1.47	toad and snake
WH3	control	Non-forested Floodplain	3.21	snake
WH4	control	Non-forested Floodplain	0.53	snake
TS	control	Non-forested Floodplain	0.29	snake
WS2	control	Willow-Sedge	0.18	toad and snake

Appendix 9. Downstream Vegetation Monitoring Project Status Update - 2019

ECOLOGIC CONSULTANTS LTD.
UNIT 4 - 252 EAST 1ST STREET
NORTH VANCOUVER BC V7L 1B3
PHONE: 604 836 2273

MEMORANDUM

DATE:	November 27, 2019
TO:	Brock Simons, M.Sc., R.P.Bio. – Terrestrial Biodiversity Specialist, Site C Clean Energy Project
FROM:	Jason Jones, Ph.D., R.P.Bio. – Senior Biologist, EcoLogic
SUBJECT:	Downstream Vegetation Monitoring Project Status Update

1. PROGRAM BACKGROUND AND OBJECTIVES

In accordance with Condition 16.3.6 of the federal Decision Statement for the Site C Clean Energy Project (the Project), BC Hydro has committed to the monitoring of measures implemented to mitigate the Project's effects on species at risk, at-risk and sensitive ecological communities, and rare plants. One aspect of this monitoring is the development and execution of a Downstream Rare Plant Occurrence, At-Risk and Sensitive Ecosystem, and Riparian Vegetation Monitoring Program (hereafter, Downstream Vegetation Monitoring).

The primary objectives of the Downstream Vegetation Monitoring, as laid out in Part of D of Section 7.4.7 of the Project's Vegetation and Wildlife Mitigation and Monitoring Plan, are to use long-term monitoring plots to:

- document the response of downstream riparian vegetation to changes in the surface water regime during construction and operations of the Site C dam;
- document the response of downstream at-risk and sensitive ecosystems (hereafter, sensitive ecosystems) to changes in the surface water regime during construction and operations;
- document the response of downstream plant species at risk occurrences to changes in the surface water regime during construction and operations; and
- document the establishment of new rare plant populations between the dam and the Pine River confluence.

The following questions will be addressed under this program:

- What are the effects of changes to the downstream surface water regime on riparian vegetation?

- What are the effects of changes to the downstream surface water regime on sensitive ecosystems?
- What are the effects of changes to the downstream surface water regime on known plant species at risk?
- Have the changes to the downstream surface water regime resulted in the establishment of new occurrences of plant species at risk?

2. PROGRAM PROTOCOLS

2.1. SELECTION OF POLYGONS FOR SAMPLING

2.1.1. Pre-field

Protocols presented in the Downstream Vegetation Monitoring Workplan (Tables 1 and 2 in EcoLogic and Tetra Tech 2018) were used as the basis for selection of plant species and ecosystems at risk in the Downstream Vegetation Monitoring study area. The tables were cross-referenced with the most current data from the CDC to confirm the listings had not changed in the interim and to determine whether any other plant or ecosystems at risk had the potential to occur in the Downstream Vegetation Monitoring study area (BC CDC 2019).

Plant species at risk with the potential to occur within the Project area were identified prior to field surveys by reviewing literature and online sources such as Douglas et al. (2002), eFlora BC (2019), and the BC Species and Ecosystem Explorer (BC CDC 2019). All Red- and Blue-listed species (i.e., species at risk) with mapped known occurrences or the potential for occurrence (based on ecological and biogeographic considerations) were subsequently identified as targets for survey.

Table 2.1-1 represents Table 2 from the EcoLogic and Tetra Tech (2018) work plan with the addition of Map Code and Site Series columns. Fifteen ecosystems were identified to occur in the downstream vegetation monitoring area. Ecosystems at risk within the Project area were identified by reviewing the most current BC CDC database (2019). The search criteria for potentially occurring at-risk ecosystems included those that are Red- or Blue-listed, within the BWBSmw and the Peace Forest District.

Table 2.1-1. Distribution of Site Series in Downstream Vegetation Monitoring Study Area

ID #	Map Code	Site Series	Site Series Name	CDC Status	Spatial Area (ha)
1	ATcp	101$6B.1	$At – Rose – Creamy peavine	Yellow	812
2	Fm02	112	AcbSw – Mountain alder – Dogwood	**Blue**	307
3	SW	103	SwPl – Soopolallie – Fuzzy-spike rye	Yellow	179
4	SH	111	Sw – Currant – Horsetail	**Blue**	133
5	ATsw	103$6B.1	$At – Rose – Fuzzy-spiked wildrye	Yellow	107

ID #	Map Code	Site Series	Site Series Name	CDC Status	Spatial Area (ha)
6	GB	00	Gravel Bar	n/a	75
7	Fl06	00	Pacific willow – Red-osier dogwood – Horsetail	Red	74
8	AM	101	Sw – Trailing raspberry – Step moss	Yellow	57
9	Gb51	00	Saskatoon – Blue wildrye	Yellow	41
10	Gg51	00	Slender wheatgrass – Pasture sage	Yellow	37
11	SHac	111$6B.1	$At – Highbush cranberry – Oak fern	Yellow	35
12	SO	110	Sw – Oak fern – Sarsaparilla	Blue	30
13	ATsk	102$6B.1	$At – Soopolallie – Kinnickinnick	Yellow	26
14	Wf02	00	Scrub birch – Water sedge	Blue	5
15	Wf01	00	Beaked sedge – Water sedge	Yellow	1

Note: dbase = attribute database; $ = seral; Acb = balsam poplar; At = trembling aspen, Sw = white spruce, Pl = lodgepole pine

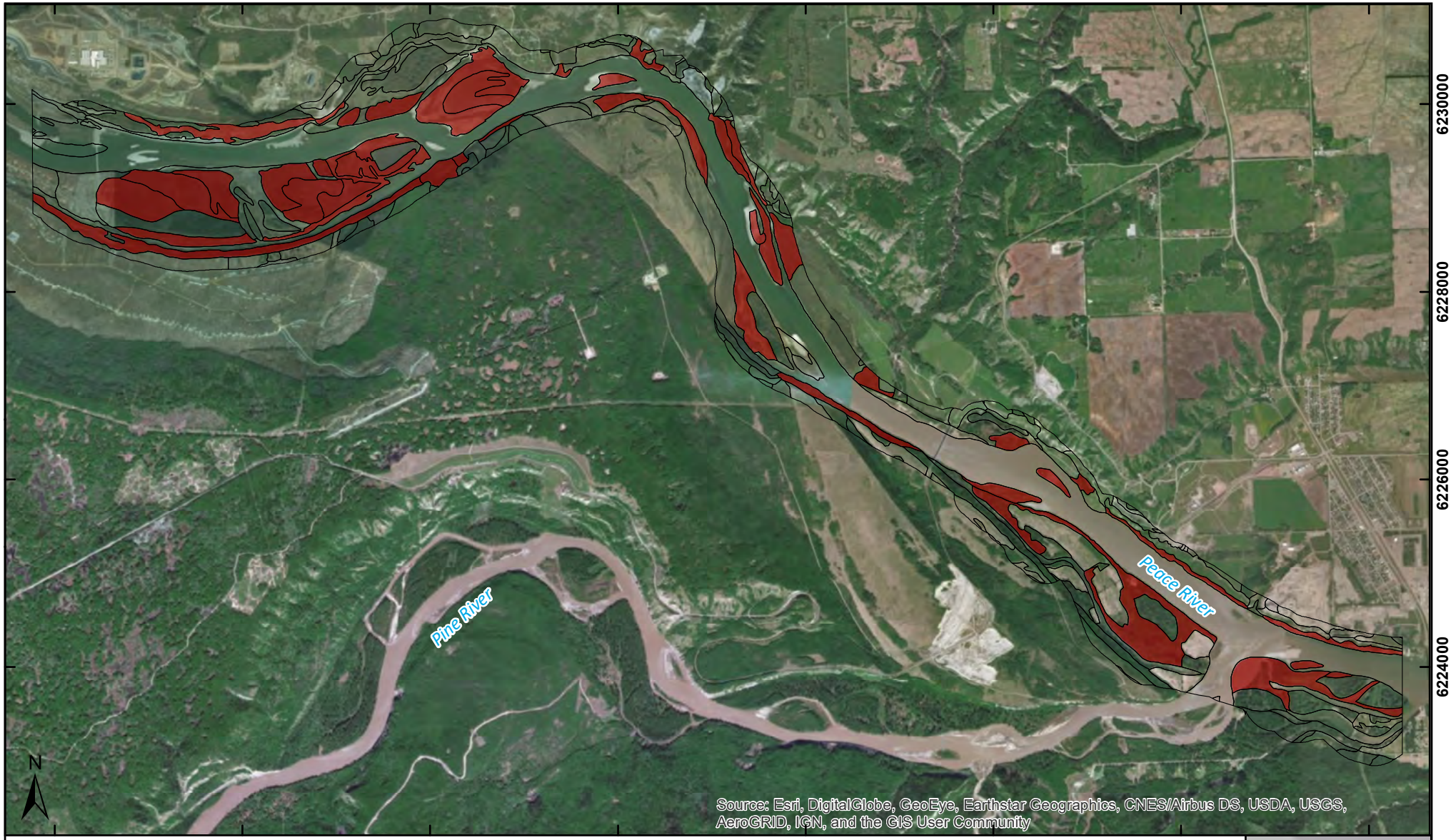
A sampling plan was prepared in Excel showing a matrix of the 15 ecosystems in Table 2.1-1 along with at-risk listings, proximity to river, and land ownership (Appendix A). The TEM ecosystems that occurred in the Downstream Vegetation Monitoring study area (Table 2.1-1) were spatially analyzed to determine which ecosystems abut the Peace River. Those ecosystems that did abut the river were retained and all other ecosystem units were dropped from consideration. Those ecosystem units remaining were spatially cross-referenced using ArcGIS to determine land ownership by polygon. In total, 44 polygons were identified as sampling targets (Appendix A, Figure 2.1-1).

2.1.2. In the field

The objective of the sampling plan was to focus on sampling ecosystems at risk and those on BC Hydro or Crown land. As such, 14 polygons were sampled, all but one of which were on Crown land (Appendix A). Preference was given to those polygons most likely to be affected by river activities (10 polygons) along with 4 polygons outside the river's influence for comparison.

2.2. Sampling Design

Selected polygons were sampled using ecosystem classification plots placed along two parallel 50-m transects set 25 m apart. One pair of transects was established for each polygon, with three plots completed along each of these transects (Figure 2.2-1). This resulted in the completion of six sampling plots in each polygon. Two exceptions to this sampling design were Polygon 3232, in which three parallel transects (i.e., nine sampling plots) were completed, and Polygon 3459, in which five sampling plots (rather than six) were completed due to the small size of the polygon. All plot centres were georeferenced, and photographs were obtained in each of the four cardinal directions for each plot.



Site C Downstream Monitoring

Polygons selected for potential sampling

Figure 2.1-1

0 1 2 3

1:57,500 km

Date: 11/19/2019

Map Number: BCHD-002

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

Legend

- Potential sampling target
- Terrestrial Ecosystem Mapping (TEM)

ECOLOGIC

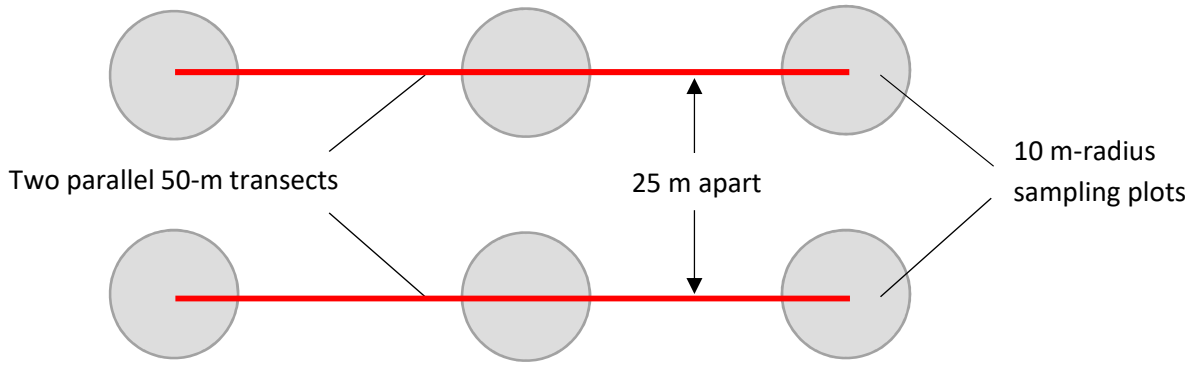


Figure 2.2-1. Sampling Design for Ecosystem Classification used in Downstream Vegetation Monitoring Program

2.3. Ecosystem Classification/Verification

Ecosystem classification protocols followed provincial standards, as prescribed by the Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2010). Ecosystem characteristics specific to the Peace River region (e.g., site series) were informed by reference to the regional ecosystem identification guide for the Boreal White and Black Spruce Biogeoclimatic (BGC) Zone of British Columbia (BC MOFR 2011).

Three categories of information were recorded in each sampling plot in the field: (i) site characteristics, (ii) soils, and (iii) vegetation characteristics (Table 2.3-1).

Table 2.3-1. Ecosystem data collected at each sampling plot

Site Characteristics	
Site series	Soil moisture regime
Seral association (where applicable)	Soil nutrient regime
Map code	Surface shape
Slope	Mesoslope position
Aspect	Substrate/ground cover types (%)
Soils	
Drainage code	Depth of mottling (when present)
Humus form	Presence of seepage
Humus thickness	Depth of seepage (when present)
Presence of gleying	Presence of root restrictive layer
Depth of gleying (when present)	Depth of root restrictive layer (when present)
Presence of mottling	Type of root restrictive layer (when present)

For each soil horizon, the following data were collected:	
Horizon depth	% stones
Horizon colour	Total coarse fragments
Horizon texture	Root abundance
% gravels	Root size
% cobbles	
Vegetation	
Structural stage	% shrub cover
Successional stage	% herb cover
Canopy composition	% moss/lichen cover
Canopy closure	% cover of each vascular plant sp. in each layer
% tree cover	

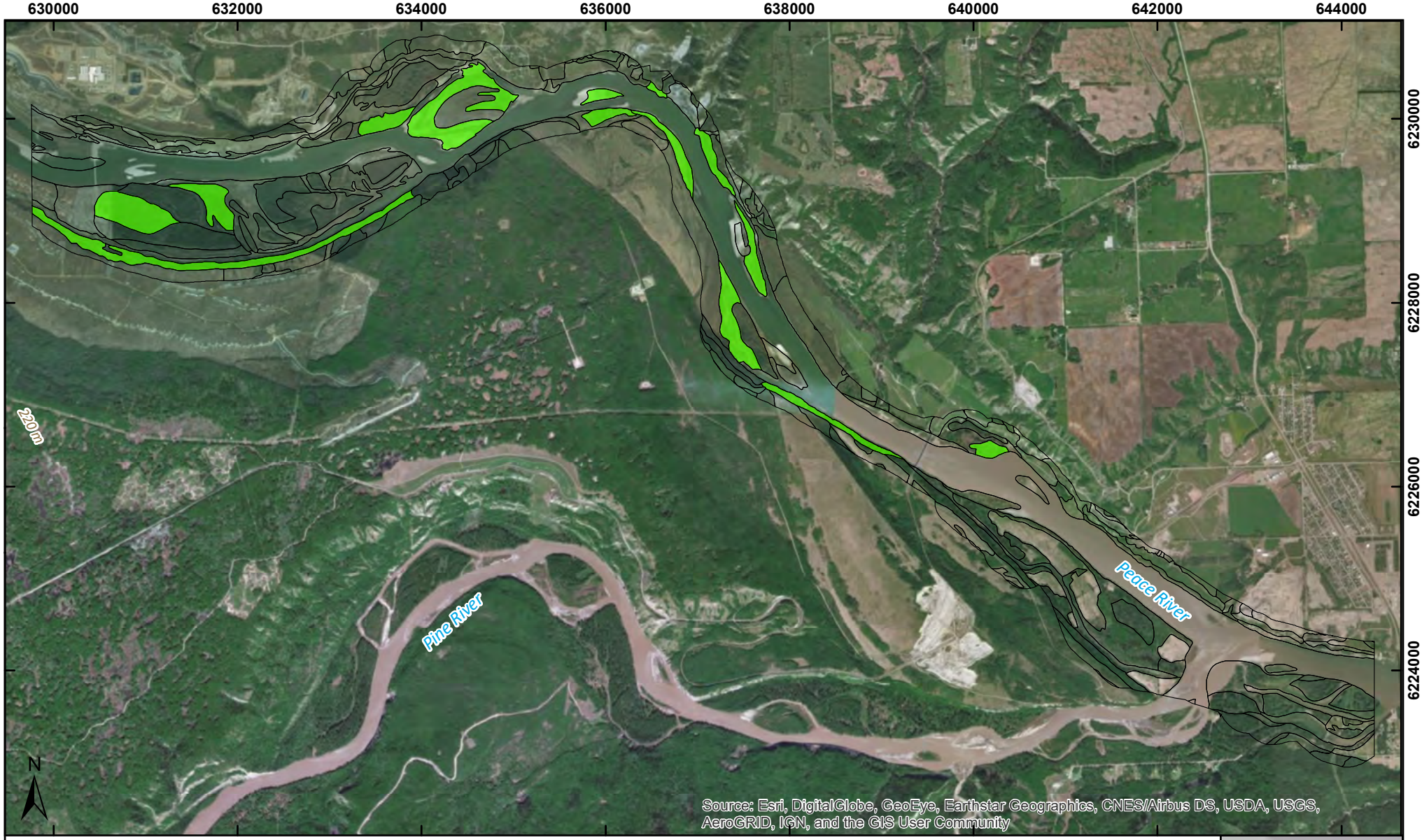
2.4. Plant Species at Risk

Each polygon sampled was assessed for the presence of plant species at risk by using the 'intuitive meander' protocol described in BC MOECCS (2018). This protocol prescribes that the surveying botanist relies on his or her knowledge of the ecology of plant species at risk within the region of interest to guide the surveys, rather than using less effective plot-based methodologies. Incidental collecting of bryophytes, particularly from within unusual microsites or habitats, was completed to broaden the survey scope beyond vascular plants. These bryophyte collections were reviewed and identified after the field session with the assistance of standard identification literature (e.g., Morin et al. 2015).

3. 2019 FIELD SEASON

3.1. Site Visit Details

Field sampling were conducted August 11 to 15, 2019. Forty-four target polygons were identified prior to the August field sampling, and sampling was completed for 14 of these polygons (Figure 3.1-1). This resulted in the completion of 86 sampling plots. All polygons were accessed through the use of jet boat.



Site C Downstream Monitoring

Polygons sampled in 2019

Figure 3.1-1

0 1 2 3

1:57,500 km

Date: 11/19/2019

Map Number: BCHD-003

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

Legend

- Sampled polygons (2019)
- Terrestrial Ecosystem Mapping (TEM)

ECOLOGIC

3.2. RESULTS

3.2.1. Ecosystem Classification

Eight of the 14 sampled polygons had been classified as at-risk ecosystems (i.e., Red- or Blue-listed by the BC CDC) prior to the field sampling. Following revision of the ecosystem classifications during the field sampling, however, the classification of three of these polygons was revised to ecosystems that are not considered at risk in the province (i.e., Yellow-listed by the BC CDC; Table 3.2-1). Furthermore, three polygons that were not classified as ecosystems at risk prior to the field sampling were revised to at-risk ecosystems in part or in full. See Appendix B for a more detailed summary of the site, soil, and vegetation data that were collected for each polygon.

Table 3.2-1. Sampling summary and ecosystem classification for polygons visited during the August 2019 field survey. Note that some polygons contained more than one ecosystem type.

Polygon	# of Plots	TEM 2017 Map Code	BC List	Actual Ecosystem	BC List
2950	6	SW	Yellow	SH/AM/SW	Blue/Yellow/Yellow
2951	6	Fm02	Blue	SHac	Blue
3059	6	Fl03/Fl06	Red	Fm	n/a
3148	6	Fm02	Blue	Fm	n/a
3232	9	SH	Blue	AM	Yellow
3239	6	SH	Blue	SHac	Blue
3284	6	Fl03/Fl06	Red	Fl	n/a
3291	6	SHac	Blue	SHac/AMap	Blue/Yellow
3367	6	GB	n/a	GB	n/a
3397	6	AMap	Yellow	SHac	Blue
3413	6	AMap	Yellow	AM/AMap	Yellow/Yellow
3448	6	GB	n/a	GB	n/a
3459	5	Fl03/Fl06	Red	Fl03/Fl06	Red/Red
4912	6	SW	Yellow	AM/SH/Fm02	Yellow/Blue/Blue

3.2.2. Rare plants

Only a single rare plant population was encountered during the August field surveys. A population of the Blue-listed Davis's Locoweed (*Oxytropis campestris* var. *davisii*) was located in Polygon 3059, and was detected in each of the six sampling plots established in that polygon. This population was already known to the BC CDC, however, and did not constitute a new occurrence.

4. PROGRAM RECOMMENDATIONS

4.1. 2020 "YEAR 1" COMPLETION

The August 2019 sampling period occurred late in the season and coincided with the onset of senescence of many plant species, reducing the ability of the surveyors to effectively assess ecosystem conditions.

Recommendation: a second round of sampling at a time of year more conducive to assessing ecosystem characteristics (particularly vegetation) is recommended for June 2020. This second round of surveys would sample a selection of the remaining 30 target polygons that were not visited during 2019 (i.e., those polygons that are likely to be influenced by river level fluctuations).

4.2. OVERALL PROGRAM

As a result of the information gained during this initial sampling program, the following are proposed to the overall program design for application in future survey years:

1. Original sampling plans had planned for the use of three parallel transects for the ecosystem classification plots, resulting in the completion of nine sampling plots within each sampled polygon. This was found to oversample the polygons while simultaneously reducing the number of polygons that could be sampled during the field session.

   Recommendation: Reduce the number of parallel transects established in each polygon to two, rather than three, resulting in the completion of six (rather than nine) sampling plots per polygon.

2. Many polygons that were sampled occurred at elevations above those that are influenced by the activities of the Peace River, and thus their applicability to the monitoring of the interaction between river activities and vegetation is considered to be negligible. Furthermore, many of the ecosystem classifications that informed the sampling design were found to be incorrect while in the field.

   Recommendation: Assess the target polygon while in the field and sample only those polygons that are likely to be influenced by fluctuations in water level. As a result, fewer polygons will be sampled overall but more attention will be paid to polygons facing potential effects.

5. REFERENCES

BC CDC. 2019. *BC Species & Ecosystems Explorer*. B.C. Ministry of Environment and Climate Change Strategy, Conservation Data Centre. Available online: https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/explore-cdc-data/species-and-ecosystems-explorer

BC MOECCS. 2018. *Inventory and Survey Methods for Rare Plants and Lichens.* B.C. Ministry of Environment and Climate Change Strategy, Ecosystems Branch, Standards for Components of British Columbia's Biodiversity No. 43.

BC MOFR and BC MOE. 2010. *Field Manual for Describing Terrestrial Ecosystems, 2nd Edition.* B.C. Ministry of Forests and Range and B.C. Ministry of Environment, Land Mgmt. Handbook No. 25.

BC MOFR. 2011. *A Field Guide to Ecosystem Identification for the Boreal White and Black Spruce Zone of British Columbia*. B.C. Ministry of Forests and Range, Forest Science Program, Land Mgmt. Handbook No. 65.

Douglas, G.W., Meidinger, D., and J.L. Penny. 2002. *Rare Native Vascular Plants of British Columbia*. Ministry of Sustainable Resource Management, B.C. Conservation Data Centre, Victoria, BC. 358 pp.

EcoLogic and Tetra Tech. 2018. *Site C Clean Energy Project Downstream Vegetation Monitoring Program*. Prepared for BC Hydro by: EcoLogic Consultants and Tetra Tech Canada Incorporated on behalf of Saulteau EBA Environmental Services Joint Venture (SEES JV).

eFlora BC. 2019. *E-Flora BC: Electronic Atlas of the Flora of British Columbia*. Available online: https://ibis.geog.ubc.ca/biodiversity/eflora/

Morin, N. R., Brouillet, L., & G.A. Levin. 2015. Flora of North America North of Mexico. *Rodriguésia*, 66(4), 973-981. https://dx.doi.org/10.1590/2175-7860201566416.

APPENDIX A. Sampling Plan

Table 1. Downstream Vegetation Monitoring Sampling Plan

ID #	Map Code	Site Series	BC Status	TEM_Site Series Name	Abut River Dec1	TEM_Dec1	Abut River Dec2	TEM_Dec2	Abut River Dec3	TEM_Dec3
1	Atcp	101$6B.1		$At - Rose - Creamy peavine	Yes	43 polygons; 17 abut river	Yes	7 polygons; 6 abut river	No	1 polygon; 0 abut river
2	Fm02	112/Fm02	Blue	AcbSw - Mountain alder - Dogwood	Yes	36 polygons; 36 abut river	Yes	15 polygons; 14 abut river	Yes	1 polygon; 1 abuts river
3	SW	103		SwPl - Soopolallie - Fuzzy-spiked rye	Yes	7 polygons; 2 abut river	No	0 polygons	No	0 polygons
4	SH	111	Blue	Sw-Currant-Horsetail	Yes	8 polygons; 5 abut river; 1 cleared	Yes	2 polygons; 2 abut river	No	0 polygons
5	Atsw	103$6B.1		$At-Rose-Fuzzy-spiked wildrye	Yes	19 polygons; 5 abut river	Yes	2 polygons; 1 abuts river	No	0 polygons
6	GB	GB		Gravel bar	Yes	12 polygons; 12 abut river	Yes	5 polygons; 5 abut river	Yes	1 polygons; 1 abuts river
7	Fl06	Fl03/Fl06	Red	Pacific willow - Red osier dogwood - Horsetail	Yes	9 polygons; 7 abut river	Yes	8 polygons; 7 abut river	Yes	1 polygons; 1 abuts river
8	AM	101		Sw - Trailing Raspberry - Stepmoss	No	8 polygons; 0 abut river	No	0 polygons	No	0 polygons
9	Gb51	Gb51		Saskatoon - Blue wildrye	No	7 polygons; 0 abut river	Yes	7 polygons; 2 abut river	No	0 polygons
10	Gg51	Gg51		Slender wheatgrass - Pasture sage	Yes	1 polygon; 1 abuts river	Yes	9 polygons; 2 abut river but very steep	No	2 polygons; 0 abut river
11	SHac	111$6B.1		$At - Highbush cranberry - Oakfern	Yes	4 polygons; 3 abut river	Yes	5 polygons; 3 abut river	No	0 polygons
12	SO	110	Blue	Sw - Oakfern - Sarsaparilla	No	6 polygons; 0 abut river	No	1 polygon; 0 abut river	No	0 polygons
13	Atsk	102$6B.1		$At - Soopolallie - Kinnickinnick	No	5 polygons; 0 abut river	No	0 polygons	No	0 polygons
14	Wf02	Wf02	Blue	Scrub birch - Water sedge	Yes	7 polygons; 1 abuts river	No	0 polygons	No	0 polygons
15	Wf01	Wf01		Beaked sedge - Water sedge	No	1 polygon; 0 abut river	Yes	2 polygons; 1 abuts river	No	0 polygons

Notes: shaded cells = completed; TBC = Land tenure to be confirmed

Table 1. Downstream Vegetation Monitoring Sampling Plan

ID #	Polygon_1	Ownership_1	Polygon_2	Ownership_2	Polygon_3	Ownership_3	Polygon_4
1	3192-7AMa:ap3-3AMa:ap5	Crown/5.7	3397-10AMa:ap5	Crown/2.31	3385-10AMa:ap5	Crown/2.31	3413-8AMa:ap5-2SHa:6
2	3254-10Fm02a4	Crown/2.11	3409-10Fm02ab:3	Crown/2.41/2.8/2.7	3148-10Fm02a:3	TBC	2951-10Fm02a5
3	3174-10SWk:6	Crown/2.7	4912-10SWgk:6	Crown/5.8			
4	3231-8SHa:6-2Fm02a:3	Crown/5.4	3308-10SHa:7	Crown/2.11	3230-8SH:6-2SO:3	Crown/5.8	3305-7SHa:5-3Fm02a:3
5	3324-10SWk:as5	Crown/2.7	3359-10SWk:as5	Crown/2.8	2950-8SWq:as5-2CB:1	TBC	2880-7SW:as5-3SW:as4
6	3367-8GB1-2WHac2	Crown/2.41/2.7/2.8	3202-5GB:1-5Fm02ab:3a	Crown/5.5/2.7	3448-10GB:1	TBC	3470-10GB:1
7	3284-9WHa:3a-1RI	Private/014-684-152	3059-8WH:af2-2GB:1	TBC	2877-10WHaf:3a	Unknown	2866-8WHaf:2-2WHaf:3
8	does not abut river						
9	3263-5Amw:4-5AS:3	Private/014-545-951	2587-6AMw:ap4-4AS:3b	Private/410.1			
10	3353-5WWgq:2-3WW:3a-2CBw:1	BCH/2.1					
11	3291-7SH:ac6-3AMw:ap3	Private/464.4	3090-7SH:ac4-3SHt:ac3	TBC	4920-10SHt:ac6	Private/464	3232-7SH:6-3SHac4
12	does not abut river						
13	does not abut river						
14	2703-6WS:3b-4SH:ac6	Partial on Private/410.2					
15	does not abut river						

Table 1. Downstream Vegetation Monitoring Sampling Plan

ID #	Ownership_4	Polygon_5	Ownership_5	Polygon_6	Ownership_6	Polygon_7	Ownership_7	Total Transects to be Sampled
1	TBC	3495:10AMh:ap4	Private/464.3					5
2	Crown	2582-8Fm02a:3-2WHa:3	Crown / Private	2575-10Fm02ab:3b	TBD	3240-6Fm02a:3-4Fm02a:5	Crown/5.8	7
3								2
4	Crown/5.5	3239-10SHa:6	Crown/5.4					5
5	TBC	2682-10SWh:as5	Private/410-410.2					5
6	TBC	3197-10GB:1	TBC					5
7	TBC	2421-5WHac:3b-5Fm02ab:3	TBC	2553-10WHac:3	TBC	3459-8WHaf:3-2RI	TBC	7
8								0
9								2
10								1
11	Crown/5.4/5/7							4
12								0
13								0
14								1
15								0

APPENDIX B. Data Summary by Polygon

Polygon: 2950		TEM Code: SH / AM / SW	
TEM Name:	Sw – Currant - Horsetail / Sw - Trailing Raspberry - Stepmoss / Sw-Pl - Soopolallie - Fuzzy-spiked rye		
Plot #s	46 - 51		
	Ecosystem 1	**Ecosystem 2**	**Ecosystem 3**
	Sw-Currant-Horsetail (SH)	Sw - Trailing Raspberry – Stepmoss (AM)	SwPl - Soopolallie - Fuzzy-spiked rye (SW)
Slope (%)	8	10-35	65-77
Aspect (deg)	30	40,320	40
SMR	Subhygric (5)	Mesic (4)	Submesic (3)
SNR	Very Rich (E)	Rich (D)	Medium (C)
Mesoslope	Gully	Gully, Lower	Middle
Structural Stage*	6	6	6
Humus Form	Moder	Moder	Mor (Moder)
Ah present	Yes	Yes	No
Soil Texture	Silt-Loam	Silt-Loam	Sandy Loam – Loamy Sand
Coarse Fragments (%)	40	45	51-55
Drainage	Imperfect	Moderate	Well - Rapid
Seepage	No	No	No
Mottling	Yes	No	No
Gleying	Yes	No	No
Dominant Vegetation			
Trees	*Picea glauca* *Betula papyrifera*	*Picea glauca* *Betula papyrifera* *Populus balsamifera*	*Picea glauca* *Betula papyrifera*
Shrubs	*Cornus sericea* *Viburnum edule* *Alnus incana*	*Rosa acicularis* *Cornus sericea* *Viburnum edule* *Rubus idaeus*	*Viburnum edule* *Rosa acicularis* *Populus tremuloides* *Cornus sericea*
Herbs	*Cornus canadensis* *Gymnocarpium dryopteris* *Rubus pubescens* *Equisetum arvense*	*Cornus canadensis* *Rubus pubescens* *Circaea alpina* *Mitella nuda* *Linnaea borealis* *Galium triflorum*	*Rubus pubescens* *Linnaea borealis* *Aralia nudicaulis*

Note: Sw – White Spruce; Pl – Lodgepole Pine

Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Poly 2950 - Plot 46: Sw-Currant-Horsetail (SH)

Poly 2950 - Plot 47: Sw - Trailing Raspberry – Stepmoss (AM)

Poly 2950 - Plot 51: SwPl - Soopolallie - Fuzzy-spiked rye (SW)

Polygon 2951		TEM Code: SHac
TEM Name:	**$At - Highbush Cranberry - Oakfern**	
Plot #s	**81-86**	
	Ecosystem	
	$At - Highbush cranberry – Oakfern	
Slope	0-5	
Aspect	999, 166, 205	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Level (lower)	
Structural Stage*	3b/5	
Humus Form	Mull	
Ah	No	
Soil Texture	Fine Sandy Loam – Silt Loam	
Coarse Fragments	0	
Drainage	Well	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Betula papyrifera*	
	Populus balsamifera	
Shrubs	*Cornus sericea*	
	Salix scouleriana	
	Salix bebbiana	
	Rubus idaeus	
	Rosa acicularis	
	Elaeagnus commutata	
Herbs	*Astragalus cicer*	
	Aralia nudicaulis	
	Calamagrostis canadensis	
	Bromus inermis	

Poly 2951 -Plot 86: $At - Highbush Cranberry - Oakfern

Note: $= seral; At = Trembling Aspen

Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon 3059	TEM Code: Fm
TEM Name:	**Mid bench floodplain**
Plot #	**16 -21**
	Ecosystem
	Mid bench floodplain (Fm)
Slope	0 - 2
Aspect	999, 300
SMR	Subhygric (5)
SNR	Rich (D)
Mesoslope	Level - Lower
Structural Stage*	3b
Ah	No
Humus Form	None
Soil Texture	Fine Sandy Loam
Coarse Fragments	90-95
Drainage	R
Seepage	No
Mottling	No
Gleying	No

Dominant Vegetation

Trees	-
Shrubs	*Populus balsamifera*
Herbs	*Oxytropis campestris* var. *davisii* *Medicago lupulina* *Poa pratensis* *Bromus inermis* *Medicago sativa*

Poly 3059 -Plot 18: Mid bench floodplain (Fm)

Note: Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon 3148		TEM Code: Fm
TEM Name:	**Mid bench floodplain**	
Plot #s	**34 – 39**	
	Ecosystem	
	Mid bench floodplain (Fm)	
Slope	0	
Aspect	999	
SMR	Subhygric (5)	
SNR	Very poor (A) – Poor (B)	
Mesoslope	Level	
Structural Stage*	3b	
Humus Form	None	
Ah	None	
Soil Texture	Sand – Silty Loam	
Coarse Fragments	0 -90	
Drainage	Well - Rapid	
Seepage	No	
Mottling	No	
Gleying	No	

Dominant Vegetation

Trees	-
Shrubs	*Populus balsamifera*
Herbs	*Astragalus cicer*
	Bromus inermis
	Poa pratensis

Poly 3148 – Plot 39: Mid bench floodplain (Fm)

Note: Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon 3232		TEM Code: AM
TEM Name:	**Sw - Trailing Raspberry - Stepmoss**	
Plot #s	**1 - 9**	
	Ecosystem	
	Sw - Trailing Raspberry – Stepmoss (AM)	
Slope	0 - 3	
Aspect	999, 200 - 300	
SMR	Mesic (4) (Subhygric (5))	
SNR	Medium (C) (Medium (D))	
Mesoslope	Level, Lower, Toe, Middle	
Structural Stage*	5 - 6	
Humus Form	Moder	
Ah	No	
Soil Texture	Fine Sandy Loam – Silt Loam	
Coarse Fragments	0	
Drainage	Moderate	
Seepage	No	
Mottling	No	
Gleying	No	

Dominant Vegetation

Trees	*Picea glauca*
	Populus balsamifera
Shrubs	*Rosa acicularis*
	Picea glauca
	Alnus incana
	Cornus sericea
	Viburnum edule
	Rubus idaeus
Herbs	*Linnaea borealis*
	Aralia nudicaulis

Poly 3232 – Plot4: Sw – Trailing Raspberry – Stepmoss (AM)

Note: Sw = White Spruce

Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon 3239	TEM Code: SHac
TEM Name:	**$At - Highbush cranberry - Oakfern**
Plots #s	**28 - 33**
	Ecosystem
	$At - Highbush cranberry – Oakfern (SHac)
Slope	0 - 6
Aspect	999, 165, 190
SMR	Subhygric (5)
SNR	Medium (C) (Poor (B))
Mesoslope	Level
Structural Stage*	6 (4)
Humus Form	Moder
Ah	No
Soil Texture	Fine Sandy Loam – Silt Loam – (Sand)
Coarse Fragments	0
Drainage	Moderate
Seepage	No (yes @15 cm in plot 32)
Mottling	No (yes in plot 32)
Gleying	No

Dominant Vegetation

Trees	*Picea glauca*
	Populus balsamifera
Shrubs	*Alnus incana*
	Rubus idaeus
	Rosa acicularis
	Cornus sericea
	Symphoricarpos albus
Herbs	*Maianthemum canadense*
	Aralia nudicaulis
	Maianthemum stellatum

Poly 3239 – Plot 32: $At - Highbush cranberry – Oakfern (SHac)

Note: At = Trembling Aspen

Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon	3284	TEM Code:	Fl
TEM Name:	**Low Bench Floodplain**		
Plot #s	**22 - 27**		
	Ecosystem		
	Low Bench Floodplain (Fl)		
Slope	0		
Aspect	999		
SMR	Subhygric (5)		
SNR	Medium (C), (Poor (B))		
Mesoslope	Level		
Structural Stage*	3b		
Humus Form	None		
Ah	None		
Soil Texture	Silt – Fine Sandy Loam		
Coarse Fragments	0		
Drainage	(Well) – Medium – (Imperfect)		
Seepage	No		
Mottling	No (yes @15cm for plot 27)		
Gleying	No		
Dominant Vegetation (in decreasing order)			
Trees	-		
Shrubs	*Salix interior* *Populus balsamifera* *Salix prolixa*		
Herbs	*Trifolium hybridum* *Bromus inermis* *Astragalus cicer* *Melilotus albus* *Medicago sativa*		

Poly 3284 – Plot 24: Low Bench Floodplain (Fl)

Note: Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon 3291		TEM Code: SHac / AMap
TEM Name:	**$At - Highbush cranberry - Oakfern / $At - Rose - Creamy peavine**	
Plot #s	**58 - 63**	
	Ecosystem 1	**Ecosystem 2**
	$At - Highbush cranberry - Oakfern	$At - Rose - Creamy peavine
Slope	12 – 40	0 – 20
Aspect	225 - 268	999, 258
SMR	Subhygric (5)	Submesic (3)
SNR	Very Rich (E)	Rich (D)
Mesoslope	Toe	Crest
Structural Stage*	3b	4
Humus Form	Mull	
Ah	None	None
Soil Texture	Silty Clay	Silty Clay
Coarse Fragments	0 - 2	0
Drainage	Poor	Moderate
Seepage	No	No
Mottling	Yes	No
Gleying	No	No
Dominant Vegetation		
Trees	*Betula papyrifera* *Picea glauca*	*Populus tremuloides*
Shrubs	*Salix bebbiana* *Salix scouleriana* *Elaeagnus commutata* *Cornus sericea* *Rosa woodsii* *Prunus virginiana*	*Populus tremuloides* *Shepherdia canadensis* *Cornus sericea* *Amelanchier alnifolia* *Salix scouleriana* *Rosa acicularis* *Betula papyrifera* *Salix lasiandra* *Picea glauca*
Herbs	*Astragalus cicer* *Trifolium hybridum*	*Astragalus cicer* *Eurybia conspicua*

Note: At – Trembling Aspen

Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Poly 3291 – Plot59: $At - Highbush cranberry - Oakfern / $At - Rose - Creamy peavine

Poly 3291 – Plot 62: $At - Rose - Creamy peavine

Polygon 3367	TEM Code: GB
TEM Name:	**Gravel Bar**
Plot #s	**10 - 15**
	Ecosystem
	Gravel Bar (GB)
Slope	0
Aspect	999
SMR	Hygric (6)
SNR	Poor (B)
Mesoslope	Level
Structural Stage*	3a (1a)
Humus Form	None
Ah	None
Soil Texture	Sand
Coarse Fragments	85-100
Drainage	Rapid (Moderate)
Seepage	No
Mottling	No
Gleying	No

Dominant Vegetation

Trees	-
Shrubs	*Populus balsamifera* *Salix prolixa*
Herbs	*Deschampsia cespitosa* *Allium schoenoprasum* *Agrostis gigantea*

Poly 3367 – Plot 11: Gravel Bar (GB)

Note: Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon 3397		TEM Code: SHac
TEM Name:	**$At - Highbush cranberry - Oakfern**	
Plot #s	**52 - 57**	
	Ecosystem	
	$At - Highbush cranberry – Oakfern (SHac)	
Slope	0 -12	
Aspect	999, 345 - 20	
SMR	Subhygric (5)	
SNR	Mesic (C)	
Mesoslope	Depression (Level, Lower)	
Structural Stage*	6 (3b)	
Humus Form	Mull	
Ah	No	
Soil Texture	Silt	
Coarse Fragments	0	
Drainage	Moderate	
Seepage	No	
Mottling	No	
Gleying	No	

Dominant Vegetation

Trees	*Populus balsamifera*
Shrubs	*Rosa acicularis* *Alnus incana* *Prunus virginiana* *Rubus idaeus* *Prunus virginiana* *Cornus sericea* *Symphoricarpos occidentalis* *Picea glauca*
Herbs	*Aralia nudicaulis*

Poly 3397 – Plot 52: $At - Highbush cranberry – Oakfern (SHac)

Note: Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon 3413		TEM Code: AM / AMap
TEM Name:	**Sw - Trailing Raspberry - Stepmoss / $At - Rose - Creamy peavine**	
Plot #s	**75 - 80**	
	Ecosystem 1	**Ecosystem 2**
	Sw - Trailing Raspberry – Stepmoss (AM)	$At - Rose - Creamy peavine (AMap)
Slope	0	0
Aspect	999	999
SMR	Mesic (4)	Mesic (4)
SNR	Medium (C)	Medium (C)
Mesoslope	Level	Level
Structural Stage*	6	2a
Humus Form	Moder - Mull	Mull
Ah	No	No
Soil Texture	Sand – Silt Loam	Silt Loam
Coarse Fragments	0	0
Drainage	Well - Moderate	Moderate
Seepage	No	No
Mottling	No	No
Gleying	No	No
Dominant Vegetation		
Trees	*Picea glauca* *Populus balsamifera*	*Populus balsamifera*
Shrubs	*Symphoricarpos occidentalis* *Rubus idaeus*	*Cornus sericea* *Symphoricarpos occidentalis* *Rubus idaeus*
Herbs	*Aralia nudicaulis* *Bromus inermis*	*Bromus inermis* *Urtica dioica*

Note: Sw = White Spruce; At = Trembling Aspen; $ = Seral

Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Poly 3413 -Plot 77: $At - Highbush cranberry – Oakfern (SHac)

Poly 3413 – Plot 80: $At - Rose - Creamy peavine (AMap)

Polygon	3448	TEM Code:	GB
TEM Name:	**Gravel Bar**		
Plot #s	**64 – 69**		
	Ecosystem		
	Gravel Bar (GB)		
Slope	0		
Aspect	999		
SMR	Subhygric (5)		
SNR	Rich (D_		
Mesoslope	Level		
Structural Stage*	2b (2a)		
Humus Form	Mull		
Ah	No		
Soil Texture	Loamy Sand – Fine Sandy Loam		
Coarse Fragments	0 -10		
Drainage	Rapid		
Seepage	No		
Mottling	No		
Gleying	No		
Dominant Vegetation			
Trees	-		
Shrubs	*Salix prolixa* *Alnus incana* *Elaeagnus commutata*		
Herbs	*Solidago altissima* *Melilotus albus* *Symphyotrichum lanceolatum* *Arnica chamissonis* *Bromus inermis* *Trifolium hybridum* *Calamagrostis canadensis* *Agrostis gigantea* *Phalaris arundinacea* *Sonchus arvensis*		

Poly 3448 – Plot 68: Gravel Bar (GB)

Note: Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Polygon 3459		TEM Code: Fl03 / Fl06
TEM Name:	**Pacific willow - Red osier dogwood - Horsetail / Sandbar Willow**	
Plot #s	**70 - 74**	
	Ecosystem 1	**Ecosystem 2**
	Pacific willow - Red osier dogwood – Horsetail (Fl03)	Sandbar Willow (Fl06)
Slope	0	
Aspect	999	
SMR	Hygric (6)	Hygric (6)
SNR	Rich (D)	Rich (D)
Mesoslope	Level	Level
Structural Stage*	3b	3b (3a)
Humus Form	Mull	Mull
Ah	No	No
Soil Texture	Sand	Sand – Loamy Sand
Coarse Fragments	0	0
Drainage	Rapid	Rapid
Seepage	No	No
Mottling	No	No
Gleying	No	No
Dominant Vegetation		
Trees	-	-
Shrubs	*Populus balsamifera* *Populus balsamifera* *Salix interior* *Alnus incana* *Salix lasiandra* *Salix prolixa*	*Salix interior* *Salix interior* *Populus balsamifera* *Salix prolixa* *Salix lasiandra*
Herbs	*Sonchus arvensis* *Bromus inermis* *Sympohyotrichum lanceolatum* *Poa palustris* *Equisetum arvense*	*Equisetum arvense* *Symphyotrichum lanceolatum* *Phalaris arundinacea* *Medicago lupulina* *Trifolium hybridum* *Astragalus cicer* *Bromus inermis* *Agrostis gigantea*

Note: Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Poly 3459 -Plot 70: Pacific willow - Red osier dogwood – Horsetail (Fl03)

Poly 3459 -Plot 74: Sandbar Willow (Fl06)

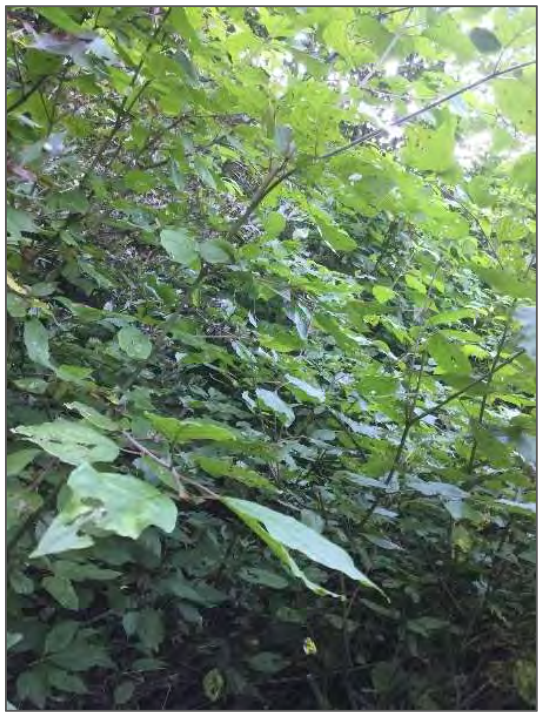
Polygon 4912		TEM Code: AM / SH / Fm02	
TEM Name:	**Sw – Trailing Raspberry – Stepmoss / Sw – Currant – Horsetail / Acb – Sw – Mountain alder – Dogwood**		
Plot #s	**40 – 45**		
	Ecosystem 1	**Ecosystem 2**	**Ecosystem 3**
	Sw – Trailing Raspberry – Stepmoss (AM)	Sw-Currant-Horsetail (SH)	AcbSw – Mountain alder – Dogwood (Fm02)
Slope	65 – 72	5 – 25	14
Aspect	335 – 344	310 – 331	330
SMR	Mesic (4)	Subhygric (5)	Hygric (6)
SNR	Medium (C)	Rich (D)	Very Rich (E)
Mesoslope	Middle (Level)	Lower – Toe	Toe
Structural Stage*	5	4, 3b	3b
Humus Form	Mull	Mull	None
Ah	No	No	Yes (24 cm)
Soil Texture	Silt Loam	Silt – Loam	Silt Loam
Coarse Fragments	16 - 46	0 – 30	0
Drainage	Well	Imperfect – Moderate	Imperfect
Seepage	No	No	Yes (46 cm)
Mottling	No	Yes (6cm)	No
Gleying	No	No	Yes (28cm)
Dominant Vegetation			
Trees	*Betula papyrifera* *Picea glauca* *Populus balsamifera*	*Betula papyrifera* *Picea glauca*	*Betula papyrifera*
Shrubs	*Picea glauca* *Cornus sericea* *Shepherdia canadensis* *Viburnum edule* *Alnus viridis*	*Alnus incana* *Picea glauca* *Cornus sericea* *Viburnum edule*	*Cornus sericea* *Ribes triste* *Salix scouleriana* *Alnus incana* *Picea glauca*
Herbs	*Pyrola asarifolia* *Orthilia secunda*	*Equisetum arvense* *Circaea alpina* *Rubus pubescens* *Mitella nuda* *Galium triflorum*	*Equisetum arvense* *Galium triflorum* *Circaea alpina*

Note: Sw = White Spruce; Acb = Balsam Poplar

Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest

Poly 4912 – Plot 43: Sw – Trailing Raspberry – Stepmoss (AM)

Poly 4912 – Plot 4: Sw-Currant-Horsetail (SH)



Poly 4912 – Plot 40: AcbSw – Mountain alder – Dogwood (Fm02)

Appendix 10. Experimental Rare Plant Translocation Program 2019 Annual Report

Experimental Rare Plant Translocation Program
2019 Annual Report

Date: December 31, 2019

PRESENTED TO:

BC Hydro
1111 West Georgia St, 9th Floor
Vancouver, BC V6E 4G2

PRESENTED BY:

EcoLogic Consultants Ltd.
Unit 4 - 252 East 1st Street
North Vancouver, BC V7L 1B3
Phone: 604 803-7146

TABLE OF CONTENTS

List of Figures

List of Tables

List of Plates

List of Appendices

ACRONYMNS & ABBREVIATIONS

Term	Definition
B.C. CDC	B.C. Conservation Data Centre
ERPT	Experimental Rare Plant Translocation
ENSCONET	European Native Seed Conservation Network
PAZ	Potential Activity Zone
PRS	Potential Recipient Sites
QAQC	Quality Assurance and Quality Control
Spp.	The abbreviation "spp." (plural) indicates "several species".
Sp.	The abbreviation "sp." Refers to a single species.

1. INTRODUCTION

The Experimental Rare Plant Translocation (ERPT) program is designed to establish new or augment existing populations of species of conservation concern that may be affected by the Site C Project. To achieve this goal, the program uses established and where necessary experimental measures. This report summarizes the measures and activities undertaken in 2019. Included is a summary of relevant updates to the conservation ranks species of species of conservation concern within the program and the general methods and activities completed related to propagule collection, ex-situ propagation, translocation and monitoring.

1.1.1 Conservation Rank Updates

Each year the provincial conservation ranks of vascular plants and bryophytes are assessed by the B.C. CDC. This annual assessment incorporates new information about the abundance and distribution of the province's flora, as well as newly recognized threats (or lack of threats) to known populations. Such rank changes often follow periods of intensive survey effort for species that are otherwise poorly known or are informed by surveys from areas that have previously been under-sampled.

Recent rare plant surveys within the Peace River region, many of them associated with the Site C environmental program, have greatly improved understanding of the distribution and frequency of occurrence of the region's rare plants. This has resulted in changes to the provincial status of several species that have been included within the ERPT program.

The ranking update published by the B.C. CDC in July 2019 (B.C. CDC 2019) changed the status of 328 species in the province relative to their status in 2018, including 8 of the 13 species within the ERPT program:

- Two species (*Erigeron pacalis and Rorippa calycina*) were removed from the Red list due to misidentification of the specimens involved. These species do not occur in British Columbia and have been removed from the ERPT program.
- Four species (*Artemisia herriotii*, *Chrysosplenium iowense*, *Cirsium drummondii, Polypodium sibiricum*) were moved from the Blue list to the Yellow list by the B.C. CDC and are no longer considered at-risk species in British Columbia. As a result, these species are no longer part of the ERPT program.
- Two species (*Carex torreyi*, *Epilobium saximontanum*) were moved from the Red list to the Blue list and remain at-risk species in British Columbia. These species remain in the ERPT program.

Based on the ranking update published by the B.C. CDC, 7 of the original 13 species are still considered at risk and therefore remain in the ERPT program (Table 1.1-1).

Table 1.1-1. Species included in the Experimental Rare Plant Translocation Program

Scientific Name	Common Name	BC CDC Provincial Rank	NatureServe Provincial Status	NatureServe Global Status	2019 Rank Change
Carex sprengelii	Sprengel's sedge	Blue	S3	G5	-
Carex torreyi	Torrey's sedge	Blue	S3?	G4G5	x
Carex xerantica	dry-land sedge	Blue	S3[1]	G5	-
Epilobium saximontanum	Rocky Mountain willowherb	Blue	S3	G5	x
Oxytropis campestris var. *davisii*	Davis' locoweed	Blue	S3[1]	G5T3	-
Penstemon gracilis	slender penstemon	Blue	S3[1]	G5	-
Ranunculus rhomboideus	prairie buttercup	Blue	S2S3	G5	-

The ERPT program is updated on an ongoing basis to incorporate relevant information related to target rare plant species and translocation methods as it emerges .

[1] Rank changed from S3? To S3.

2. GENERAL METHODS

2.1 PHASE 1. PROPAGULE COLLECTION

2.1.1 In-Situ Seed Collection

The 2019 seed collection focused on acquiring propagules from natural species occurrences, according to a prioritization based on the project land-clearing schedule; the presence/absence of seeds held at the native plant nurseries from previous collections; and the conservation status of the species. Propagule collection was conducted in accordance with the decision framework established for the ERPT program (Appendix D of BC Hydro 2019) using guidance outlined by the Royal Botanic Gardens (Millennium Seed Bank Partnership 2014), the BC Ministry of Environment (Maslovat 2009), and the European Native Seed Conservation Network (ENSCONET 2009).

The field team collected from as many plants as possible if there was only the one opportunity to collect (e.g., clearing activities scheduled to occur in 2019), and from approximately 10% of the occurrence if there was more than one opportunity to collect. The field team aimed to capture a range of genetic variability by sampling a minimum of 25 plants per species occurrence, while taking into consideration the potential negative effects of the collection on the occurrence. In instances with larger populations (i.e., more than 25 plants), the rare plant occurrences were divided into distinct sampling quadrants. Seed collectors targeted a minimum of 500 seeds at sites with 100 or more plants to increase the genetic diversity of the sample and the opportunities to propagate the plants at both Twin Sisters Plant Nursery (Twin Sisters) and NATS native plant nurseries (NATS). Seeds are being stored at NATS and Twin Sisters for more in-depth analysis and care.

2.1.2 Ex-Situ Seed Collection

The 2019 seed collection efforts also focused on acquiring seeds that developed on nursery plant stock originating from the 2017 seed collection from the Peace River Region. Seeds and/or seed heads were collected from nursery stock and then sorted to remove non-viable seeds (i.e., empty or poorly developed). The remaining seeds were cleaned and dried (when necessary) following collection to maximize viability. Cleaning included the removal of waste material from around the seed capsule, and the use of sieves, hand separation, and water baths. Seeds were then placed in cold storage at the nursery to maintain seed quality and longevity. The provenance, seed collection procedures, and quantity collected were recorded.

2.2 PHASE 2. EX-SITU PROPAGATION

Ex-situ propagation involved stratification and propagation for each individual target species in a nursery environment. Curation Protocols and Recommendations (ENSCONET 2009) and professional horticultural experience were used to inform the methods for this aspect of the program.

Seeds that were slated for immediate planting were scarified and/or stratified as required, whereby they were treated with rough sand and either cold temperatures or moist heat to simulate natural germination conditions. Through the pre-treatment and stratification process, seeds were treated to simulate the relevant natural conditions for breaking seed dormancy and initiating germination. Seeds that were not intended for immediate planting were not treated and are being stored until Spring 2020, at which time they will be treated and planted.

Propagation methods were developed based on the ecological conditions observed at the source populations and included several measures and considerations (Vallee et al. 2004; Maslovat 2009):

- examination of the ecological and, if available, translocation literature to determine experimental trials, including optimum founder plant size, reproductive status relevant to propagation for each rare plant species, and out- planting requirements;
- review of common garden experiments as a potential source of horticultural information for a specific target species;
- exploration and implementation of a range of techniques (e.g., varying soil media) to determine the most effective propagation options for each target species;
- multiple germination trials to determine viability; and
- holding back source propagules in an ex-situ collection as material for future propagation.

All utilized ex-situ propagation methods have been documented including the following:

- provenance (i.e., origin of material collected);
- type of material collected (e.g., seed);
- location and date of collection; and
- growing conditions such as potting media, temperature of propagation area, watering and treatment of seeds.

2.3 PHASE 3. TRANSLOCATION

Translocation implementation included four components: 1) recipient site selection, 2) transport and plant preparation, 3) characterization of source population, and 4) translocation to recipient sites within the Peace Region.

2.3.1 Recipient Site Selection

Suitable recipient site selection, based on the species-specific preferred habitat characteristics, was informed by the extensive existing information collected for Site C along with the expert knowledge of qualified botanists who performed the field verification work (Appendix A - Site C Experimental Translocation Project: Potential Recipient Site Selection Methods & Results Memo). Sites selected contained habitat analagous to the source occurrences in areas that are unlikely to be developed by

industry in the foreseeable future. In some cases, sites also contained one or more target rare plant occurrences. All sites selected are located within 50 km surrounding Site C.

The stated goal of recipient site selection was to locate two suitable recipient sites for most of the priority taxa. Prior program planning indicated a need to identify 17 recipient sites to accommodate the planned number of propagules in 2019. Ten taxa[2] were initially included in the scope; however, conservation status updates in 2019 resulted in changes to the provincial status of eight taxa, which resulted in the removal of five species from the ERPT program.

A literature review was conducted for each of the priority taxa to evaluate any new relevant species information. In the process of determining potential recipient sites, aerial imagery, and GIS attributes were visually evaluated for the following:

1. accessible planting areas outside of the Site C Potential Activity Zone (PAZ),
2. Crown land near the Peace River,
3. presence of appropriate rare plant habitat,
4. low levels of both non-native plants
5. low levels of disturbance,
6. planting areas greater than one kilometre from known sites of the same taxon,
7. not already occupied by other rare plant species, and
8. close to a source of water.

Thirty potential recipient sites (PRS) were identified during this desktop exercise, of which 24 received field verification and were ranked for suitability using weighted desirable site characteristics. The six potential planting areas not field-checked presented the most difficult access or contained species that have been removed from the program. Of the sites field checked, five planting areas were considered to be worth investigating further and PRS plots were completed. A cursory survey of these five "best choice" planting areas indicated that four of these areas met the majority of the stated requirements. Two of these planting areas contain a variety of habitats and are suitable for multiple species translocation (See Sites 1 and 2 in Appendix A). The remaining two planting areas were specifically selected for single taxa. Where possible, supplemental planting locations were marked in suitable habitat near these areas to provide increased planting options.

During the course of the field verification surveys, 16 new rare plant sites were discovered: 6 patches of *O. campestris* var*. davisii*, 3 patches of *C. torreyi*, 2 patches each of *C. xerantica* and *R. rhomboideus*, and 1 patch each of *P. gracilis* and *A. herriotii* (the last species has since been removed from the Blue list by

[2] *Epilobium saximontanum* was not included in the 2019 PRS selection. Numerous attempts to locate this species have been made in and around the documented occurrences and within potentially suitable habitat in the region by several botanists, but no individuals of the species have been observed.

the B.C. CDC). Surveyors attempted to avoid occupied sites when reviewing potential planting locations, however, this was only partially successful because suitable planting sites often hosted target rare plant species. At three of the four recommended planting sites, PRS plots either had to be placed less than one kilometre from an already occupied site of the same species, or in the vicinity of other rare plant species; these conditions were accepted as a reasonable compromise given that a sufficient number of suitable unoccupied sites have not been found.

A detailed account of the recipient site selection process is provided in Appendix A.

2.3.2 Transport and Plant Preparation

Nursery plugs were transported from Twin Sisters' nursery in West Moberly on 5 June 2019 to Dunvegan Gardens nursery in Fort St. John. Robust individuals were held at Dunvegan Gardens nursery until transplant at recipient sites. Dunvegan Gardens was selected for its proximity to the PRS and was used as a local laydown for withdrawal of plants required for the ERPT program. Seedlings not scheduled to be outplanted remained at Dunvegan Gardens. At the end of all 2019 planting opportunities, remaining *O. campestris* var. *davisii* plugs were naturally hardened off and stored locally at a private residence in Taylor, B.C. Remaining plants were placed in a metal enclosure surrounded by soil and covered with wire mesh to protect the seedlings from environmental conditions and potential herbivory (Plate 2.3-1).

Plate 2.3-1. Remaining *O. campestris* var. *davisii* plugs in over-winter storage conditions, Taylor, BC. Measures have been taken to protect seedlings from environmental conditions as well as herbivory.

2.3.3 Characterization of Source Population Site Conditions

Designing effective conservation strategies rests in part on an ability to understand the specific ecological requirements of a given species. In past years of the program, habitat characterization efforts have largely focused on understanding species-specific preferred habitat characteristics at the site level. This was necessary to be able to identify potential recipient sites within the larger landscape of the Peace Region. As more information emerges and the knowledge of habitat requirement increases, more focus is being placed on identification of optimal microsite habitat. Microsite habitat characteristics may be critical for maintaining rare plant populations and enhancing native species' population viability (Wendelberger and Machinski 2016).

In 2019, characterization of microsite conditions was conducted at three randomly selected existing occurrences of *O. campestris* var. *davisii* along the Peace River (Plates 2.3-2 and 2.3-3). Transects between 25 m and 50 m were established. At each 1-m interval along a transect, presence-absence data for substrate, vegetation, biocrust, and litter were collected.

Plate 2.3-2. Transect established to characterize microsite habitat for *O. campestris* var. *davisii.*

Plate 2.3-3. Microsite habitat for *O. campestris* var. *davisii.*

2.3.4 Translocation to Recipient Sites

The specific timing windows for planting were determined based on the plant phenology, the development stage of the propagated plants, the local weather, temperature, and soil moisture

conditions. The initial out-planting occurred on 13 June and 23 September 2019. Some plant stock was withheld from planting as insurance should inclement conditions negatively affect the initial out-planting stock. Implementation of the translocation planting included the following:

- placement of plants into optimal microhabitats at the recipient sites, and in a spatial pattern suitable to the rare plant's biology as observed at the source populations or otherwise known;
- installation of durable, long-lasting tags or markers to label individual plants and plant groupings.
- code systems to differentiate various experimental treatments (e.g., plants grown in various soil media during ex-situ propagation efforts), as needed to retain as much information as possible on the pathway of a given plant (e.g., from seed collection to planting) to facilitate annual assessments of success;
- marked boundaries for plants, plant groupings, and translocation site boundaries using GPS points and imported into the project GIS system;
- care and maintenance at the time of planting, such as watering, and creation of microhabitat as necessary; and
- documentation of each translocation effort (including time spent on each phase), which includes the methods used to prepare and transport the material from the nursery to the recipient site, day of pre-translocation site preparation, environmental conditions, method of re-introduction, care and maintenance activities, planting density, and spatial pattern.

2.4 PHASE 4. MONITORING

The monitoring program documents a suite of parameters designed to evaluate the efficacy of translocation methods in relation to the stated objectives of the program (IUCN/SSC 1998; Sutter 1996 in Monks and Coates 2002; Austin 2004; Vallee et al. 2004; Maslovat 2009; Vaino 2011). Monitoring activities were initiated in 2019 to assess the survival of individuals translocated in 2018. Key metrics included:

- individual plant health (e.g., dead, alive, growth measures, increase in number of stems, observations of herbivory or fungal attack, dieback); and
- reproductive success markers (e.g., flowering, seed/fruit set, seedlings).

Monitoring activities also re-evaluated sites for the one or more of the following:

- invasive species, especially those closely surrounding the founder plants, and/or any species that may have inadvertently been introduced to the site during the translocation;
- herbivory or other possible problems (e.g., pest insects, trampling, vandalism); and
- microsite habitat preferences.

2.5 QUALITY CONTROL AND ASSURANCE – DATA CAPTURE METHODS

To ensure comparability of results across sites and species, numerous field personnel are required to perform field activities, make observations, and record data annually using standard and consistent methods. Quality assurance and quality control (QAQC) measures are used for capturing data within the field program so that methods are consistently replicated across all trials, and to ensure that pertinent variables or variations in methodology are recorded.

The 2018 data capture form (Appendix C) was updated in the 2019 field season to an electronic mobile onsite inspection form using DoForms™ and was expanded to include fields for recording seeding and monitoring information (Appendix D). Data were uploaded at the end of each field day to a cloud server.

In certain cases, data collection using the mobile form was less effective than conventional methods, such as percent covers. In these cases, data were entered directly in Excel and incorporated into the overall dataset. Each individual data capture form was tracked using a unique informative identifying code built of the components indicating the species, the nursery of origin, and the full date of the transplant. Where individual plant tracking was required, "*n*" indicated the n^{th} individual associated with a unique aluminum tag number.

3. RESULTS

3.1 PHASE 1. PROPAGULE COLLECTION

The 2019 propagule collection efforts resulted in successful seed collection for six of the seven target species: *Carex sprengelii*, *C. xerantica*, *C. torreyi*, *O. campestris* var. davisii, *P. gracilis*, and *R. rhomboideus* (Table 3.1-1). One species, *E. saximontanum,* remains undetected. Seed collection activities occurred for *C. drummondii* prior to the status change from the B.C. CDC that resulted in its removal from the ERPT program.

Seed collections were taken from various locations within the Peace Region including Bear Flat, Fish Creek, Farrell Creek, Watson's Slough, and various sites along the Peace River in July and August (Figure 3.1-1). Field collections were made for *C. sprengelii* (26 seeds), *C. torreyi* (350 seeds), *O. campestris* var. *davisii* (600 seeds), *P. gracilis* (450 seeds), and *R. rhomboideus* (345 seeds). Multiple collection attempts were required for *C. torreyi* and *P. gracilis,* potentially due in part to cooler temperatures and wetter conditions than average in the Peace Region (Environment Canada 2019) and due to the lack of available information on specific seed timing windows for these species. Seed collections in the field were also attempted for *C. xerantica* and *A. herriotii* (prior to the rank change from Blue to Yellow). However, no viable seeds were detected; the plants seemed to have abortive ovaries with only undeveloped seeds.

Seed collections were also taken in June through August from nursery stock. Nursery collections were made for *C. xerantica* (approximately 20,000 seeds; Plates 3.1-1 and 3.1-2), *O. campestris* var. davisii (approximately 11,000 seeds; Plates 3.1-3 and 3.1-4), and *C. drummondii* (approximately 7,000 seeds Plates 3.1-5 and 3.1-6). Seeds were collected from plant stock originating from the 2017 seed collection from the Peace Region. Seeds were processed according to the methods outlined in Section 3.1.2, *Ex-Situ Seed Collection*. Appendix B provides a summary of the collection efforts by species and by year.

Table 3.1-1. Summary of 2019 Propagule Collection Efforts

Species Name	Propagule Amount[1] and Type	Collection Timing	Collection Type	Collection Location
C. sprengelii	26 seeds	August 8	in-situ	Bear Flat
C. torreyi	350 seeds	July 25 and August 8	in-situ	Fish Creek
C. xerantica	125 grams (approximately 20,000 seeds)	throughout July	ex-situ	NATS Nursery
C. drummondii	58 grams (approximately 7,000 seeds)	throughout June	ex-situ	NATS Nursery
O. campestris var. *davisii* (Davis' locoweed)	600 seeds and 12 grams (approximately 11,000 seeds)	July 16 and July 17	in-situ and ex-situ	Peace River-various locations

Species Name	Propagule Amount[1] and Type	Collection Timing	Collection Type	Collection Location
P. gracilis	450 seeds	August 8 and August 23	in-situ	Farrell Creek and Bear Flats
R. rhomboideus (prairie buttercup)	345 seeds	July 2	in-situ	Watson Slough

[1] Precise measurements will be attained in winter of 2020.

Plate 3.1-1. *C. xerantica* seed bank plant stock.

Plate 3.1-2. *C. xerantica* - approximately 125 grams of viable seed collected in 2019.

Plate 3.1-3. *C. drummondii* seed bank stock.

Plate 3.1-4. *C. drummondii* approximately 58 grams of viable seed collected in 2019.

Plate 3.1-5. *O. campestris* var. *davisii* seed bank stock.

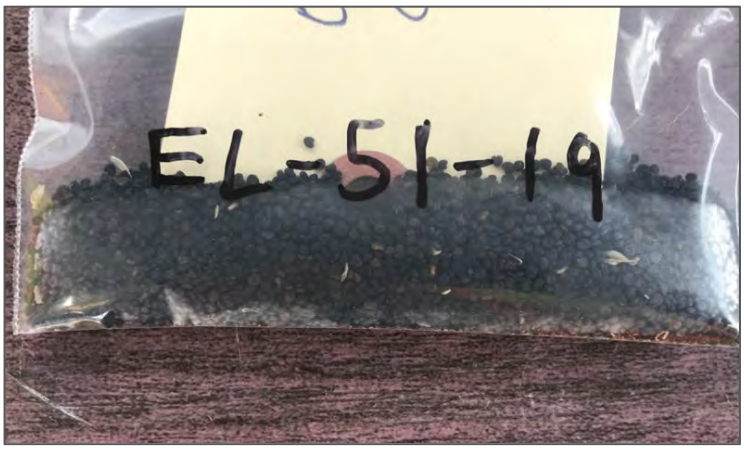


Plate 3.1-6. *O. campestris* var. *davisii* approximately 12 grams of viable seed collected in 2019.

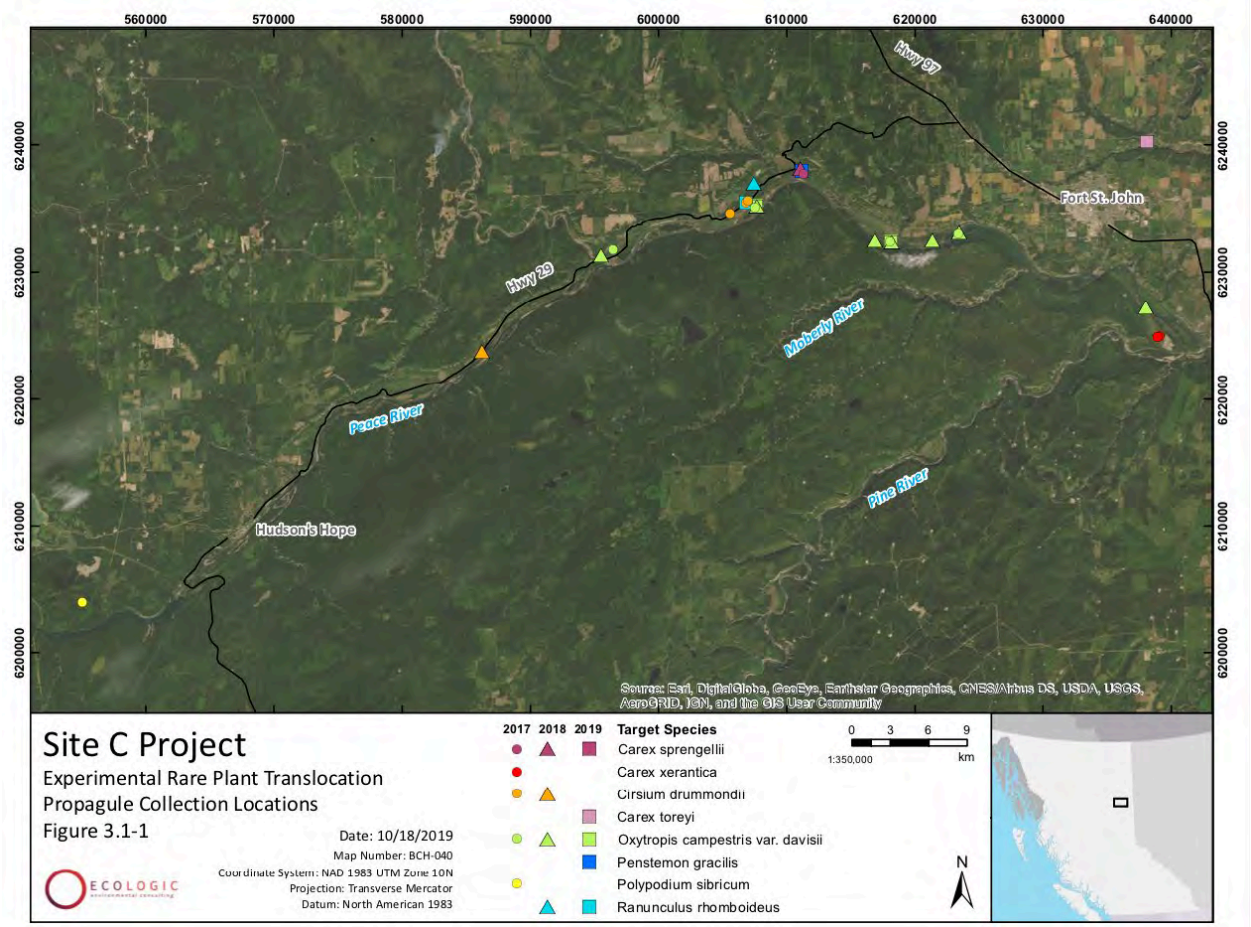


Figure 3.1-1. Experimental Rare Plant Translocation Propagule Collection Locations

3.2 PHASE 2. EX-SITU PROPAGATION

By the end of 2018 there were over 2,700 plants available for the 2019 planting season. As such, few additional plants were propagated in 2019. Efforts focused instead on species that are more difficult to propagate or require longer stratification periods (*R. rhomboideus*), species with few nursery-grown individuals (*C. sprengelli*), and species for which supplemental material may have been required (*C. drummondii*; Table 3.2-1).

In late June of 2019, the ranking update published by the B.C. CDC in 2019 (B.C. CDC 2019) indicated that the number of known occurrences had increased for two species, *C. drummondii* and *P. sibiricum*, such that their rank was changed from Blue to Yellow. As a result, the B.C. CDC was consulted to discuss the rank changes in order to determine the future status of the remaining nursery plants, which consisted of 716 *C. drummondii* and 908 *P. sibiricum.*

By this point, the remaining *C. drummondii* plants had completed their life cycle and seeds had already been collected from the majority of the plants. The seeds are currently being stored at NATS nursery pending further discussion given that there is some uncertainty associated with the status of this species (E. LoFroth, email 04 July 2019).

The remaining *P. sibiricum* plants reside at NATS nursery and have been made available to the public as this species is no longer considered at risk.

Table 3.2-1. Ex- situ Propagation Results from the 2018 Seed Collection Efforts

Scientific Name	Common Name	Nursery of Origin	Quantity
R. rhomboideus	prairie buttercup	NATS	4
C. sprengelii	Sprengel's sedge	NATS	13
C. drummondii	Drummond's thistle	NATS	100
Total			**117**

3.2.1 Propagation trials

On 22 March 2019, translocation trials for *O. campestris* var. *davisii* were initiated to test germination success and plant survival in substrates similar to those of source populations. A total of 320 seeds (40 per tray) were planted within either mixed sand and cobble substrates (Plate 3.2-1) or sand substrates (Plate 3.2-2). Seeding trials were assessed on 11 December 2019 and approximately 9% of the seeds germinated compared to over 80% germination using nursery soils. The seeds and plants within these trials are being used to gather further information on the various life stages of the species including seed germination, leaf production and growth, flowering, and seed production, as available (Plates 3.2-3 and 3.2-4).

Plate 3.2-1. *O. campestris* seedling at NATS on 3 June (73 days after planting).

Plate 3.2-2. *O. campestris* seedling at NATS on 6 September (168 days after planting).

Plate 3.2-3. *O. campestris var. davisii* plants at NATS on 13 December (266 days after planting).

Plate 3.2-4. *O. campestris var. davisii* plant at NATS on 13 December (266 days after planting).

3.3 Phase 3. Translocation Implementation

Translocation implementation included a combination of planting and seeding trials at recipient sites that have greater long-term security than the locations of the source material. The recipient sites are within the known distribution range for the target plant and have similar habitat to the location of the source material.

3.3.1 Carex xerantica

One *C. xerantica* planting trial was established within a Crown parcel on the north side of Highway 29 above Bear Flat (Figure 3.3-1). A total of 50 *C. xerantica* were planted within a grassland area with conditions similar to those of other known occurrences (Figure 3.3-2; Plates 3.3-1 and 3.3-2). *C. xerantica* plants were placed within a small hole (5 cm width x 10 cm depth) excavated for the plug. Soil removed from the excavations was mixed with wetted nursery soil and then used to fill gaps within the hole (Plate 3.3-3). Individual plants were systematically tagged with numbered round aluminum tags (Plate 3.3-4) fixed to the ground using 6-inch ground staples and coloured flagging tape. Each plant was watered sufficiently to saturate the surrounding soil matrix, indicated by an even presence of water visible at the surface.

Individual plants were assessed for the first season's success on 19 July 2019. Of the 50 individuals planted, 40 were alive, 5 were dead, and 5 were absent (Figure 3.3-2). The 40 plants that were alive were in good health. A subsequent visit on 9 August 2019 confirmed that the plants remained in good health and that there were no signs of herbivory. Individuals will continue to be monitored in follow-up years.

PAGE HAS BEEN REDACTED

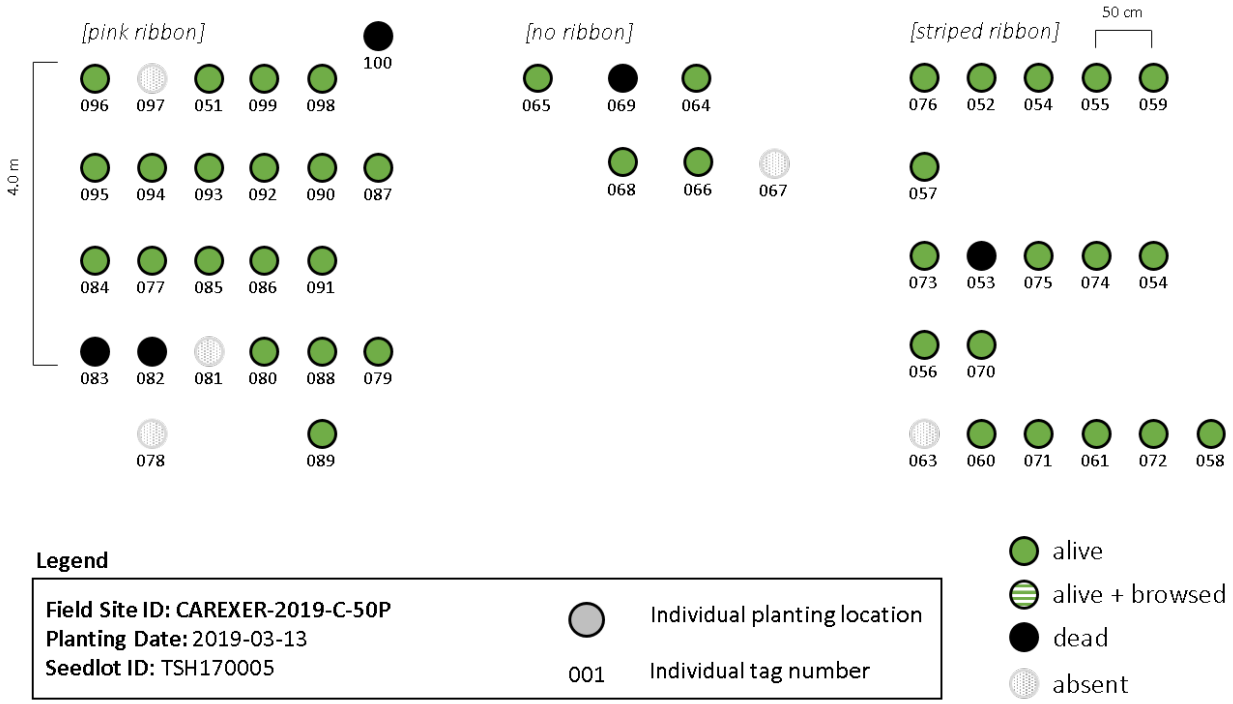


Figure 3.3-2. Field Site ID: CAREXER-2019-C-50P - planting map for *C. xerantica* ex situ propagated seedlings

Plate 3.3-1. Eastward view of the recipient site (CAREXER-2019-C).

Plate 3.3-2. Westward view of the recipient site (CAREXER-2019-C).

Plate 3.3-3 Local technician preparing the soils and water mix to place within the excavated hole along with the plant.

Plate 3.3-4. Installed *C. xerantica* plug and identification tag.

3.3.2 *Oxytropis campestris* var. *davisii* Seeding Trials

O. campestris var. *davisii* seeds were stratified on 9 June 2019, 24 hours prior to being direct-seeded in natural conditions at the recipient sites on 10 June 2019. The stratification method used was identical to the process employed at the nurseries, which has demonstrated the best success. At the time of seeding, both of the proposed recipient sites were reviewed for a final time; only one was selected to host seeding trials due to its more suitable and available distribution of preferred habitat. A 10 m x 10 m network of numbered grids was overlaid on the potential habitat on a map of the recipient sites. Grid squares were randomly selected for inspection, but only grids with potentially suitable habitat (cobble or sand; Plate 3.3-5) were selected for quadrat placement and seed installment.

Quadrats with a row-column configuration of strings that intersected at 50 points were placed in a way that minimized microsite disturbance. Quadrat corners were marked with flagged ground staples and numbered aluminum tags. Ordination was recorded and the quadrat was photographed in context. A total of 18 quadrats were distributed across the recipient site. A single seed was planted at each row-column string intersection for a total of 50 seeds per quadrat, and a total field seeding trial consisting of 900 stratified seeds (Plate 3.3-6).

Seeding trials were assessed for the first season's germination success on 18 September 2019 by examining the placement location (row-column string intersection) for each individual seed. Presence or absence of an *Oxytropis* germinant at each location was recorded along with the microsite conditions at each seed placement location. Seeding locations will continue to be monitored in follow-up years.

Plate 3.3-5. Seeding quadrats within sand and within cobble microsites.

Plate 3.3-6 Local technician placing seeds according to the planting design within the quadrat.

3.4 MONITORING

Monitoring was initiated in 2019 to assess the survival of the individuals translocated in 2018. The information collected will be used to identify possible pathways of success or failure and to identify opportunities for improvement.

3.4.1 Cirsium drummondii

Monitoring of *C. drummondii* individuals planted in September 2018 occurred three times over the course of the 2019 field season: 15 May, 7 June and 18 July. The initial reconnaissance trip focused on identifying if the plants were still present and, if so, whether they survived the winter. A selection of individuals from both planting groups (i.e. the 50P size plugs and the 1 Gallon (G) pots[3]) were assessed. Of the 14 50P size plugs assessed, eight were alive and were generally in good health (Plates 3.4-1 and 3.4-2). Of the ten 1G size assessed, nine were alive and in good health (Figure 3.4-1; Plate 3.4-3) and one was dead. The second trip focused on collecting first-year growth assessments from the 1G individual *C. drummondii* such as presence and number of flowering stalks, longest leaf and aboveground biomass at peak growing. Biomass assessments were standardized by collecting digital photos of the live biomass against a high-contrast background of a known and standard size (Plate 3-4.4). Several of the plants had flowering stalks and in many cases more than one. The focus of the third and final trip was to determine if any of the plants had produced seeds. Of the nine plants assessed, seven had produced seeds (Plate 3.4-5). While on site, the head grower from NATS assessed the seeds and indicated that there were a large number of seeds that appeared to be viable.

[3] These plants were grown at the same time but in different container sizes.

Plate 3.4-1. Several of the 50P size plugs were alive when assessed on 15 May.

Plate 3.4-2. The 50P size plugs that were alive were generally in good health on 15 May.

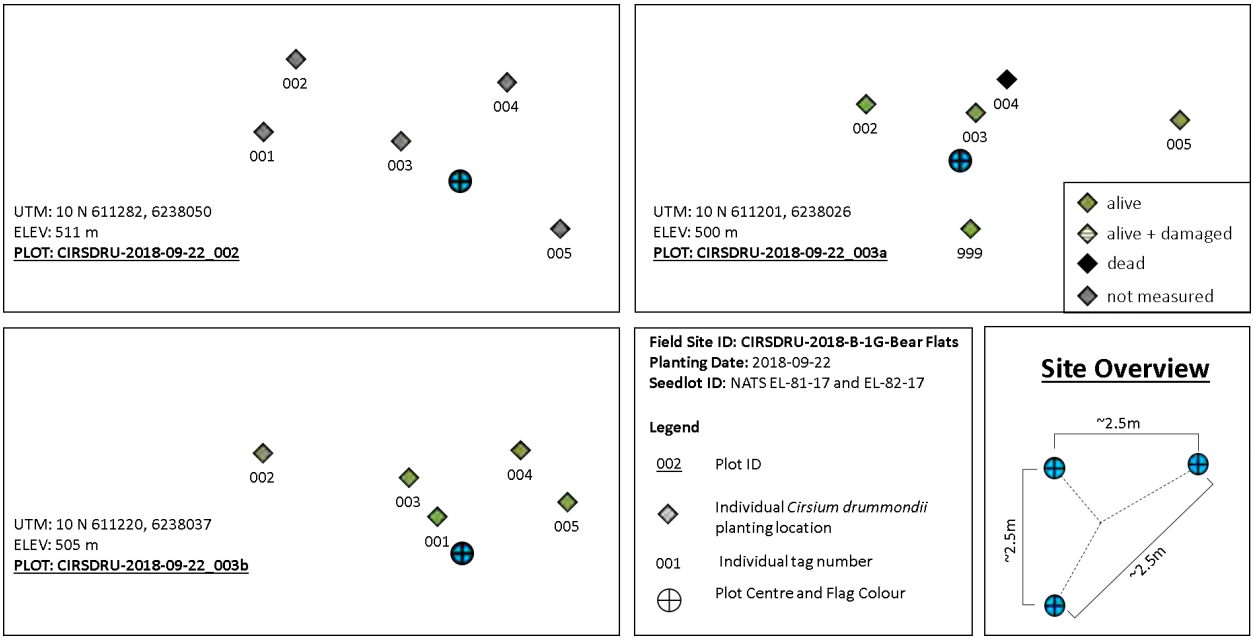


Figure 3.4-1. Field Site ID: CIRSDRU-2018-B-1G-Bear Flat planting grid and 2019 monitoring results for *C. drummondii*

Plate 3.4-3. Large rosette of a *C. drummondi* plant on May 15th.

Plate 3.4-4. Large rosette of a *C. drummondi* plant with a flowering stalk on June 7th.

Plate 3.4-5. *C. drummondi* plant producing seed July 18th.

3.4.2 *Carex xerantica*

Monitoring of the *C. xerantica* individuals planted at Bear Flat (ID: CAREXER-2018-A-50P) in September 2018 occurred on 12 June 2019. Of the 45 individuals planted, 17 were alive (15 of which had been browsed), 6 were dead (all of which had been browsed), and 22 were absent. The 17 plants that were alive were generally in good health (Figure 3.4-2). Individuals will continue to be monitored in follow-up years.

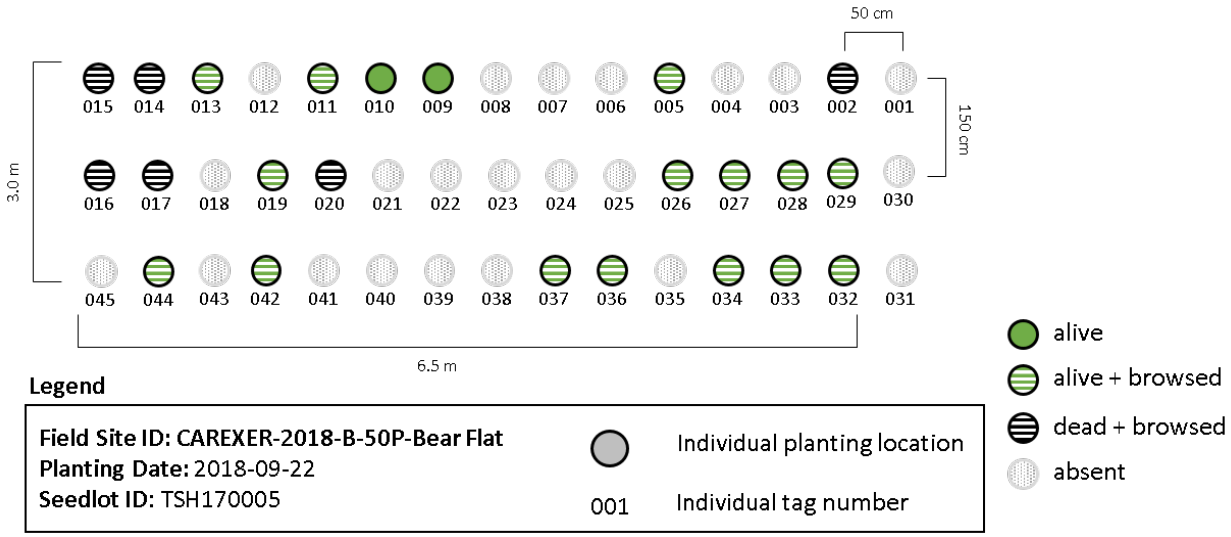


Figure 3.4-2. Field Site ID: CAREXER-2018-A-50P-Bear Flat planting grid and 2019 monitoring results for *C. xerantica*

Monitoring of the *C. xerantica* individuals planted at the second Bear Flat location (ID: CAREXER-2018-B-50P) in September 2018 occurred on 12 June 2019. Of the 42 individuals planted, 7 were alive (4 of which had been browsed), 9 were dead (all of which had been browsed), and 26 were absent. The plants that were alive were generally in good health (Figure 3.4-3). Individuals will continue to be monitored in follow-up years.

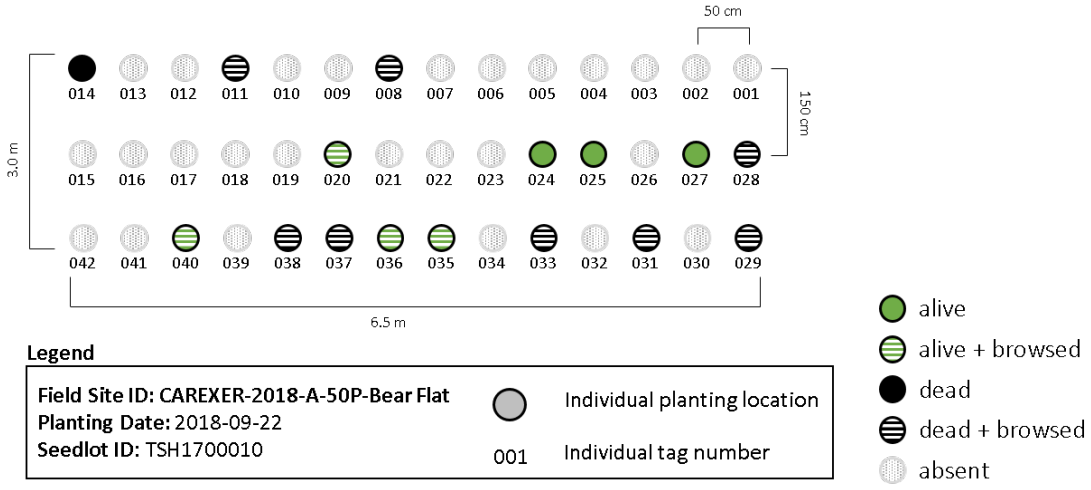


Figure 3.4-3. Field Site ID: CAREXER-2018-B-50P-Bear Flat planting grid and 2019 monitoring results for *C. xerantica*

3.4.3 *Carex sprengelii*

Monitoring of the *C. sprengelli* individuals planted at Bear Flats (ID: CARESPR-2018-A-50P) in September 2018 occurred on 15 May and 7 June 2019. Of the 6 individuals planted, three were alive on the first trip, one was not detected and two were dead. On the second visit, one was alive, four were dead and one remained undetected. The plant that was alive was identified as *C. xerantica* not *C. sprengelli* (Figure 3.4-4), indicating a potential plant identification error during seed collection or during ex-situ propagation.

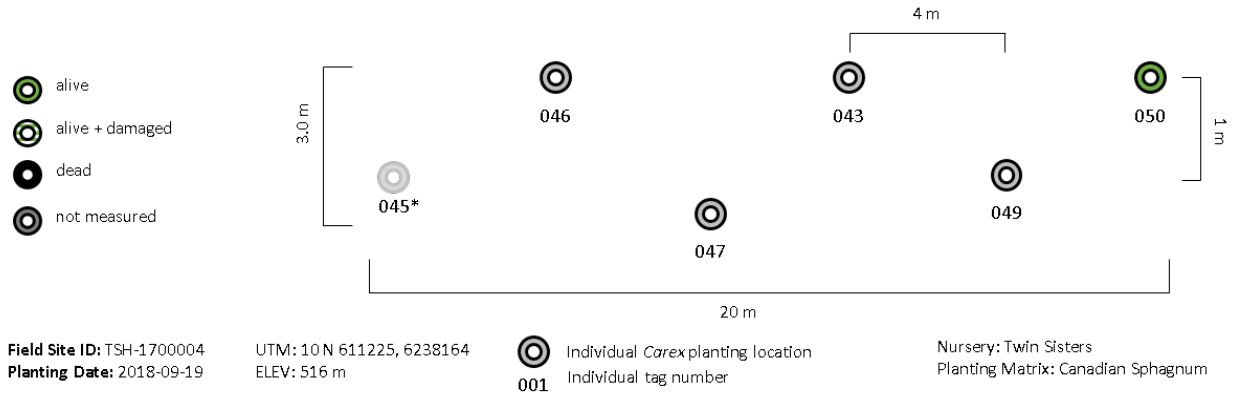


Figure 3.4-4. Field Site ID: CARESPR-2018-50P-Bear Flat - 2019 monitoring results for *C. sprengelii*

3.4.4 Oxytropis campestris var. *davisii*

Monitoring of the 155 *O. campestris* var. *davisii* individuals planted in September 2018 occurred on 21 September 2019. Twenty one of the 57 individuals planted on transect 1 survived, 23 died and 13 were absent (Table 3.4-1 and Figure 3.4-5). Twenty one of the 48 individuals planted on transect 2 survived, 15 died and 12 were absent (Figure 3.4-6). Eighteen of the 50 individuals planted on transect 3 survived, 21 died, and 11 were absent (Figure 3.4-7). In summary, 64 of the plants survived, 57 died and 37 were absent.

Table 3.4-1. Monitoring 2019 Results- *O. campestris* var. *davisii*

Transect Number	Planted	Survived	Died	Absent	% Survived
1	57	21	23	13	36.8
2	48	21	15	12	43.8
3	50	18	21	11	36.0
Total	**155**	**60**	**59**	**36**	**38.7**

Additional information collected included health indicators (leaf length, number of plant nodes), presence and number of flowering stalks as well as microsite conditions (substrate, vegetation, biocrust, and litter). Individuals will continue to be monitored in follow-up years.

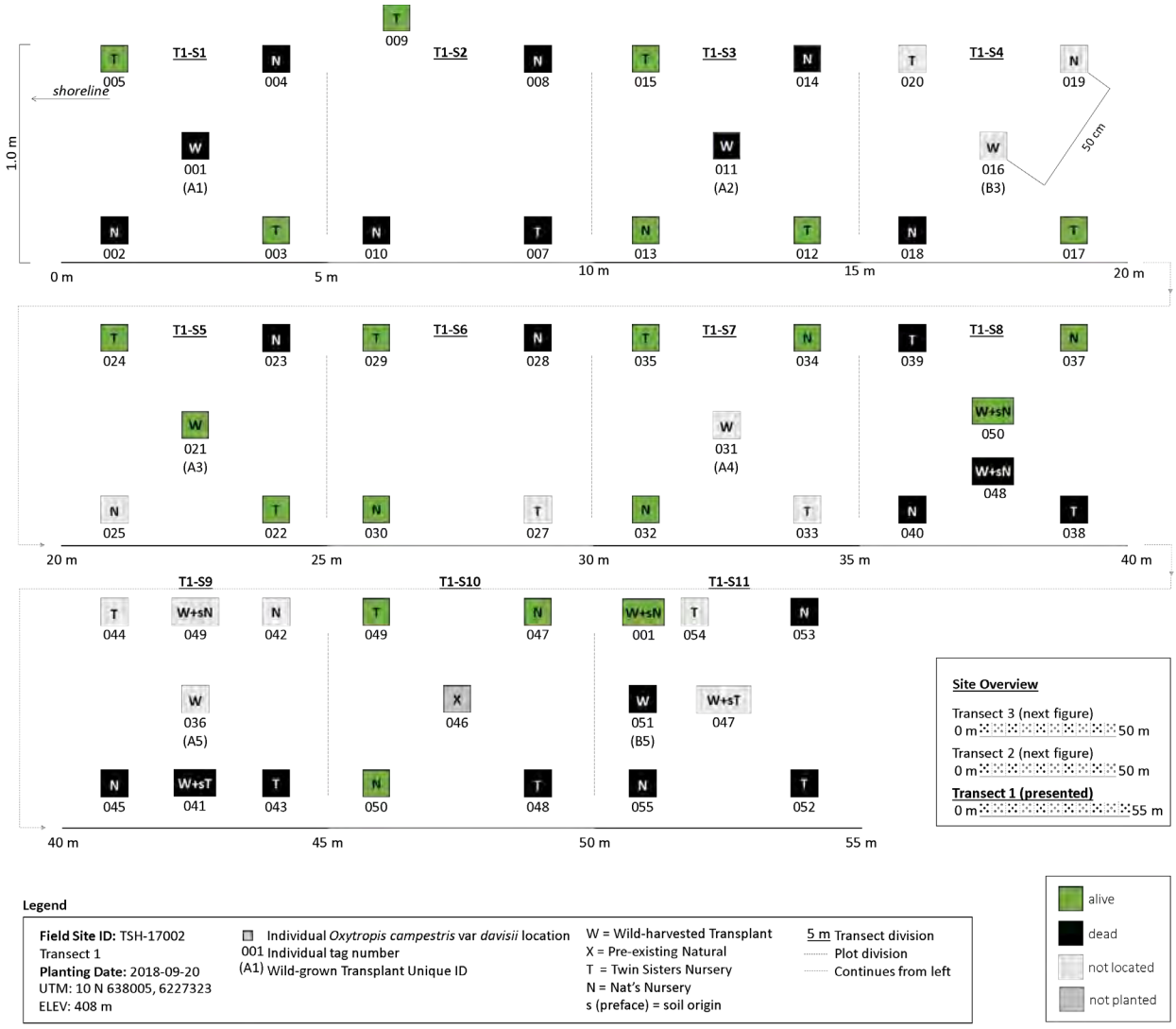


Figure 3.4-5. Field Site ID: OXYTCAM3-2018-001-Transect 1- 2019 monitoring results for *O. campestris* var. *davisii*

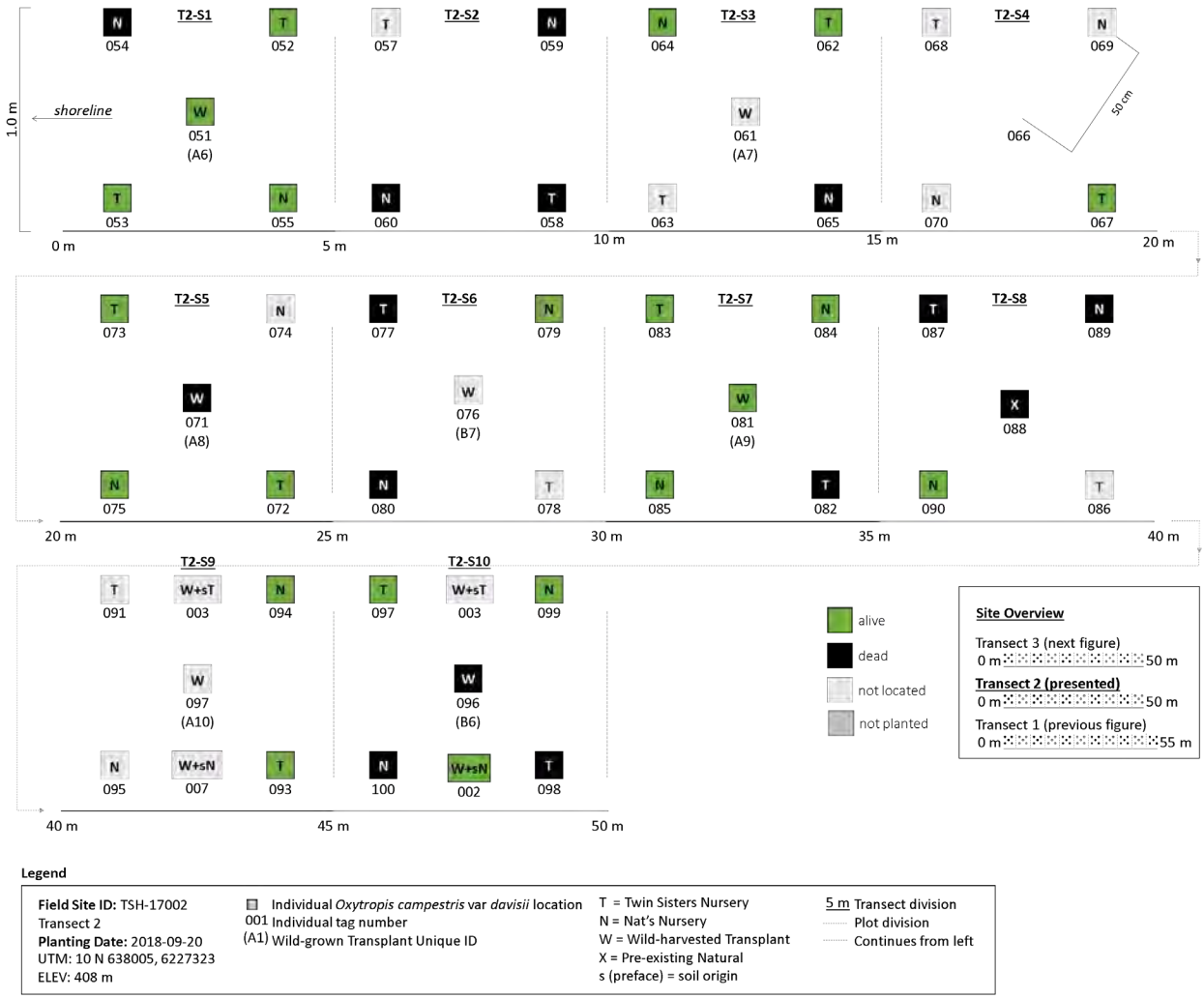


Figure 3.4-6. Field Site ID: OXYTCAM3-2018-001-Transect 2- 2019 monitoring results for *O. campestris* var. *davisii*

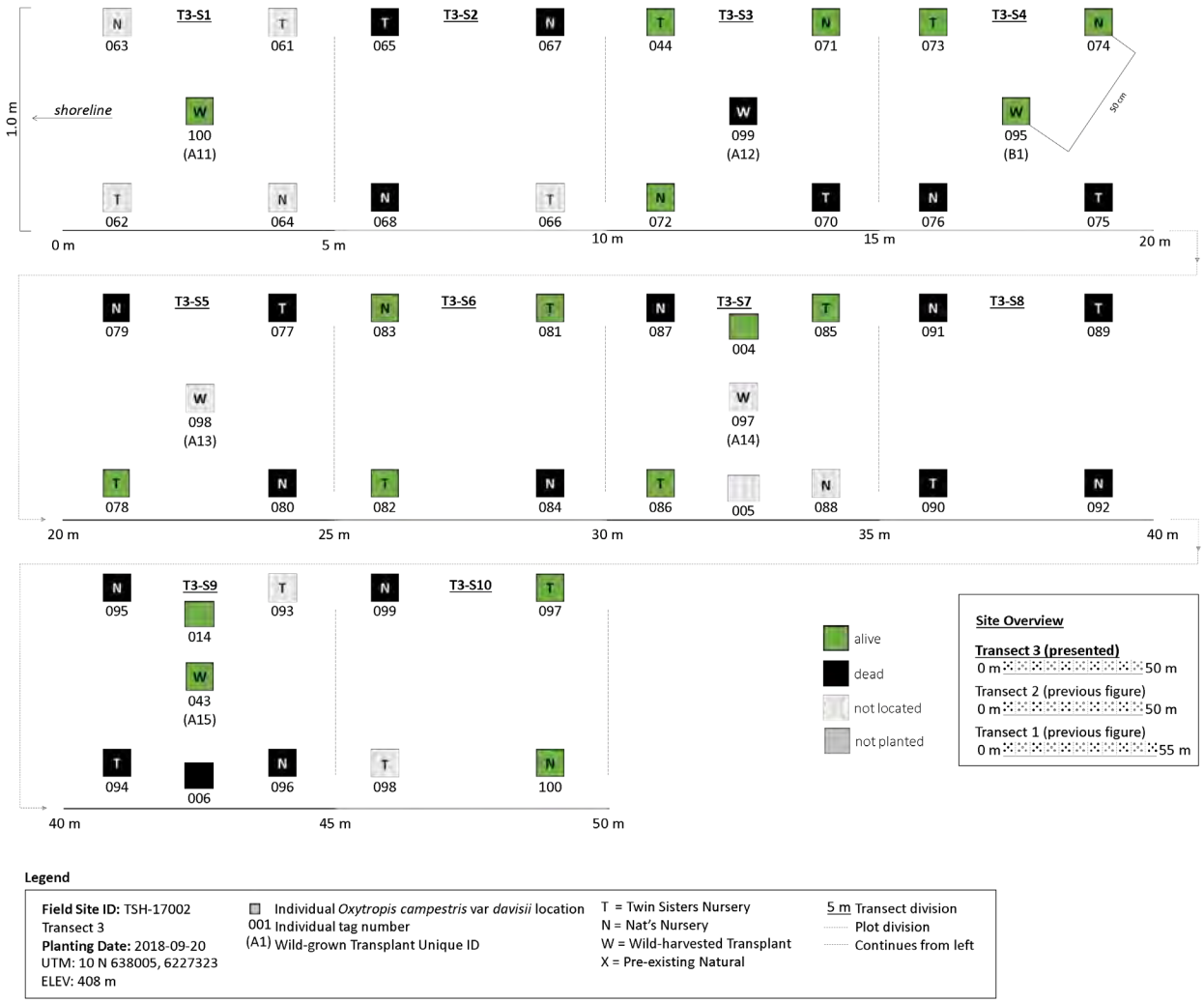


Figure 3.4-7. Field Site ID: OXYTCAM3-2018-001-Transect 3- 2019 monitoring results for *O. campestris* var. *davisii*.

3.5 PLAN FORWARD

The information collected from the previous years is being used to evaluate the efficacy of translocation methods in relation to the stated objectives of the program and to inform revisions to the 2020 program. The information gained from the experimental approach is being used to identify which approaches are effective and to isolate inadequacies in specific methods or management. Monitoring the success or failure of the methods is assisting in identifying opportunities for improvements to each of the program phases, where warranted, within an adaptive management framework.

Specific mitigation will be implemented to reduce browse and drought impacts on planted *Carex xeratica* and *Carex sprengelii*. The steps in place to avoid future instances of mortality associated with heavy browse in relation to *C. xerantica* will include the following:

- Continued planting within recipient sites that have lower risk of browse (i.e. lower forage potential);
- Continued planting in the spring to allow for increased monitoring;
- Increased frequency of monitoring to assess the survival and general health of the planted individuals; and
- Fencing if warranted. In 2019, fencing materials were purchased for CAREXER-2019-C-50P but fencing was not erected as the monitoring results indicated high survival throughout the summer and fall.

The steps in place to avoid future instances of mortality associated with drought in relation to *Carex sprengelii* will include the following:

- Continued placement of plants into microsites that have sustained moist conditions.
- Continued planting in the spring to allow for increased monitoring; and
- Increased frequency of monitoring to assess the survival and general health of the planted individuals.

REFERENCES

Albrecht, M.A., Guerrant, E. Jr., Machinski, J., and Kennedy, K. (Editorial). 2011. A long-term view of rare plant reintroduction. A response to Godefroid et. al. 2011. *How successful are plant reintroductions*? Environmental Science and Management Faculty Publications and Presentations. Paper 32. Retrieved from: http://pdxscholer.library.pdx.edu/esm_fac/32

B.C. CDC. 2019. *Recent Data Changes*. Available online: https://www2.gov.bc.ca/gov/content /environment/plants-animals-ecosystems/conservation-data-centre/explore-cdcdata/ conservation-data-centre-updates.

Carlsen, T.M., L. Patterson, and T. Alfaro. 2011. *Managing Natural and Reintroduced Rare Plant Populations within a large Government Reservation*. Rare Plants in Government Reservations. Proceedings of the CNPS Conservation Conference. 17-19 Jan 2009.

EcoLogic. 2019. *Site C Clean Energy Project Experimental Rare Plant Translocation*. Prepared for BC Hydro Ltd. By EcoLogic Consultants Ltd.

ENSCONET. 2009. *Seed Collecting Manual for Wild Species*. Main editors: Royal Botanic Gardens (UK) & Universidad Politécnica de Madrid (Spain). Edition 1: 17 March 2009.

Clements D.R. 2013. Translocation of rare plant species to restore Garry Oak ecosystem in western Canada: challenges and opportunities. *Botany*, 283. 91. doi:10.1139/cjb-2012-0269.

Guerrant, E.O. 1996. Designing populations: demographic, genetic and horticultural dimensions. In D.A. Falk, C.I. Millar, and M. Olwell, (eds). *Restoring diversity: strategies for reintroduction of endangered plants*. (pp 171–207). Center for Plant Conservation, Missouri Botanical Garden and Island Press, Washington, DC.

Guerrant., E.O. Jr., and Kaye, T.N. 2007. Reintroduction of rare and endangered plants: common factors, questions, and approaches. *Australian Journal of Botany*, 55:362-370.

Guerrant., E.O. Jr. 2013. The Value of Proprietary Reintroduction as a Conservation Tool for Rare Plants. Environmental Science and Management Faculty Publications and Presentations. Paper 33. Retrieved from: http://pdxscholar.library.pdx.edu/esm_fac/33

Guerrant, E.O. Jr., Havens, K., and Vitt, P. 2014. Sampling for Effective Ex Situ Plant Conservation. *International Journal of Plant Sciences*, 175 (1), 11-20. Doi:10.1086/674131

IUCN/SSC. 2013. *Guidelines for Reintroductions and Other Conservation Translocations*. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission, viiii + 57 pp.

Maslovat, C. 2009. *Guidelines for translocation of plant species at risk in British Columbia*. British Columbia Ministry of Environment, Victoria, BC.

Millennium Seed Bank Partnership. 2014. *Assessing a Population for Seed Collection*. [Technical Information Sheet 02]. Way, M. and K. Gold (authors). Royal Botanic Gardens, Kew. UK: Richmond.

Monks, L. and D. Coates. 2002. The translocation of two critically endangered Acacia species. *Conservation Science of Western Australia* 4:54–61

NRC Research Press. 2013. *Reintroduction of species at risk: learning from the past to plan for the future*. 5092.128.98

Pavlik, B.M. 1996. Defining and measuring success. In: Falk DA, Millar CI, Olwell M (eds*) Restoring diversity: strategies for reintroduction of endangered plants*. Island Press, Washington, pp 127–155.

Rynear, J., Peterson, C.L., and Richardson, M.L. 2013. Variables influencing germination and initial survival of two critically endangered plants: *Warea amplexifolia and Lupinus aridorum*. *Botany*, 91: 323–326. doi:10.1139/cjb-2012-0242.

Sutter, R.D. 1996. Monitoring. In *Restoring Diversity: Strategies for Reintroduction of Endangered Plants*. Falk, D.A., Millar, C.I., and Olwell, M. (eds.), pp. 235- 264. Island Press, Washington D.C.

Vaino, K. 2011. Species and ecosystems at risk. In *Restoring British Columbia's Garry Oak Ecosystems: Principles and Practices*. Clements, D.R., Hooper, T.D., Martell, K., and Masson, C. (eds.). Garry oak ecosystems recovery team. 520 pp. Retrieved from: http://www.goert.ca /gardeners_restoration/restoration.php.

Vallee, L., Hogbin, T., Monks, L., Makinson, B., Matthes, M., and Rossetto, M. 2004. *Guidelines for the translocation of threatened plants in Australia*. 2nd ed. Australian Network for Plant Conservation. Canberra, Australia.

Wandrag, E.M., J.A. Catford, R.P. Duncan. 2019. Quantifying niche availability, niche overlap and competition for recruitment sites in plant populations without explicit knowledge of niche axes. *Journal of Ecology*. https://doi.org/10.1111/1365-2745.13137

Weeks, A.R., Sgro, C.M., Young, A.G., Frankham, R., Mitchell, N.J., Miller, K.A., Byrne, M., Coates, D.J., Breed, M.F., James, E.A., Hoffmann, A.A. 2011. Assessing the benefits and risks of translocations in changing environments: a genetic perspective. *Evol Appl*., 4:709–725.

Wendelberger, K.S. and Maschinski J. 2009. Assessing microsite and regeneration niche preferences through experimental reintroduction of the rare plant. *Plant Ecology*, 02/2016, Volume 217, Issue 2

APPENDIX A. SITE C EXPERIMENTAL TRANSLOCATION PROJECT: POTENTIAL RECIPIENT SITE SELECTION METHODS & RESULTS MEMO

EAGLE CAP CONSULTING
environmental consulting services

MEMO

Date: November 8, 2019

To: Natasha Bush (EcoLogic)

From: Randy Krichbaum (Eagle Cap), Margaret Krichbaum (Eagle Cap)

Subject: Site C Experimental Translocation Project: Potential Recipient Site Selection Methods & Results

INTRODUCTION

An important component of the Site C Experimental Rare Plant Translocation (ERPT) program is the selection of suitable recipient sites for planting of propagules collected from the project activity zone. Program planning in the spring of 2019 identified a need for 17 recipient sites to accommodate the propagules collected (or planned for collection). This memo outlines the methods and results of the potential recipient site selection work performed in 2019.

The goal of this work was to locate and document suitable recipient sites for planting of rare plant propagules (seeds, achenes, and started plants). The sites needed to meet a number of criteria regarding habitat (both biotic and abiotic components), accessibility, and geographic location.

It should be noted that the BC Conservation Data Centre (BCCDC) revised the statuses of several translocation target species, taking them off of the BC Red and Blue lists, in July of 2019 as the work was ongoing (BCCDC 2019). This resulted in these species being removed from the ERPT program. Before the BCCDC status revisions, twelve taxa were considered to be translocation target species; after the July revision, only six taxa remained. Work performed before July to select potential recipient sites for these removed species is still described in this report for completeness of documentation.

METHODS

Prefield Review

A prefield review was conducted to identify and delineate potential recipient sites for later verification in field. The review followed a structured workflow designed to locate the optimal planting locations based on the desired site characteristics.

A team of two qualified botanists completed the majority of the prefield and field portions of this work, in consultation with the ERPT project manager and a third qualified botanist. All the botanists have performed extensive rare plant work in the BC Peace River area, and as such are familiar with both the habitat requirements of rare species and the logistics of working in the Peace region.

Initially, ten taxa were chosen by the ERPT project manager as priority species in need of recipient sites for translocation:

- *Artemisia herriotii* (Herriot's sage)
- *Carex sprengelii* (Sprengel's sedge)
- *Carex torreyi* (Torrey's sedge)
- *Carex xerantica* (dry-land sedge)
- *Chrysosplenium iowense* (Iowa golden-saxifrage)
- *Cirsium drummondii* (Drummond's thistle)
- *Oxytropis campestris* var. *davisii* (Davis' locoweed)
- *Penstemon gracilis* (slender penstemon)
- *Polypodium sibiricum* (Sibirian polypody)
- *Ranunculus rhomboideus* (prairie buttercup)

The project botanical team met in May 2019 to review the priority species list and define desired recipient site characteristics. Each desired site characteristic was also assigned a weighting to reflect its relative importance to successful propagule establishment. This allowed for the potential recipient sites to be ranked for suitability following the field visits.

The prefield review identified eleven desirable characteristics of the potential recipient sites. While no potential recipient site can meet all of the listed criteria, the intent of the work was to locate the best possible sites given the limitations present. An ideal site would have the following characteristics:

- be located in the Peace River region of BC
- be located on land owned by BC Hydro or on Crown land
- not be located in the Site C Project Activity Zone (PAZ)
- be accessible by road or boat during the entire growing season
- contain suitable good-quality habitat for the specific rare plant taxon
- have a low likelihood of future disturbance
- have a low percentage of non-native plants
- have good cell service
- be more than one kilometre from known occurrences of the same taxon
- not contain known occurrences of other rare plant taxa
- be close to a source of water

A literature review was conducted for each of the ten priority species to evaluate any new information relevant to the translocation work. This included checks of recent BCCDC data to uncover any new element occurrences, and a Google Scholar search on all priority species literature published since 2018. The review supplemented literature searches conducted in previous years for the translocation project. Queries were also run on the project rare plant database to uncover apparent habitat associations for the ten priority species based on updated field data.

The habitat needs for the ten priority taxa were then reviewed and delineated into eight types, in order to aid in the visual evaluation of aerial imagery:

1. river or large stream, with steep, moist slope, shading & aspect variable, sparsely vegetated, dark soil (eroding shale) or other soil
2. river or large stream, with level, open, non-active cobble bar, shading open to partial, sparsely vegetated, sandy soil, well drained
3. very dry, steep, open south-facing hillside, sparsely vegetated, pale soil
4. very dry, level, open, sparsely vegetated, pale soil
5. moist, shrubby, level to moderate slope, shading open to full, aspect variable, densely vegetated, may dry out later in season, relatively rich clay/silt soil
6. dry to moist, open to shrubby, level to moderate slope, vegetation moderate to dense, aspect level to south-facing, can dry out later in season, pale to rich clay/silt soil
7. vernally wet graminoid hummocks, possibly emergent, level, open to partial shade, vegetation moderate at root level, dense canopy not present, relatively rich soil
8. dry to mesic rock outcrops, boulders & cliffs in upland mixed woodland, shading open to full, aspect various, sparsely vegetated

Using the list of desired site characteristics, the eight habitat grouping types, and other collected information, GIS layers were visually examined and potential recipient sites were selected. Primary GIS layers used for this phase of the prefield review were:

- aerial imagery of the BC Peace River region;
- property ownership provided by BC Hydro;
- known element occurrences of the priority taxa; and
- the Site C Project Activity Zone.

Field Verification

Once the potential recipient sites had been identified, selected sites were inventoried in the field to determine suitability. Each suitable Potential Recipient Site (PRS) was evaluated and classified at the site, with the data entered into a digital form for later analysis. Data elements collected included all those typically required by the BCCDC to document rare vascular plant element occurrences, as well as ratings for each of the eleven desired site characteristics.

In addition, vegetation composition and cover data were recorded for the overall site, and three one-metre-square plots placed in representative locations. Species codes, with their associated percent covers, were recorded on a paper form for later analysis.

RESULTS

Prefield Review

The literature search uncovered four recent papers containing information relevant to the translocation of the priority species.

- *Perigynia removal improved germination in two native Carex species* (Nelson et al. 2018)
- *Micropropagation and Reintroduction of Hill's Thistle (Cirsium hillii.(Canby) Fernald) to its Natural Habitat in Bruce Peninsula National Park (Master thesis)* (Sheikholeslami 2018)
- *Habitat filtering influences plant–pollinator interactions in prairie ecosystems* (Bizecki Robson et al. 2019)
- *Preventing Extinction of At-Risk Plant Species in a Complex World (Doctoral dissertation)* (Bernardo 2018)

The queries run on the Site C rare plant database to identify habitat associations for the ten priority species returned three helpful correlations that may have not been otherwise noted:

- For *Cirsium drummondii*: 0-3° slope for all occurrences where slope was recorded (n=13), except one record (which was 10°)
- For *Oxytropis campestris* var. *davisii*: 0-5° slope for all occurrences where slope was recorded (n=16)
- For *Penstemon gracilis*: most occurrences are on steeper slopes (15-30°) that are south facing (all aspects are S, SW, or SE where aspect is recorded)

A total of 30 planting areas which appeared to have a high likelihood of meeting the requirements for recipient sites were selected from the examination of the GIS layers. The most weight was given to appropriate habitat types and ease of legal access. Some planting areas appeared to contain habitat specific to only one rare taxon, and other areas were thought to contain habitat for multiple rare taxa. Not all potential planting areas in the BC Peace region were considered; rather the review focussed on areas that appeared to be easily accessible by road from Fort St. John, and on areas that were known to be easily accessible by boat on the Peace and Halfway Rivers. Therefore, if additional potential recipient sites are required in the future, the as-yet unreviewed portions of the BC Peace region remain to be analyzed.

A unique PRS point was then generated for each planting area microsite thought to have suitable habitat for translocation of one of the ten priority species: 133 PRS points in total were delineated. These points were intended to speed the field verification work by directing the surveyors' effort on the ground towards microsites of the best quality habitat. There was no expectation that every PRS point would be field checked, and the exact location for each actual PRS plot was to be decided in the field after a cursory area survey.

The number of PRS points initially generated for each of the ten priority taxa varied, primarily according to the expected level of difficulty in locating good-quality recipient sites for that taxon. Thus, *Carex sprengelii, C.*

torreyi, C. xerantica, and *Ranunculus rhomboideus* were each given 10-13 PRS points, since it was anticipated that finding good recipient sites for these taxa would be relatively easy. *Cirsium drummondii* and *Penstemon gracilis* received 16 and 17 PRS points, respectively, and *Oxytropis campestris* var. *davisii* 39 PRS points. Fewer PRS points were generated for the three remaining priority species, mainly due to lack of available habitat close to the Peace River (*Artemisia herriotii* - 9 PRS points, *Chrysosplenium iowense* - 5 PRS points, and *Polypodium sibiricum* - 3 PRS points).

Field Verification

The team of two qualified botanists performed the main portion of the field verification work between May 30 and June 7, 2019. One additional day of field verification was completed on August 10, 2019. In preparation, the 30 selected planting areas were grouped according to general access route to allow for efficient survey days. Of the 30 planting areas delineated, 24 received either complete or partial field checks. Twenty-three areas were reached by road from Fort St. John, with the closest area located approximately 3 km and the farthest area approximately 86 km from the town. The twenty-fourth area consisted of sites along a 21 km stretch of the Peace River below Taylor, BC, and was accessed by boat.

The six planting areas not field verified consisted of four which presented the most difficult access situations for work crews, and two which only contained potential habitat for species subsequently downlisted by the BCCDC in July.

The 24 field checks produced the following results:

- seven planting areas were found to be not easily accessible due to locked gates or other issues;
- seven planting areas did not contain appropriate habitat for the target species;
- five planting areas were deemed to be not currently suitable for various reasons but worth setting aside for future consideration; and
- five planting areas were considered to be worth investigating further.

A cursory survey of each of the five “best choice” planting areas was performed, and a total of 15 PRS plots were completed (Table 1). Supplemental planting locations were also marked in suitable habitat near the PRS plots, where possible, to provide options for the planting crew. Upon final review, one planting area was removed from consideration leaving four recommended for use in the ERPT program.

It should be noted that during the course of the field verification surveys, 16 new rare plant sites were discovered: 6 patches of *Oxytropis campestris* var. *davisii*, 3 patches of *Carex torreyi*, 2 patches each of *Carex xerantica* and *Ranunculus rhomboideus*, and 1 patch each of *Penstemon gracilis, Artemisia herriotii,* and *Carex backii* (the last two species have since been removed from the Red/Blue lists by the BCCDC).

Table 1: Potential Recipient Site Plots 2019

PRS Site ID	*Taxon*	Habitat	Survey Date	Area (sq m)	Elevation (m)
PRS-CARESPR-004	*Carex sprengelii*	Seeps and shrub patches.	2019-06-05	50	597
PRS-CARESPR-007	*Carex sprengelii*	Willow seep in forest.	2019-05-31	500	706
PRS-CARESPR-012	*Carex sprengelii*	Mesic forest areas in wetland.	2019-06-02	100	728
PRS-CARETOR-010	*Carex torreyi*	Open grassland between shrubby areas.	2019-06-02	1,000	730
PRS-CARETOR-013	*Carex torreyi*	Open shrub and grassland in forest mosaic.	2019-06-05	450	598
PRS-CAREXER-004	*Carex xerantica*	Steep open grassland slopes that are south-facing.	2019-05-31	1,000	590
PRS-CAREXER-008	*Carex xerantica*	Grassland opening within forest mosaic.	2019-06-02	150	743
PRS-CHRYIOW-002	*Chrysosplenium iowense*	Swamp/Fen habitat.	2019-05-31	1,000	704
PRS-CIRSDRU-011	*Cirsium drummondii*	Open shrub/grassland within forest mosaic.	2019-06-02	3,000	730
PRS-OXYTCAM3-018	*Oxytropis campestris var. davisii*	Early- to mid-seral cottonwood forest on cobble/soil substrate.	2019-06-04	750	395
PRS-OXYTCAM3-020	*Oxytropis campestris var. davisii*	Early- to mid-seral cottonwood forest on cobble/soil substrate.	2019-06-04	15,000	395
PRS-PENSGRA-004	*Penstemon gracilis*	Steep open grassland slopes.	2019-06-05	400	588
PRS-PENSGRA-010	*Penstemon gracilis*	Open grassland with low shrubs.	2019-08-10	500	601
PRS-RANURHO-004	*Ranunculus rhomboideus*	Open grassland next to shrubby areas along the ridgetop.	2019-05-31	500	579
PRS-RANURHO-010	*Ranunculus rhomboideus*	Interface between grassland opening and low shrubs or trees.	2019-06-02	100	742

Discussion

The goal of the work was to locate two suitable recipient sites for most of the priority taxa, based on the 11 criteria listed in the Methods section above. During the course of the field verification, it became clear that the first 8 criteria were relatively easy to meet (that is, accessible planting areas outside of the Site C PAZ, on Crown land near the Peace River, which contain appropriate rare plant habitat, low levels of both non-native plants and disturbance, and which have good cellular coverage).

However, the final three criteria proved much more challenging (i.e., planting areas greater than one kilometre from known sites of the same taxon, not already occupied by other rare plant species, and close to a source of water). While the prefield review specifically avoided known rare plant sites in choosing potential planting areas to evaluate, it was anticipated that new rare plant occurrences would be discovered since the goal was to target high-quality rare plant habitats. Thus, 16 new rare plant sites were documented by the survey team during the field verification process. The surveyors attempted to avoid these new sites when placing PRS plots and marking supplemental planting locations, but this was only partially successful: at three of the four recommended planting sites, PRS plots either had to be placed less than one kilometre from an already-occupied site of the same species, or in the vicinity of other rare plant populations. This was accepted as a reasonable compromise considering that naturally-occurring multi-species rare plant sites are frequently found in the BC Peace region.

The final compromise for PRS plot placement, as anticipated, was that only the *Oxytropis campestris* var. *davisii* plots along the Peace River could be said to have a source of water. The remaining five priority taxa require mesic to xeric habitats generally found on dry slopes well above the river, and only rarely near year-round streams or springs.

Therefore, given the above caveats, four of the five planting areas where PRS plots were completed do meet the majority of the requirements of an ideal recipient site, and it is recommended that translocation work be focussed on these four areas. The first two of these planting areas contain a variety of habitats and are suitable for multiple species translocation. The remaining two planting areas were specifically selected for single taxa.

At the first area, a Crown parcel just north of Fort St. John above Fish Creek, five PRS plots were completed (and an additional 17 planting sites marked) for *Carex sprengelii, C. torreyi, C. xerantica, Penstemon gracilis,* and *Ranunculus rhomboideus*. These sites were placed in the western and central areas of the parcel in order to avoid impacts to two newly-discovered rare plant occurrences.

The second area selected for multiple species translocation was a Crown parcel above Bear Flat on the north side of Highway 29. Five PRS plots were completed, for *Carex sprengelii, C. torreyi, C. xerantica, Cirsium drummondii,* and *Ranunculus rhomboideus.* An additional 10 planting sites were marked, for *Carex torreyi, C. xerantica, and Cirsium drummondii*. These sites were placed in the western third of the parcel in order to avoid impacts to a newly documented rare plant occurrence. (The *Cirsium drummondii* PRS plot and planting locations were later omitted when the species was removed from the BCCDC Blue list).

Due to the difficulty of finding accessible recipient sites for *Penstemon gracilis* relatively close to Fort St. John, one PRS plot was also completed for this taxon on a Crown parcel west of Clayhurst Road, near the Alberta border. The site was placed west and south of two newly-discovered rare plant occurrences.

For *Oxytropis campestris* var. *davisii*, which requires a specific type of riparian habitat, two PRS plots were completed on the Peace River, downstream of Taylor, BC.

The fifth planting area, where the remaining two PRS plots were completed, is no longer recommended as a translocation site because *Chrysosplenium iowense* has been downlisted by the BCCDC, and *Carex sprengelii* has better-quality recipient sites above Fish Creek and Bear Flat.

References

BC Conservation Data Centre (BCCDC). 2019. BC Species and Ecosystems Explorer [Internet]. [cited 2019 Nov 4]. Available from: http://a100.gov.bc.ca/pub/eswp

Bernardo HL. 2018. Preventing Extinction of At-Risk Plant Species in a Complex World [Doctoral Dissertation]. St. Louis, Missouri: Washington University.

Bizecki Robson D, Hamel C, Neufeld R, Bleho BI. 2019. Habitat filtering influences plant–pollinator interactions in prairie ecosystems. Botany. 97:204–220.

Nelson RS, McGinnis EE, Daigh ALM. 2018. Perigynia removal improved germination in two native *Carex* species. Seed Sci Technol. 46:489–495.

Sheikholeslami B. 2018. Micropropagation and Reintroduction of Hill's Thistle (*Cirsium hillii* (Canby) Fernald) to its Natural Habitat in Bruce Peninsula National Park. Guelph, Ontario: The University of Guelph.

APPENDIX B. 2019 EXPERIMENTAL RARE PLANT TRANSLOCATION SUMMARY

Table 1. Planned Activities for the Experimental Rare Plant Translocation 2019 Program

Rare Plant Species		Propagule Collection by Year						Ex-situ Propagation by Year				Translocation Implementation				Monitoring		Clearing Timing (version April 25, 2018)
		2017		2018		2019		2018		2019		2018		2019	2019	2019	2019	
Scientific Name	English Name	Collection successful?	Collection Summary	Collection successful?	Collection Summary	Collection successful?	Collection Summary	Propagation successful?	# of Plants Propagated	Propagation successful?	# of Plants Propagated	Translocation carried out?	# of Plants Transplanted	Translocation carried out?	# of Plants Transplanted	Monitoring Carried Out	# of Plants survived (planted in 2018)	Season and Year
Artemisia herriotii	Herriot's sage	No	Several attempts to collect seeds occurred between July and November but none of the visited plants had developed mature seeds.	no attempt	Lower priority species due to the number of available occurences for collection. Propagule collection efforts will occur within the Middle Reservoir in 2019.	No	Moved from the Blue list to the Yellow list and is no longer considered at-risk species in British Columbia. Plants located at Bear Flats were evaluated in the Spring to determine if residual seeds from the previous year remained. No viable seeds were located; the plants seemed to have abortive ovaries and the seeds were not developing.	na	na	na	na	na	na	na	na	na	na	Summer 2015 - Spring 2016 Summer 2018 - Spring 2020 Winter 2017/2018 - Spring 2019 Winter 2021/2022
Carex sprengelii	Sprengel's sedge	Yes	Collected from Bear Flats.	Yes	Collected from Bear Flats.	Yes	Collected from Bear Flats in August.	Yes	12 (6 held back)	Yes	13	Yes	6	No	na	Yes	0	Winter 2017/2018 - Spring 2019
Carex torreyi	Torrey's sedge	no attempt	Lower priority species in 2017 collection year as the occurences are located in quarries that were not scheduled for use in 2018.	No	Several attempts to collect propagules from the occurrence at Industrial 85th Avenue. The first visit occured in June; however, none of the visited plants had mature seeds. The second visit was unsuccessful due to lack of access.	Yes	Four collection attempts overall in July and August. Two successful collection occurred in August from Fish Creek.	na	na	no attempt	na	na	na	No	na	na	na	not available
Carex xerantica	dry-land sedge	Yes	Collected from Area E.	No	Lower priority species due to the number of plants being stored at the native plant nurseries for transplant and/or use as a seed bank One attempt was made to collect from Area E on August 13th but the seeds had already dispersed.	Yes	Collected from the nursery seed bank throughout July. No viable seeds were located in the field; the plants that were assessed seemed to have abortive ovaries and the seeds were not developing. Lower priority species due to the number of plants being stored at the native plant nurseries for transplant and/or use as a seed bank.	Yes	450 plants. 363 remaining plants available for transplant and/or use in creating a seed bank.	no attempt as additional stock was not required in 2019.	0	Yes	87	Yes	50	Yes	24	Winter 2017/2018 - Spring 2019 and some areas not available

Rare Plant Species		Propagule Collection by Year						Ex-situ Propagation by Year				Translocation Implementation				Monitoring		Clearing Timing (version April 25, 2018)
		2017		2018		2019		2018		2019		2018		2019	2019	2019	2019	
Scientific Name	English Name	Collection successful?	Collection Summary	Collection successful?	Collection Summary	Collection successful?	Collection Summary	Propagation successful?	# of Plants Propagated	Propagation successful?	# of Plants Propagated	Translocation carried out?	# of Plants Transplanted	Translocation carried out?	# of Plants Transplanted	Monitoring Carried Out	# of Plants survived (planted in 2018)	Season and Year
Chrysosplenium iowense	Iowa golden-saxifrage	No	No attempt.	No	Species not detected during the June 21st site visit along the right bank of Peace River upstream from Wilder Creek. Only *Chrysosplenium tetandrum* was detected.	No	One attempt to locate the historic occurrence in May was unsuccessful. Moved from the Blue list to the Yellow list and is no longer considered at-risk species in British Columbia.	na	na	na	na	na	na	na	na	na	na	Winter 2017/2018 - Spring 2019
Cirsium drummondii	Drummond's thistle	Yes	Collected from Watson Slough.	Yes	Collected from south side of Hwy 29 east of Farrell Creek.	Yes	Collected from the nursery seed bank throughout June. There was no additional attempt to collect seeds in the field. Moved from the Blue list to the Yellow list and is no longer considered at-risk species in British Columbia.	Yes	971 plants. 911 remaining plants available for use in creating a seed bank.	Yes	100	Yes	65	na	na	Yes	Of the 14 50P size plugs assessed, 8 were alive. Of the ten 1G size assessed, 9 were alive.	Summer 2015 - Spring 2016 Summer 2018 - Spring 2020 Summer 2020 - Spring 2021
Erigeron pacalis	Peace daisy	No	Species not detected in August after 9 person hours at the documented occurence.	No	Species not detected.	no attempt	Species removed from the Red list and removed from inclusion in the project due to misidentification of the specimen involved. This species do not occur in British Columbia.	na	na	tbd	na	na	na	na	na	na	na	The only known documented occurence is located outside of the inundation area but near the high water mark.
Oxytropis campestris* var. *davisii	Davis' locoweed	Yes	Collected from 2 occurences along the Peace River and 1 occurrence near the mouth of the Halfway River.	Yes	Collected from 7 occurences along the Peace River.	Yes	Collected from the nursery seed bank throughout July. Seeds were also successfully collected from the field; however, many plants were not ready for collection due to cooler and wetter than average temperatures in the Peace Region. For example, Fort St. John had 93 mm of rain in August, nearly double the monthly normal of 51 mm.	Yes	1075 plants. Approximately 925 remaining plants available for transplant and/or use in creating a seed bank.	Yes (from seeds)	0	Yes	150	Yes (whole plants and seed)	900 (seeds)	Yes	60	Summer 2018 - Spring 2020 Winter 2017/2018 - Spring 2019

Rare Plant Species		Propagule Collection by Year						Ex-situ Propagation by Year				Translocation Implementation				Monitoring		Clearing Timing (version April 25, 2018)
		2017		2018		2019		2018		2019		2018		2019	2019	2019	2019	
Scientific Name	English Name	Collection successful?	Collection Summary	Collection successful?	Collection Summary	Collection successful?	Collection Summary	Propagation successful ?	# of Plants Propagated	Propagation successful?	# of Plants Propagated	Translocation carried out?	# of Plants Transplanted	Translocation carried out?	# of Plants Transplanted	Monitoring Carried Out	# of Plants survived (planted in 2018)	Season and Year
Penstemon gracilis	slender penstemon	No	Several attempts to collect seeds. The first visit occured in July; however, none of the plants had mature seeds. The second attempt occured in August; however, the plants had been browsed such that no seed collection was possible.	No	Plants assessed on July 30th at the occurrence on the northwest side of Don Phillips Way but the plants did not have mature seeds.	Yes	Three collection attempts overall in August. Two successful collection overall occurred in August from Farrell Creek (August 8th) and Bear Flats (August 23rd) .	na	na	Yes (from cuttings and seeds)	na	na	na	No	na	na	na	
Ranunculus rhomboideus	prairie buttercup	No	New species to the program; plants unavailable for seed collection in July 2017 due to early seed maturation (mid-June).	Yes	Collected from north of the Hwy 29 realignment corridor in the Cache Creek area.	Yes	Collected from Watson's Slough in July.	na	na	Yes (from seeds)	4	na	na	No	na	na	na	Summer 2018 - Spring 2020

APPENDIX C. DATA CAPTURE FORM- TRANSLOCATION

Experimental Rare Plant Translocation Program

Data Capture Form - Phase 3: Translocation Implementation

**Complete one form per (provide direction on when to use this form, ex. per individual plant, or per site, or per population, etc.).*

Data Sheet Tracking Number

Project Number: 1463-01-11-

Plant Level Information — **SITE LEVEL**

Donor Site ID	Species Short Code	Nursery	Wild-Grown Whole Plant Transplant	Growth Media	Tag Type	Tag Colour	Tag Inscription	UTM Zone
11	1	9	24	25	26	28	29	34

Recipient Site ID	Marker Type (desc)	Marker Inscription	Proximity to Open Water (m)	Transplant Solocator Photos	Site Solocator Photos (NSEW)	Easting
31	32	33	37	39	40	35

Soils Characterized (Y/N)	Soil Samples Collected (number)	SIVI Completed	Rare Plant Survey Form Completed	Northing
38	39	40	42	36

Seedling

Date Removed from Nursery	Plug Size (l x h (mm))	Transportation Method	Storage Location	Storage Duration
45	46	48	49	50

Outplanting Conditions

Date (yymmdd)	Weather Cond	Ambient Temp (°C)	Soil Temp (at plug depth) (°C)	Soil Moisture (at plug depth)
43	44	45	46	47

Site Prep

Land Owner Permission	Site Physical Prep (date)	Site Engineering	Microcatchment Created
50	51	52	53

Invasive Plants Present	Invasive Plants Removed	Equip Cleaned of Invasives	Comment
54	55	56	

**If yes, provide spatial area and method in comments*

Planting Design

Outplanting Technique	Pruning	Co-Planting Group	Co-Planting Total (n)	Co-Planting Area (m x m)	Spatial Pattern (cat)
57	58	59	60	61	62

Injury or Damage (1st type)	Extent (1st type)	Injury or Damage (2nd type)	Extent (2nd type)	Injury or Damage (3rd type)	Extent (3rd type)
63	64	65	66	67	68

Planting Area Boundary Delineated

Type (desc)	Perimeter (m)
69	70

Collateral Disturbance

Area Disturbed (m2)	Disturbance Severity (severity)	Disturbance Restoration (restoration req)
71	72	73

Post-Outplanting Treatments (immediately post-plant)

Watering Volume (ml)	Mulch Type (cat)	Mulch Depth (cm)	Fencing Type (cat)	Fencing Height (m)
74	75	76	77	78

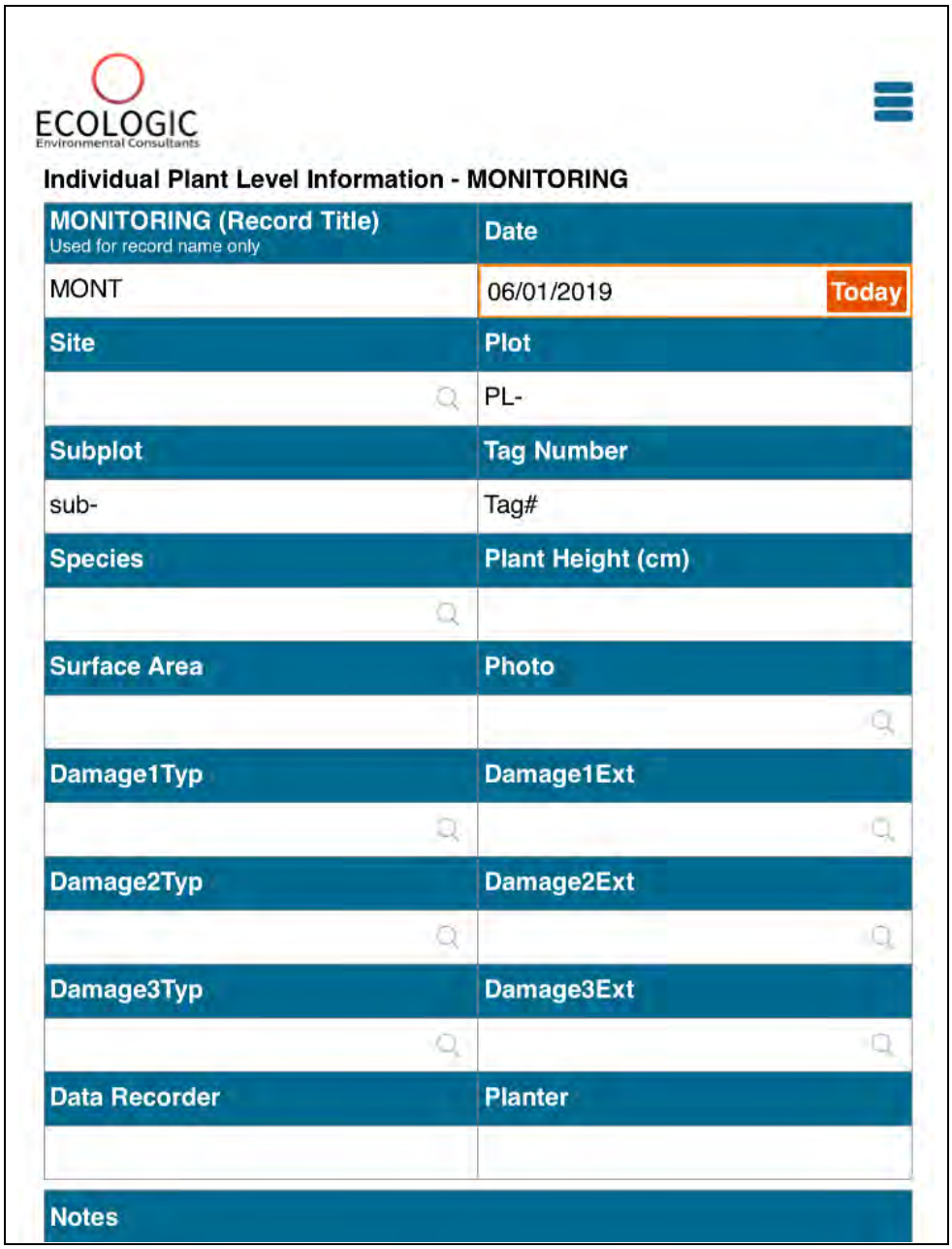
**Watering volme must be applied at same rate across all plants*

Transplant Team

Data Recorder	Active Transplant Personnel	Team
79	80	81

General Comments

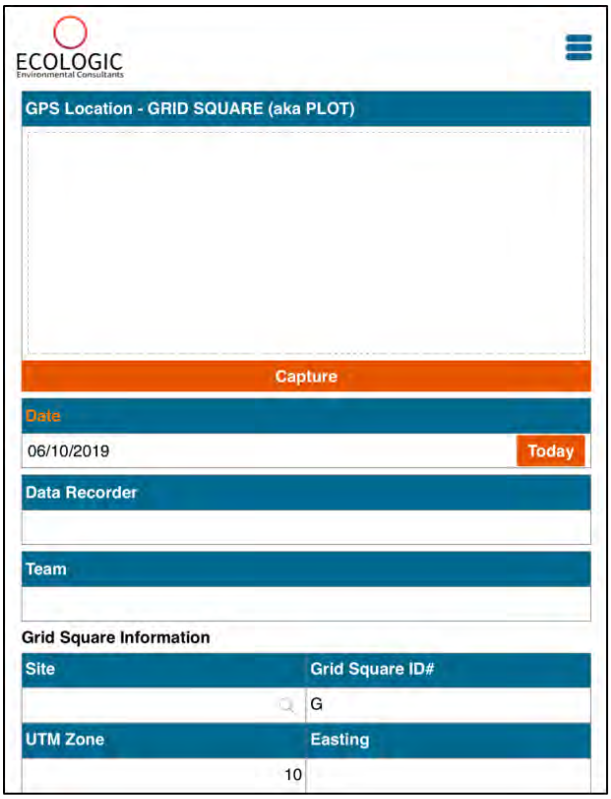
APPENDIX D. DATA CAPTURE FORM- MONITORING



ECOLOGIC
Environmental Consultants

Individual Plant Level Information - MONITORING

MONITORING (Record Title) Used for record name only	Date
MONT	06/01/2019 Today
Site	**Plot**
	PL-
Subplot	**Tag Number**
sub-	Tag#
Species	**Plant Height (cm)**
Surface Area	**Photo**
Damage1Typ	**Damage1Ext**
Damage2Typ	**Damage2Ext**
Damage3Typ	**Damage3Ext**
Data Recorder	**Planter**
Notes	


ECOLOGIC
Environmental Consultants

GPS Location - GRID SQUARE (aka PLOT)

Capture

Date

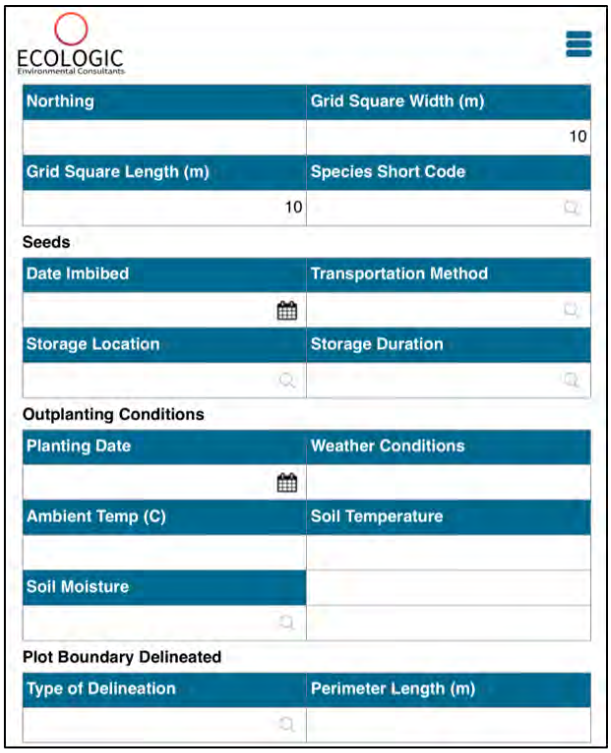
06/10/2019 Today

Data Recorder

Team

Grid Square Information

Site	Grid Square ID#
	G
UTM Zone	Easting
10	


ECOLOGIC
Environmental Consultants

Northing	Grid Square Width (m)
	10
Grid Square Length (m)	Species Short Code
10	

Seeds

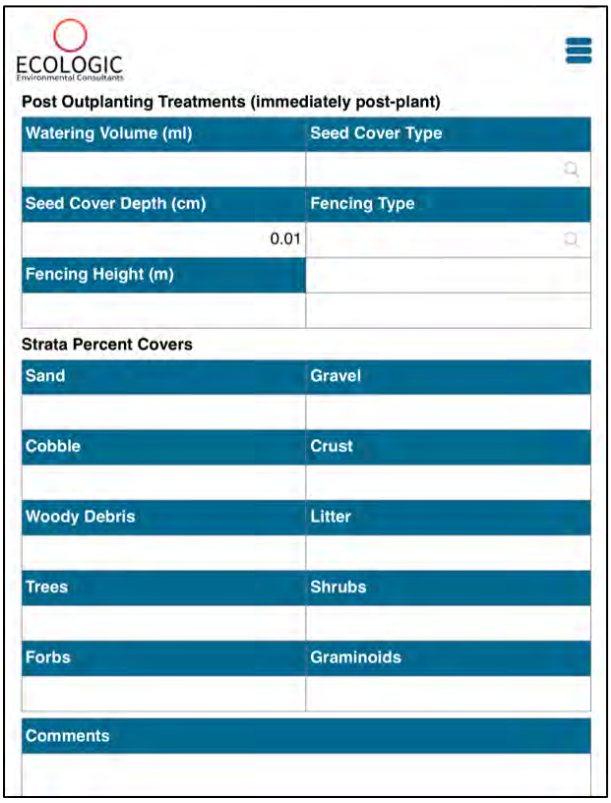
Date Imbibed	Transportation Method
Storage Location	Storage Duration

Outplanting Conditions

Planting Date	Weather Conditions
Ambient Temp (C)	Soil Temperature
Soil Moisture	

Plot Boundary Delineated

Type of Delineation	Perimeter Length (m)


ECOLOGIC
Environmental Consultants

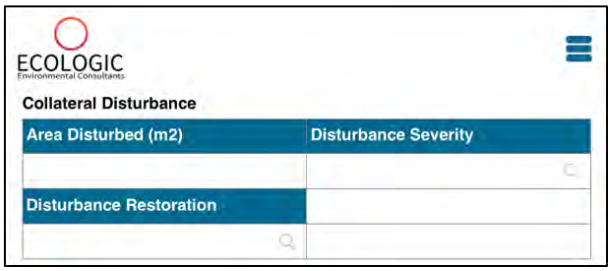
Post Outplanting Treatments (immediately post-plant)

Watering Volume (ml)	Seed Cover Type
Seed Cover Depth (cm)	Fencing Type
0.01	
Fencing Height (m)	

Strata Percent Covers

Sand	Gravel
Cobble	Crust
Woody Debris	Litter
Trees	Shrubs
Forbs	Graminoids

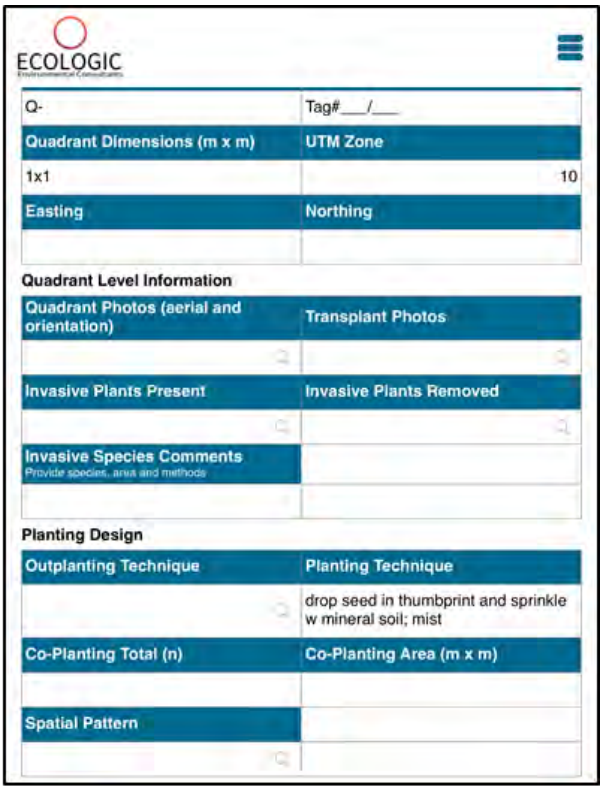
Comments

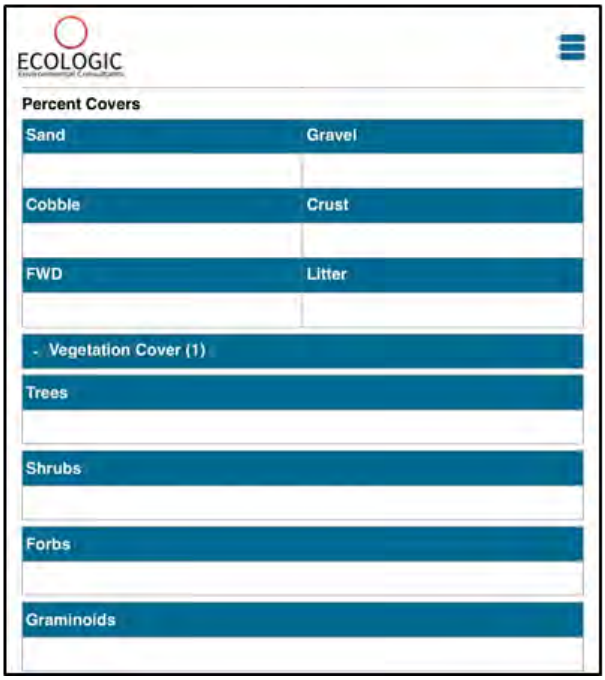

ECOLOGIC
Environmental Consultants

Collateral Disturbance

Area Disturbed (m2)	Disturbance Severity
Disturbance Restoration	


ECOLOGIC
GPS Location - Quadrat
Capture
Date
12/10/2019
Today
Data Recorder
Active Transplant Personnel
Quadrat Level Information
Site
Grid#
G-
Quadrant#
Corner Staple Tag#'s
Q-
Tag#___/___


ECOLOGIC
Q-
Tag#___/___
Quadrant Dimensions (m x m)
UTM Zone
1x1
10
Easting
Northing
Quadrant Level Information
Quadrant Photos (aerial and orientation)
Transplant Photos
Invasive Plants Present
Invasive Plants Removed
Invasive Species Comments
Provide species, area and methods
Planting Design
Outplanting Technique
Planting Technique
drop seed in thumbprint and sprinkle w mineral soil; mist
Co-Planting Total (n)
Co-Planting Area (m x m)
Spatial Pattern


ECOLOGIC
Percent Covers
Sand
Gravel
Cobble
Crust
FWD
Litter
- Vegetation Cover (1)
Trees
Shrubs
Forbs
Graminoids


Species
Percent Cover
Comments

Appendix 11. Bald Eagle Nest Surveys – Summary for 2019

MEMORANDUM

Date:	October 15, 2019
To:	Brock Simons, Terrestrial Biodiversity Specialist, Site C Clean Energy Project
From:	Jason Brogan, M.Sc., R.P.Bio. Hemmera
File:	989619-05
Re:	Bald Eagle Nest Surveys – Summary for 2019

1.0 INTRODUCTION

This memo summarizes the findings of the bald eagle (*Haliaeetus leucocephalus*) nest surveys on the Peace River conducted in May and June 2019. The purpose of the surveys was to document the status of known bald eagle nests along the Peace River, at wetlands near the Site C transmission line, at artificial (mitigation) nest poles, and to determine if new bald eagle nests had been constructed in either area. This is a continuation from the surveys that were completed in 2016 through 2018 (Hemmera 2016, 2018a, 2018b) and during baseline studies for the Site C Clean Energy Project (Keystone Wildlife Research 2009).

Bald eagle nest surveys were conducted with two objectives:

1. Determine the activity status (active/not active) and productivity of bald eagle nests in the study area (the Site C footprint plus the Peace River between the Alberta border and Hudson's Hope); and
2. Provide the data to BC Hydro for informing Site C construction mitigation.

Data collected during this survey provide information on nest status (i.e., if it is still present), activity (i.e., birds observed on the nest), and productivity (i.e., number of eggs or chicks per active nest).

2.0 METHODS

Known bald eagle nest locations (Hemmera 2018b) along the Peace River and at natural wetlands adjacent to the Site C transmission line right-of-way were surveyed over five days in May and June 2019 (May 8, 29, and June 12 via helicopter; June 20 and 21 via standwatch surveys), following the methods outlined by the Resources Inventory Committee (RIC 2001). The helicopter survey was conducted with a two-person crew consisting of a crew lead and a technician. The helicopter maintained a minimum 50 m height above nests. Previously identified nest locations from past aerial surveys (Hemmera 2018) were visited. New nests observed during the survey were added to the database, with unique identification designations starting with 800 for 2019 surveys. Bald eagle nests reported by other crews working for BC Hydro were also visited. Nests that were no longer present in 2018 (e.g., nest disintegrated, host tree failed naturally or host tree was felled) were not visited in 2019.

Ground-based standwatch surveys were conducted to gather focused information for three nests that were not surveyed by helicopter in 2019 due to a data management error during survey planning (nests 302, 708, 709). Two biologists monitored each nest and its surrounding area for bald eagle activity for a duration of 30 – 35 minutes on days with no precipitation and good visibility (>3km). Surveys were conducted before

12 noon to capture the most active time for parenting bald eagles. Observations at each known or new bald eagle nest, or sick nests constructed by other species, were recorded, with statuses of “active”, “inactive”, “not detected” or “tree gone”, or “unknown”, and the associated species assigned to each nest.

Survey results were provided to BC Hydro in Excel (.csv) format, including applicable comments and coordinates for each nest.

Productivity for bald eagle nests was calculated as the sum of estimated productivity from active nests divided by the number of active nests. Productivity for each nest was estimated according to the following assumptions:

- Active nests included those with evidence of adults present at any one of the three field surveys;
- The number of chicks in a nest at the last observation reflects the number fledged, except nests with three chicks which were only assumed to fledge two chicks; and
- No second clutches.

Fledging success for bald eagles raised in nests with multiple chicks is much-reduced and chicks from the third-laid eggs are unlikely to survive (Gerrard and Bortolotti 1988, as cited in Buehler 2000). In two chick broods, both chicks generally survive (e.g., only two chicks from 37 two-chick broods in Saskatchewan died [Bortolotti 1986]).

Second clutches in natural populations of bald eagle are not observed (Buehler 2000), likely due to the long duration of breeding, as speculated by Newton (1977). Exceptions are known when eggs or nestlings are artificially removed as part of captive breeding programs (Morrison and Walton 1980, Wood and Collopy 1993), or eggs are lost early in the season (Steenhof and Newton 2007). No second clutches have been observed or are expected in the study area.

3.0 SURVEY RESULTS

A total of 62 potential bald eagle nests and artificial nesting platforms were monitored in 2019 (**Appendix A**). Of the 62 nests, 29 were active bald eagle nests, 22 inactive nests, six nests that were not detected or the host tree was gone, and four Canada geese (*Branta canadensis*) nests (**Table 3.1**). Of the 29 active bald eagle nests found in 2019, 90% produced chicks. The number of chicks observed at active nests ranged from zero (i.e., adult or adults present, but no chicks) to two at the time of fledging. The estimated productivity for the population was 1.45 fledged chicks per active nest (**Table 3.1; Appendix B**). Seven new bald eagle nests were found in 2019 (nest IDs 801 – 807). Five of those nests were active (IDs 801, 802, 804, 806, and 807) and two were inactive (IDs 803 and 805). Given the close proximity to other active and/or inactive nests, these newly identified inactive nests may be alternate or abandoned nests. Alternate nests are common; data show an average of 1.5 nests per pair across the range of bald eagles with some eagles reportedly having up to five nests, though in Saskatchewan only 10% of bald eagle pairs had alternate nests (Buehler 2000).

BC Hydro erected three artificial nesting platforms (p32, p39, and p37) in 2015. No use had previously been identified by BC Hydro, and there was no evidence of use during the 2019 surveys. The nest platforms are placed near the periphery of the future reservoir, and are therefore likely too far from water to be attractive sites for bald eagle nesting prior to reservoir filling.

There were six undetected nests (Nest IDs 25, 137, 303, 603, 708, and 709) due to the tree no longer present; these nests will not be included in future surveys. Two of the nests, 708 and 709, were removed by BC Hydro while the other four were not able to be relocated, likely due to natural tree fall or the nest falling from the tree. Four of the surveyed nests contained actively breeding Canada geese. These nests will be included in future surveys because there is potential for bald eagles to nest in those locations.

All nests, whether active or inactive in 2019, will be surveyed again in 2020 except for nests that were not detected, or where the nest tree was known to be removed.

Table 3.1 Bald Eagle Nest Activity and Productivity on the Peace River (2017-2019)

Nest Status	2017	2018	2019
Active	34	28	29
Inactive	7	15	22
Not Detected/Tree Gone	18	4	6
Unknown	-	1	0
Total	**59**	**48**	**57**
Estimated productivity (total chicks)	**39**	**34**	**42**
Estimated productivity per active nest	**1.15**	**1.21**	**1.45**

Note: unknown – incidental observation from third party, nest status unconfirmed by Hemmera

4.0 DISCUSSION

The 2019 surveys represent the third year of productivity monitoring of bald eagle nests in the study area. In comparison to Year 1 and Year 2 of the study, 2019 had the highest estimated productivity; 42 chicks over 29 active nests, for an average of 1.45 chicks per active nest (**Table 3.1**). The year-to-year variation from surveys on the Peace River in this study is considered to be natural because the observed range of productivity is comparable with other areas where pesticides have not affected productivity in bald eagles (Elliott and Norstrom 1998). Examples from other studies include 0.88 to 1.24 young produced per active nest in the Aleutian archipelago, Alaska (Anthony et al 1999), 0.72-1.18 young fledged per active nest in Oregon (Isaacs et al 1983), and 1.56 eggs or downy young per nest in Alaska (Hodges 1982).

Bald eagle nesting phenology in the Peace is asynchronous; some bald eagles were observed incubating eggs on nests at the same time as other bald eagles were brood-rearing or had chicks that had already fledged. Some bald eagles were observed establishing nests very late in the nesting season that is identified by MOE (2013) as occurring from February 5 – June 25. This asynchronous nesting makes surveying for productivity difficult, particularly in late spring when tree leaves obscure nests and the precise numbers of fledged chicks are difficult to discern. Nonetheless, estimates of productivity gained by helicopter observations using consistent methods form a useful basis for comparison of relative productivity between nests (including artificial platform nests) and years.

Continued challenges with obtaining precise productivity metrics include (i) the large size of the study area (~200 km long), which to survey in one day requires stable weather conditions that sometimes don't coincide with desirable survey timing, (ii) limiting visitations to limit disturbance of bald eagles and (iii) leaves obscuring nest visibility during surveys conducted in mid-June or later.

Surveys using the methods described here will continue in 2020 as per the commitments in the bald eagle management plan for the project (BC Hydro 2016).

5.0 CLOSING

This Work was performed in accordance with BCO95055 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Canada Inc. (Ausenco), and BC Hydro (Client), dated 21 June 2016 (Contract). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this Work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

We have appreciated the opportunity of working with you on this project and trust that this report is satisfactory to your requirements. Please feel free to contact the undersigned regarding any questions or further information that you may require.

Report prepared by:
Hemmera Envirochem Inc.

ORIGINAL SIGNED

Jason Brogan, M.Sc., R.P.Bio.
Biologist
604.669.0424 (181)
bboyce@hemmera.com

Report Peer reviewed by:
Hemmera Envirochem Inc.

ORIGINAL SIGNED

Charlie Palmer, M.Sc., P.Biol., R.P.Bio.
Practice Leader
604.669.0424 (125)
cpalmer@hemmera.com

6.0 REFERENCES

Anthony, R.G., A.K. Miles, J.A. Estes, F.B. Isaacs. 1999. Productivity, diets, and environmental contaminants in nesting bald eagles from the Aleutian archipelago. Environmental Toxicology and Chemistry pp 2054–2062

BC Hydro. 2016. Site C Vegetation and Wildlife: Bald Eagle Mitigation and Monitoring Program. Burnaby, BC.

Bortolotti, G. 1986. Influence of sibling competition on nestling sex ratios of sexually dimorphic birds. American Naturalist 127 pp 495-507.

Buehler, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). In The Birds of North America (P. G. Rodewald, editor). Cornell Lab of Ornithology, Ithaca, New York, USA.

Elliott, J.E. and R.J. Norstrom. 1998. Chlorinated hydrocarbon contaminants and productivity of bald eagle populations on the Pacific coast of Canada. Environmental Toxicology and Chemistry 17(6). pp 1142-1153.

Hemmera. 2016. Bald eagle nest surveys. Memorandum to Anre McIntosh BC Hydro. 20 December 2016.

Hemmera. 2018a. Bald eagle nest surveys - summary for 2017: Site C Wildlife Monitoring BCO 95055. Memorandum to Brock Simons BC Hydro. 19 January 2018.

Hemmera. 2018b. Bald eagle nest surveys - summary for 2018: Site C Wildlife Monitoring BCO 95055. Memorandum to Brock Simons BC Hydro. 7 December 2018.

Hodges, I.R. 1982. Bald eagle nesting studies in Seymour Canal , Southeast Alaska. Condor 84 pp 125-127.

Isaacs, F.B. R.G. Anthony, R.J. Anderson. 1983. Distribution and productivity of nesting bald eagles in Oregon, 1978-1982. The Murrelet 64. pp 33-38.

Keystone Wildlife Research. 2009. Peace River Site C Hydro Project Stage 2 Baseline Vegetation and Wildlife Report. Prepared for BC Hydro Site C Project. July 2009

MOE. 2013. Guidelines for Raptor Conservation During Urban and Rural Land Development in British Columbia. Best Management Practices, B.C. Ministry of Environment. <http://www.env.gov.bc.ca/wld/documents/bmp/raptor_conservation_guidelines_2013.pdf>. Accessed 15 Aug 2013.

Morrison, M.L. and B.J. Walton. 1980. The laying of replacement clutches by Falconiforms and Strigiforms in North America. Raptor Research 14 pp 79-85.

Newton, I. 1977. Breeding strategies in birds of prey. The Living Bird 16th Annual. Institute of Terrestrial Ecology. Edinburgh. pp 34-82.

RIC. 2001. Inventory methods for raptors. Ministry of Sustainable Resource Management, Environmental Inventory Branch for the Terrestrial Ecosystems Task Force, Resources Inventory Committee (RIC), Victoria, BC.

Steenhof, K. and I. Newton. 2007. Assessing nesting success and productivity. Raptor Research and Management Techniques Chapter 11 pp 181-191

Wood, B.B and M.W. Collopy. 1993. Effects of egg removal on bald eagle nest productivity in northern Florida. Journal of Wildlife Management 57(1). pp1-9.

APPENDIX A

Nest Survey Results for 2019

Nest ID	Year first observed*	08-May-19	29-May-19	12-Jun-19	20, 21-Jun-19	Comments
Bald Eagle						
6	pre-2014	Active	Active	Active	-	2 chick 1 adult
8	pre-2014	Active	Active	Active	-	1 chick and 1 adult
13	pre-2014	Active	Active	Active	-	2 chicks and adult perched nearby
25	pre-2014	Tree Gone	Tree Gone	Tree Gone	-	No nest present anymore. Nest was present in 2018 and "in good shape." < 300m from 224 and 223
29	pre-2014	Active	Active	Active	-	2 chicks - nest low in tree
38	pre-2014	Active	Active	Active	-	2 chicks and 1 adult
100	pre-2014	Active	Active	Inactive	-	Empty. Possible failure. This nest was inactive during 2018.
101	pre-2014	Inactive	Inactive	Inactive	-	Good condition. This nest was active in 2018.
104	pre-2014	Active	Active	Active	-	2 chicks and 1 adult nearby
121	pre-2014	Active	Active	Active	-	1 chick and 1 adult
122	pre-2014	Active	Active	Active	-	1 chick and adult nearby. This nest was inactive and deteriorating in 2018.
127	pre-2014	Inactive	Inactive	Inactive	-	Did not detected this nest during first two surveys. Bit lopsided but ok. Not active. Inactive in 2018.
128	pre-2014	Inactive	Inactive	Inactive	-	Nothing present. Nest OK. This nest was active in 2018.
132	pre-2014	Active	Active	Active	-	2 chicks and 1 adult
133	pre-2014	Active	Active	Active	-	1 chick and 1 adult
137	pre-2014	Tree Gone	Tree Gone	Tree Gone	-	Not detected. Not found in 2018. Omit from future surveys. <300m from 702
138	pre-2014	Active	Active	Active	-	Obscured view - suspect two chicks and adult present. This nest was inactive and deteriorating in 2018. <50m from 601
144	pre-2014	Active	Active	Active	-	2 chicks and 1 adult
146	pre-2014	Active	Active	Active	-	1 chick present

Nest ID	Year first observed*	08-May-19	29-May-19	12-Jun-19	20, 21-Jun-19	Comments
147	pre-2014	Inactive	Inactive	Inactive	-	Nothing present. Good condition. Active in 2018
155	pre-2014	Inactive	Inactive	Inactive	-	Adult nearby but nothing at nest. Active in 2018.
203	pre-2014	Active	Active	Inactive	-	No adults or young present. Possible failure. Activity in 2018 was adult only presence in the early surveys (no chicks).
218	pre-2014	Active	Active	Active	-	1 chick. Nest was inactive in 2018 and deteriorating.
219	pre-2014	Active	Active	Active	-	2 chicks
222	pre-2014	Inactive	Inactive	Inactive	-	Nest was active in 2018.
223	pre-2014	Inactive	Inactive	Inactive	-	Good condition. Nest was inactive in 2018, and in good condition. < 300m from 224 and 25
224	pre-2014	Active	Active	Active	-	2 chicks. Nest was inactive and deteriorating in 2018. <300m from 223 and 25
225	pre-2014	Unknown	Inactive	Inactive	-	Good condition. Nest not detected in 2018. <200m from 611
302	2014	-	-	-	Inactive	Standwatch survey. Active 2018
303	2014	Tree Gone	Tree Gone	Tree Gone	-	Not detected. Omit from future surveys
400	2016	Inactive	Inactive	Inactive	-	No activity. Nest was active in 2018.
600	2017	Active	Inactive	Inactive	-	Good condition. This nest failed to produce in 2018, eggs seen on first visit, but inactive on subsequent visits.
601	2017	Inactive	Inactive	Inactive	-	Nest is lopsided. In 2018 this nest was inactive, but "in good shape". <50m from 138
602	2017	Active	Active	Active	-	1 chick. In 2018 this nest was inactive and deteriorating.
603	2017	Inactive	Tree Gone	Tree Gone	-	Not detected. Omit from future surveys
604	2017	Inactive	Inactive	Inactive	-	Nothing present. Good condition. Active in 2018
607	2017	Active	Active	Active	-	2 chicks and 1 adult nearby
608	2017	Inactive	Inactive	Inactive	-	This nest was active in 2018.
610	2017	Inactive	Inactive	Inactive	-	Poor condition. This nest was inactive in 2018 and reported as deteriorating.
611	2017	Inactive	Inactive	Inactive	-	Poor condition.

Nest ID	Year first observed*	08-May-19	29-May-19	12-Jun-19	20, 21-Jun-19	Comments
701	2018	Inactive	Inactive	Inactive	-	Good condition. Inactive in 2018.
702	2018	Active	Active	Active	-	2 chicks with 1 adult. <300m from 137
705	2018	Active	Active	Active	-	2 chicks and 1 adult flushed. <400m from 500 and 803
707	2018	Active	Active	Active	-	1 adult and 1 chick
708	2018	-	-	-	Tree Gone	Standwatch survey. Tree gone. Omit from future surveys. Inactive 2018
709	2018	-	-	-	Tree Gone	Standwatch survey. Tree gone. Omit from future surveys. Active 2018
710	2018	Tree Gone	Tree Gone	Tree Gone		Not detected. Omit from future surveys
801	2019	Active	Active	Active	-	1 chick
802	2019	Active	Active	Active	-	2 chicks. <100m from 62c
803	2019	Inactive	Inactive	Inactive	-	<400m from 705 and 500
804	2019	Active	Active	Active	-	2 chicks adult nearby
805	2019	Inactive	Inactive	Inactive	-	Nest in good shape
806	2019	-	-	Active	-	2 chicks with adult nearby. Found during last survey. <150m from 22
807	2019	Active	Active	Active	-	1 chick and 2 adults. Assumed this was nest 710 but it was removed by BCH
62c	pre-2014	Inactive	Inactive	Inactive	-	Nest present, no activity. <100m from 802
Artificial Platforms						
p32	2018	Inactive	Inactive	Inactive	-	A few sticks that were likely placed there by contractors.
p39	2018	Inactive	Inactive	Inactive	-	A few sticks that were likely placed there by contractors.
p47	2018	Inactive	Inactive	Inactive	-	A few sticks that were likely placed there by contractors.

Nest ID	Year first observed*	08-May-19	29-May-19	12-Jun-19	20, 21-Jun-19	Comments
Canada Goose						
22		Active	Inactive	Inactive		Adult CAGO on eggs 08-May. Although BAEA nearby on 12-June, it is in close proxiity (<150m) from an active BAEA nest, thus not included as active BAEA nest
703		Active	Inactive	Inactive		Adult on nest 08-May
2018 CAGO1		Active	Inactive	Inactive		Adult with 4 eggs
2019 CAGO2		Active	Inactive	Inactive		Adult on nest with 5 eggs on 08-May

Notes:

'*' - Year first observed for nests recorded before 2014 is not known as the Site C EIS does not provide this detail, but rather only that that BAEA nest surveys were conducted and the nests found in 2006, 2008, and 2011. Surveys were conducted in 2012, but no nests were detected.

Active – nest present and BAEA in area or using nest; Inactive – nest present but unused; not detected- nest not detected; unknown – incidental observation from third party, nest status unconfirmed by Hemmera; '-' nest not surveyed.

APPENDIX B

Active bald eagle nests and assumed productivity, May and June 2019

Nest ID	May 8	May 29	June 12	Estimated Productivity (# fledged/active nest)
6	Adult	Chick (1)	Adult, Chicks (2)	2
8	Adult	Adult, Chick (1)	Adult, Chick (1)	1
13	Adult	Adult, Chicks (2)	Adult, Chicks (2)	2
29	Adult, Chick (1)	Adult	Chicks (2)	2
38	Adult, Chicks (2)	Adult, Chick (1)	Adult, Chicks (2)	2
100	Adult	Adult	Inactive	0
104	Adult	Adult, Chick (1)	Adult, Chicks (2)	2
121	Adult	Adult, Chick (1)	Adult, Chick (1)	1
122	Adult, Chick (1)	Adult	Adult, Chick (1)	1
132	Adult	Adult, Chicks (2)	Adult, Chicks (2)	2
133	Adult	Adult, Chick (1)	Adult, Chick (1)	1
138	Chick (1)	Chick (1)	Adult, Chicks (2)	2
144	Adult, Chicks (2)	Chicks (2)	Adult, Chicks (2)	2
146	Adult	Adult, Chick (1)	Chick (1)	1
203	Adult	Adult	Inactive	0
218	Adult	Adult, Chick (1)	Chick (1)	1
219	Adult	Adult, Chick (1)	Chicks (2)	2
224	Adult, Chicks (2)	Chicks (2)	Chicks (2)	2
600	Adult, Eggs (2)	Inactive	Inactive	0
602	Egg (1), Chick (1)	Chick (1)	Chick (1)	1
607	Adult, Eggs (3)	Chick (1)	Adult, Chicks (2)	2
702	Adult, Chicks (2)	Adult, Chicks (2)	Adult, Chicks (2)	2
705	Adult	Adult, Chicks (2)	Adult, Chicks (2)	2
707	Adult, Egg (1), Chick (1)	Chick (1)	Adult, Chick (1)	1
801	Adult	Adult, Chick (1)	Chick (1)	1
802	Adult, Chick (1)	Adult, Chicks (2)	Chicks (2)	2
804	Adult, Chicks (2)	Adult, Chicks (2)	Adult, Chicks (2)	2
806	-	-	Adult, Chicks (2)	2
807	Adult	Adult, Chick (1)	Adult, Chick (1)	1
			Total chicks	**42**
			Percent of active nests that produced chicks (%)	**90**
			Estimated average productivity (# fledged per active nest)	**1.45**

Note: Active – nest present and BAEA using nest; Inactive – nest present but unused; '-' nest not surveyed.

Appendix 12. Ground Nesting Raptor Monitoring 2019 Annual Report

Site C Clean Energy Project
Ground-Nesting Raptor Monitoring
2019 Annual Report



PRESENTED TO

BC Hydro and Power Authority

MARCH 30, 2020
ISSUED FOR USE
FILE: 704-ENV.VENV03095-01.GNRM

Saulteau EBA Environmental Services Joint Venture.
Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

Site C Clean Energy Project Ground-Nesting Raptor Monitoring 2019 Annual Report

FILE: 704-ENV.VENV03095-01.GNRM
March 30, 2020

PRESENTED TO

Site C Clean Energy Project
BC Hydro and Power Authority
P.O. Box 49260
Vancouver, BC V7X 1V5

PRESENTED BY

Saulteau EBA Environmental Services Joint Venture
1000-885 Dunsmuir Street
Vancouver, BC V6E 3X2
P 604.685.0275

Prepared by:
FILE: 704-ENV.VENV03095-01.GNRM
FILE: 704-ENV.VENV03095-01.GNRM

Camille Roberge, B.Sc., E.Pt. **2020-03-30**
Environmental Scientist

Reviewed by:
FILE: 704-ENV.VENV03095-01.GNRM
FILE: 704-ENV.VENV03095-01.GNRM

Jeff Matheson, M.Sc., R.P.Bio. **2020-03-30**
Senior Biologist

EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors (i.e., Short-eared Owl [*Asio flammeu*] and Northern Harrier [*Circus cyaneus*]) in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2019. The surveys were part of BC Hydro's Ground-Nesting Raptor Follow-up Monitoring Program. This report describes the methods used to conduct the surveys and provides a summary of the results.

The ground-nesting raptor surveys were completed at six cleared portions of the Site C reservoir: along the Peace River (between Wilder Creek and Moberly River), Halfway River, Moberly River, Cache Creek, Bear Flats, and Highway 29 (Bear Flats area). Ground-nesting raptor surveys were completed up to four times over May and June 2019. The surveys were conducted either through transects or through stationary standwatches. The cleared portions near Highway 29 were accessed on foot and the areas along the Peace River were accessed by boat. No Short-eared Owls were observed. Northern Harriers were observed in several cleared areas during the migration in May, but were not observed during the breeding period in June. No nests or possible nests were observed at any of the areas surveyed. At the present time, there is no evidence of ground nesting raptors nesting within cleared portions of the reservoir. Surveys in 2020 will continue in all cleared areas within the reservoir.

TABLE OF CONTENTS

LIST OF TABLES IN TEXT

APPENDIX SECTIONS

FIGURES

APPENDICES

1.0 INTRODUCTION

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2019. The surveys were part of BC Hydro's Ground-Nesting Raptor Follow-up Monitoring Program (BC Hydro 2016). This report describes the methods used to conduct the surveys and provides a summary of the results.

The Ground-Nesting Raptor Follow-up Monitoring Program is specifically focussed on two ground-nesting raptor species: Short-eared Owl (*Asio flammeus)* and Northern Harrier (*Circus cyaneus)* (Table 1). Other species were observed incidentally during surveys and are reported in Appendix A.

Table 1: Species Covered in the Ground Nesting Raptor Follow-up Monitoring Program

Common Name	Scientific Name	BC List	COSEWIC [1] Status	SARA [2] Status
Short-eared Owl	*Asio flammeus*	Blue	Special Concern	Schedule 1 – Special Concern
Northern Harrier	*Circus cyaneus*	Yellow	-	-

[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada.
[2] SARA – *Species at Risk Act*.

The objectives of the ground-nesting raptor monitoring program are to determine the following:

- The number of Northern Harrier and Short-eared Owl nesting in areas cleared during reservoir preparation;
- The effects of seasonal headpond flooding on Northern Harrier and Short-eared Owl nests; and
- Use of open fields within mitigation properties being managed to provide nesting habitat for Northern Harrier and Short-eared Owl.

This document reports on the ground nesting raptor surveys that were conducted in 2019.

2.0 METHODS

In 2019, surveys were conducted at the six areas outlined in Table 2 and in Figures 1 through 7. Surveys were not completed at the mitigation properties in 2019. Ground-nesting raptors were surveyed up to four times over May and June 2019 to capture early, middle, and late stages of their breeding season. The Moberly River site was surveyed only once because of construction activity after the first survey. No surveys were conducted at H29SW04 (Peaceview Pit area along Highway 29) or along the Peace River between the Moberly River and PRSW08 (shown on Figure 7) because of active construction.

The surveys were conducted using a combination of transects and stationary standwatches. The cleared Bear Flats, Cache Creek, Halfway River, Highway 29, and Moberly River areas were accessed by foot and the cleared Peace River area was accessed by boat. Surveys were completed by three teams of two observers. Each team was composed of a biologist with raptor survey experience and an assistant (Appendix B).

Table 2: Survey Areas with Dates and Times

Survey Location	First Visit	Second Visit	Third Visit	Fourth Visit
Bear Flats (Cleared)	May 4, 2019 12:30 – 15:15	June 8, 2019 19:00 – 21:30	June 22, 2019 18:30 – 21:00	June 27, 2019 20:45 – 23:30
Cache Creek (Cleared)	May 4, 2019 17:15 – 19:15	June 8, 2019 18:15 – 20:00	June 22, 2019 18:15 – 20:15	-
Halfway River (Cleared)	May 3, 2019 13:15 – 14:45	June 8, 2019 16:30 – 17:45	June 22, 2019 16:30 – 21:15	June 27, 2019 20:30 – 21:45
Highway 29 (Cleared)	May 4, 2019 19:15 – 21:15	June 8, 2019 17:45 – 22:30	June 19, 2019 19:00 – 22:45	June 27, 2019 22:00 – 23:15
Moberly River (Cleared)	May 5, 2019 07:30 – 08:00	-	-	-
Peace River (Cleared)	May 3, 2019 15:30 – 21:45	June 8, 2019 16:15 – 22:00	June 22, 2019 16:15 – 22:00	-

Northern Harrier are diurnal and research suggests they are generally active between 05:30 and 21:30 (Smith et al. 2011). Short-eared Owl are a crepuscular species and optimal survey timing is in the evening just prior to civil twilight (Wiggins at al. 2006). Daytime and evening surveys were conducted at all survey areas (with the exception of Moberly River).

2.1 Transect Survey Protocol

The transect surveys were conducted by walking at a speed of 0.5 – 2 km/hr, looking and listening for birds. Surveyors stopped whenever required in order to confirm identification and to record data. The walking transects were located only in cleared portions of the reservoir. Surveyors walked in such a way to ensure visual coverage of the entire portion of suitable habitat in each property. Surveyors were not required to walk the precise transect as walked in previous visits. During the transect, surveyors stopped at regular intervals to complete standwatches. From each standwatch location the surveyors had a view from the previous standwatch station to the next station in the transect. Adding these standwatches into the transect surveys allowed surveyors to observe areas for longer periods to increase potential to observe bird activity and to monitor potential nesting behaviour for the purpose of locating ground-nesting raptor nests. Standwatches were conducted by remaining stationary for approximately 20 minutes.

At all survey areas at least one set of surveys was conducted during daylight hours and at least one set of surveys was conducted at dusk, to maximize the possibility of observing Northern Harrier and Short-eared Owl, respectively (Table 2). Surveys were not completed during periods of high wind (greater than Beaufort 3, 12 - 19 km/hr), rain or fog, when bird activity and detectability are likely to be low. The order that the stations were visited were different on each of the survey days.

For all raptor observations, species, sex, age, activity, distance and compass direction were recorded. Other species were recorded as incidental observations. For Northern Harrier or Short-eared Owl observations, if a pair was observed or there was evidence of nesting behaviour, a nest search was conducted to attempt to locate any nest that might be present in the area. Since ground-nesting raptors are sensitive to disturbance and ground nests can easily be destroyed by human traffic, surveyors were instructed to observe for behaviour suggesting a nest was nearby (e.g., one or both of the pair returning to the same location with nesting materials or food, a pair of Northern

Harriers exchanging prey or nesting materials through aerial passes, or a male Short-eared Owl defending a nest with distraction displays) (Smith et al. 2011, Wiggins et al. 2006) rather than conduct intensive foot searches to locate a nest.

2.2 Standwatch Survey Protocol without Transects

Standwatch surveys in the absence of associated transects were conducted in cleared portions of the reservoir that (1) could not be visited by foot due to impassible terrain and/or (2) could not be linked with other standwatch stations to form a transect. Standwatches were conducted by remaining stationary for approximately 20 minutes.

At all survey areas except Moberly River (which was only surveyed once), at least one set of surveys was conducted during daylight hours and at least one set of surveys was conducted at dusk, to maximize the possibility of observing Northern Harrier and Short-eared Owl, respectively (Table 2). Surveys were not completed during periods of high wind (greater than Beaufort 3, 12 - 19 km/hr), rain or fog. The order that the stations were visited were different on each of the three survey days.

Ground-nesting raptor observations were collected following the same protocol as described in Section 2.1 for transect surveys.

3.0 RESULTS

3.1 Habitat at Survey Areas

Habitat information for each survey station was noted during surveys to determine the quality of the cleared area as hunting and nesting habitat for ground-nesting raptors. Table 3, below, outlines the habitat at each survey station. Photographs of the habitat at each station are presented in Figures 2-7.

Table 3: Habitat at Peace River Standwatch Stations

Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
Bear Flats (transect surveys and standwatch surveys)			
BFSW01	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with new shrub and forb growth covering 50% of the cleared area by June. Regrowing vegetation included prickly rose, aspen, spreading dogbane, bedstraw, and grasses. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.
BFSW02	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with new shrub and forb growth covering 70% of the cleared area by June. Regrowing vegetation included prickly rose, aspen, spreading dogbane, bedstraw, and grasses. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.
BFSW03	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with new shrub and forb growth covering 40% of the cleared area by June. Regrowing vegetation included prickly rose, aspen, spreading dogbane, bedstraw, and grasses. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.

Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
BFSW04	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with new shrub and forb growth covering 70% of the cleared area by June. Regrowing vegetation included prickly rose, aspen, spreading dogbane, bedstraw, and grasses. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.
BFSW05	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with new shrub and forb growth covering 60% of the cleared area by June. Regrowing vegetation included prickly rose, aspen, spreading dogbane, bedstraw, and grasses. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.
Cache Creek (transect surveys and standwatch surveys)			
CCSW01	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with vegetation regrowth of horsetails, prickly rose, and grasses covering 2% of the cleared area by June. Regrowth was less than 30 cm high. The cleared area is in a steep-sided drainage in an agriculturally-dominated area with some remnant forest patches on the eastern side and bounded by Highway 29 to the south.
CCSW02	Winter 2018/2019	0	Exposed soils, mulched trees, and slash piles, with vegetation regrowth of horsetails, prickly rose, and grasses covering 30% of the cleared area by June. Regrowth was less than 30 cm high. The cleared area is in a steep-sided drainage in an agriculturally-dominated area with some remnant forest patches on the eastern side and bounded by Highway 29 to the south.
CCSW03	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with vegetation regrowth of horsetails, prickly rose, and grasses covering 30% of the cleared area by June. Regrowth was less than 30 cm high. The cleared area is in a steep-sided drainage in an agriculturally-dominated area with some remnant forest patches on the eastern side and bounded by Highway 29 to the south.
CCSW04	Winter 2016/2017	2	Reestablished vegetation consisting of a patchwork of balsam poplar saplings, shrubs, grasses and horsetails covering 90% of the cleared area. Located in a steep-sided drainage in an agriculturally-dominated area with some remnant forest patches on the eastern side and bounded by Highway 29 to the south.
CCSW05	Winter 2016/2017	2	Reestablished vegetation consisting of a patchwork of balsam poplar saplings, shrubs, grasses and horsetails covering 90% of the cleared area. Located in a steep-sided drainage in an agriculturally-dominated area with some remnant forest patches on the eastern side and bounded by Highway 29 to the south.
Halfway River (standwatch surveys only)			
HRSW01	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with shrub, grass, and weed regrowth covering 95% of the area by June. Cleared area is adjacent to the Halfway River, agricultural land, and remnant riparian forest.

Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
HRSW02	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with shrub, grass and weed regrowth covering 95% of the area by June. Cleared area is adjacent to Highway 29 and the Halfway River in an agriculturally dominated area.
HRSW03	Winter 2018/2019	0	Exposed soils, mulched trees and slash piles, with shrub, grass and weed regrowth covering 95% of the area by June. Cleared area is adjacent to Highway 29, with the Peace River to the south, the Halfway River to the east, agricultural land to the north and remnant forest to the west.
Highway 29 (standwatch surveys only)			
H29SW01	Winter 2016/2017	2	Cleared area with shrubby regrowth under 1 m tall and unburned slashpiles within a forest patch on the western side of Watson Slough.
H29SW02	Winter 2016/2017	2	Cleared area adjacent to pastureland to the east and Watson Slough to the west, being reestablished by tembling aspen saplings.
H29SW04	Winter 2016/2017	2	Active construction site, could not be surveyed in 2019.
H29SW05	Winter 2016/2017	2	Vegetation regrowth consists of a dense cover of grasses, weeds, forbs, and shrubs under 1 m tall with trembling aspen saplings growing to up to 2 m tall on the western side. Peace River and riparian balsam poplar forest to the south.
Moberly River (standwatch surveys only)			
MRSW01	Winter 2017/2018	1	At the confluence of the Moberly and Peace Rivers. Cleared and mulched area with some willows and riparian vegetation remaining.
Peace River (transect surveys and standwatch surveys; transect #1)			
PRSW02	Winter 2017/2018	1	Cleared and mulched bench in river channel with thick herbaceous and shrubby regrowth under 60 cm tall covering 90% of the cleared area. Bounded on the northern and southern sides by intact strips of open riparian forest between the cleared area and the Peace River.
PRSW03	Winter 2017/2018	1	Cleared and mulched bench in river channel with thick herbaceous and shrubby regrowth under 30 cm tall covering 90% of the cleared area. Bounded on the northern and southern sides by intact strips of riparian forest between the cleared area and the Peace River.
PRSW04	Winter 2017/2018	1	Cleared and mulched bench in river channel with shrubs, herbs and grasses growing over much of the cleared area. Bounded on the northern and western sides by an intact strip of coniferous forest between the cleared area and the Peace River.
Peace River (transect surveys and standwatch surveys; transect #2)			
PRSW05	Winter 2017/2018	1	A cleared stretch of coniferous forest on a north-facing slope with some shrub regrowth less than 1 m tall. Bounded to the south by the Peace River, and to the north and west by coniferous forest.

Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
PRSW06	Winter 2017/2018	1	A cleared stretch of coniferous forest on a north-facing slope with some shrub regrowth less than 1 m tall. Bounded to the south by the Peace River, and to the north by coniferous forest.
PRSW07	Winter 2017/2018	1	A cleared stretch of coniferous forest on a north-facing slope with some shrub regrowth less than 1 m tall. Bounded to the south by the Peace River, and to the north by coniferous forest.
PRSW08	Winter 2017/2018	1	A cleared stretch of coniferous forest on a north-facing slope with some shrub regrowth less than 1 m tall. Bounded to the south by the Peace River, and to the north by coniferous forest.
Peace River (transect surveys and standwatch surveys; transect #3)			
PRSW11	Winter 2018/2019	0	Cleared trees in slashpiles, and low vegetation regrowth of weeds, forbs and grasses covers about 30% of the ground. Bounded by dry south-facing slopes to the north and an intact strip of riparian forest along the Peace River to the south.
PRSW12	Winter 2018/2019	0	Partially-cleared area with intact patches of riparian shrubs, slashpiles and grasses revegetating most of the previously cleared and mulched areas. Bounded by dry south-facing slopes to the north and cleared land with patches of remnant forest to the south.
PRSW13	Winter 2018/2019	0	Slashpiles and low vegetation regrowth of weeds, forbs, and grasses covers about 30% of the ground. Bounded by dry south-facing slopes to the north and cleared land with patches of remnant forest to the south.
Peace River (standwatch surveys only)			
PRSW01	Winter 2017/2018	1	A cleared patch of coniferous forest on a north-facing slope with some shrub regrowth less than 1 m tall. Bounded to the south by the Peace River, and surrounded on other sides by coniferous forest.
PRSW10	Winter 2018/2019	0	Cleared trees and brush left on the ground, at least 60 cm deep, not formed into slash piles. No vegetation regrowth. Bounded by dry south-facing slopes to the north and an intact strip of riparian forest along the Peace River to the south.
PRSW14	Winter 2018/2019	0	Slashpiles and low vegetation regrowth of weeds, forbs, and grasses cover about 10% of the ground. Bounded by dry south-facing slopes to the north and an intact strip of riparian forest along the Peace River to the south.

3.2 Transect Results

Twenty (20) Northern Harrier observations were recorded during the transect surveys at Bear Flats, Cache Creek, and along the Peace River (Table 4). It is estimated that only seven or eight individuals were observed, as some individuals were hunting and were seen circling back over the same ground multiple times and were thus observed multiple times. All observations were recorded during the May surveys. No nests or potential nests were observed at any of the areas surveyed.

3.3 Standwatch Results

Two (2) Northern Harriers were observed at standwatch stations; one male and one of unknown sex (Table 4). All observations were recorded during the May surveys. No nests or potential nests were observed at any of the areas surveyed.

3.4 Other Observations

In addition to the twenty-two (22) ground-nesting raptor observations recorded during the transect and standwatch surveys, three Northern Harriers were observed incidentally when transiting between transect or standwatch locations (Table 4). One of these three incidentally observed individuals was female while the other two were of unknown sex.

4.0 DISCUSSION

No Northern Harriers were observed after May 4 and no nests or potential nests were observed at any of the areas surveyed, indicating that these individuals were likely utilizing the cleared areas during migration but not for nesting. Therefore, there is no evidence of ground-nesting raptors nesting within cleared portions of the reservoir.

Areas surveyed in 2016 through 2019 will be surveyed again in 2020 in addition to newly cleared areas within the reservoir. The additional evening surveys completed in 2019 to enhance the potential for detecting Short-eared Owl will also be completed in 2020. Surveys in the reservoir will continue until the reservoir has filled.

The ground-nesting raptor monitoring data collected in 2019 will be submitted to the BC Ministry of Environment Wildlife Species Inventory (WSI) database[1].

[1] http://www.env.gov.bc.ca/wildlife/wsi/index.htm

Table 4: Northern Harrier Observations

Location	Date	Time	Count	Activity	Sex	Age Class	Observation Location			Comments[1]
							UTM Z	UTM E	UTM N	
OBSERVATIONS FROM TRANSECTS										
Bear Flats Transect	May 4	12:40	1	In transit	F	Adult	10V	611024	6237976	Flying over post-sapling aspen forest on the bench above the floodplain
		13:22	1	In transit	M	Adult	10V	611505	6237348	Flying along edge of cutblock, making rounds
		13:23	1	In transit	F	Adult	10V	611530	6237321	Flying along edge of cutblock, making rounds
		13:41	1	In transit	F	Adult	10V	612069	6237349	Female NOHA doing laps/rounds of the perimeter of the cutblock, came around once at 13:41, again at 13:49, and again at 13:58
		14:09	2	Hunting	M+F	Adult	10V	612294	6237289	Male & female NOHA hunting in forest N of cutblock
		14:31	1	In transit	M	Adult	10V	612434	6237090	Crossing over cutblock to reach forest to the north of cutblock from the forest south of cutblock
		14:40	2	Hunting	M+F	Adult	10V	612803	6236950	Hunting together in trees between Bear Flats transects BFSW04 and BFSW05
		14:57	1	Hunting	M	Adult	10V	612652	6236716	Hunting in uncut trees near river
Cache Creek Transect	May 4	18:58	1	Hunting	F	Adult	10V	609359	6237808	Hunting over toe of slope in the portion of Cache Creek cut in 2016/2017
		19:04	1	Hunting	M	Adult	10V	609394	6237821	Hunting over toe of slope in the portion of Cache Creek cut in 2016/2017
		19:31	1	Hunting	M	Adult	10V	609344	6237588	Hunting over fallow fields and agricultural fields
		19:33	2	Flying, Perching	M	Adult	10V	609409	6237819	On the slope down to Cache Creek, two males interacting
		19:43	1	Hunting	F	Adult	10V	609271	6237598	Hunting over fallow fields and agricultural fields
		20:05	1	Hunting	M	Adult	10V	609306	6237560	Male NOHA hunting over fallow field across the Hwy from the pullout where the survey was conducted

Location	Date	Time	Count	Activity	Sex	Age Class	Observation Location			Comments[1]
							UTM Z	UTM E	UTM N	
Peace River Transect #1	May 3	20:01	1	Hunting	U	Adult	10V	624471	6233311	Flying close to ground, dipping down into grass
Peace River Transect #3	May 3	16:20	1	In transit	U	Adult	10V	619689	6232374	NOHA was travelling along the river <100 m from survey location
		17:20	1	In transit	M	Adult	10V	621062	6232531	Bird in transit
OBSERVATIONS FROM STANDWATCHES										
HRSW01	May 3	13:23	1	In transit	F	Adult	10V	595671	6231732	Flying over uncut shrubs to the north of the cleared area
PRSW10	May 3	15:41	1	In transit	U	Adult	10V	617726	6232784	NOHA was travelling along the river <50 m from survey location
INCIDENTAL OBSERVATIONS										
-	May 3	12:38	1	In transit	F	Adult	10V	605650	6233805	Incidental
-	May 3	15:34	1	In transit	U	Adult	10V	612600	6236695	Incidental
-	May 3	17:34	1	In transit	U	Adult	10V	621538	6232075	NOHA was travelling along the river >500 m from closest survey location

[1] NOHA = Northern Harrier

5.0 REFERENCES

BC Hydro. 2016. Ground Nesting Raptor Follow-up Monitoring Program Plan. Prepared for BC Hydro's Site C Clean Energy Project.

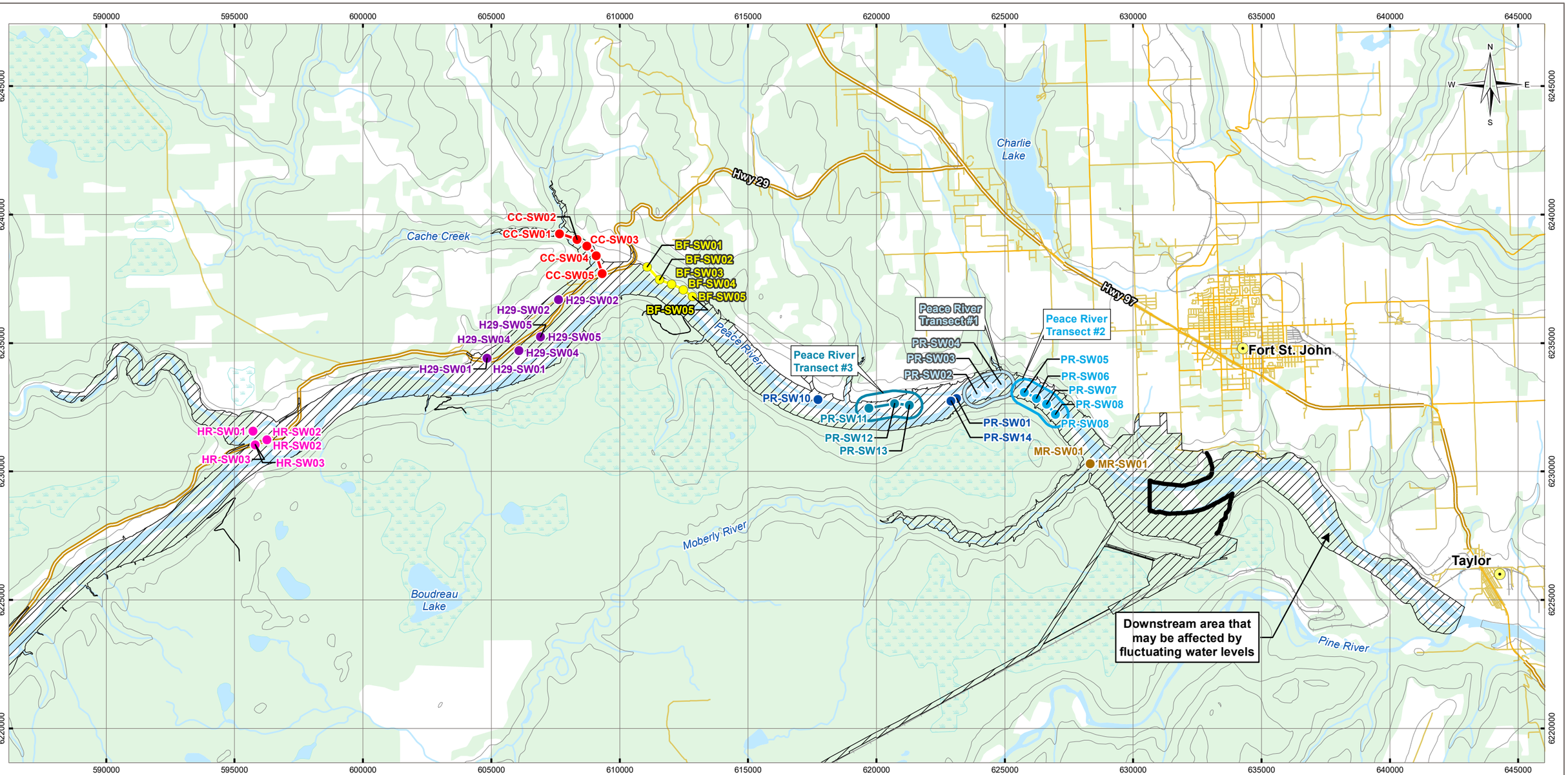
Resources Inventory Committee. 2001. Inventory Methods for Raptors. Standards for Components of British Columbia's Biodiversity No. 11. BC Ministry of Sustainable Resource Management, Environment Inventory Branch, Victoria, BC.

Siddle, C. 2010. Birds of North Peace River (Fort St. John and Vicinity), British Columbia, 1975-1999: Part 1 (Introduction and Nonpasserines: waterfowl through woodpeckers). Wildlife Afield 7(1):12–123.

Smith, K.G., Wittenbergm S.R., Macwhirter, R.B., and K.L. Bildstein. 2011. Hen/Northern Harrier (Circus cyaneus/hudsonius), version 2.0. In The Birds of North America (A.F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.210

Wiggins, D.A., Holt, D.W., and S.M. Leasure. 2006. Short-eared Owl (Asio flammeus), version 2.0. In The Birds of North America (A.F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.62

FIGURES



LEGEND

- Project Footprint

Standwatch Station
- Halfway River
- Highway 29
- Moberly River
- Peace River

Transect Standwatch Station
- Bear Flats
- Cache Creek
- Peace River #1
- Peace River #2
- Peace River #3

Transect
- Bear Flats
- Cache Creek
- Peace River #1
- Peace River #2
- Peace River #3

- Populated Place
- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Railway
- Residential Area
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Wooded Area

NOTES
Base data source: CanVec 1:250,000.

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2019 ANNUAL REPORT

Project Overview

PROJECTION UTM Zone 10			**DATUM** NAD83	**CLIENT** BC hydro
Scale: 1:150,000 (2 1 0 2 Kilometres)				TETRA TECH
FILE NO. VENV03095-01_Figure01_Overview.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** BB	**APVD** CR	**REV** 0
DATE March 30, 2020	**PROJECT NO.** ENV.VENV03095-01			**Figure 1**

W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\Raptor\2019\VENV03095-01_Figure01_Overview.mxd modified 2020-03-30 by stephanie leusink

609500 610000 610500 611000 611500 612000 612500 613000 613500 614000 614500 615000

6238500 6238000 6237500 6237000 6236500

BF-SW01
Bear Flats Transect
BF-SW02
BF-SW03
BF-SW04
BF-SW05
Hwy 29
Peace River

N W E S

LEGEND

- Northern Harrier Observation
- Bear Flats Transect Standwatch Station
- Bear Flats Transect
- Project Footprint
- Highway
- Watercourse
- Waterbody

NOTES
Base data source:
Imagery from ESRI; DigitalGlobe (2016).

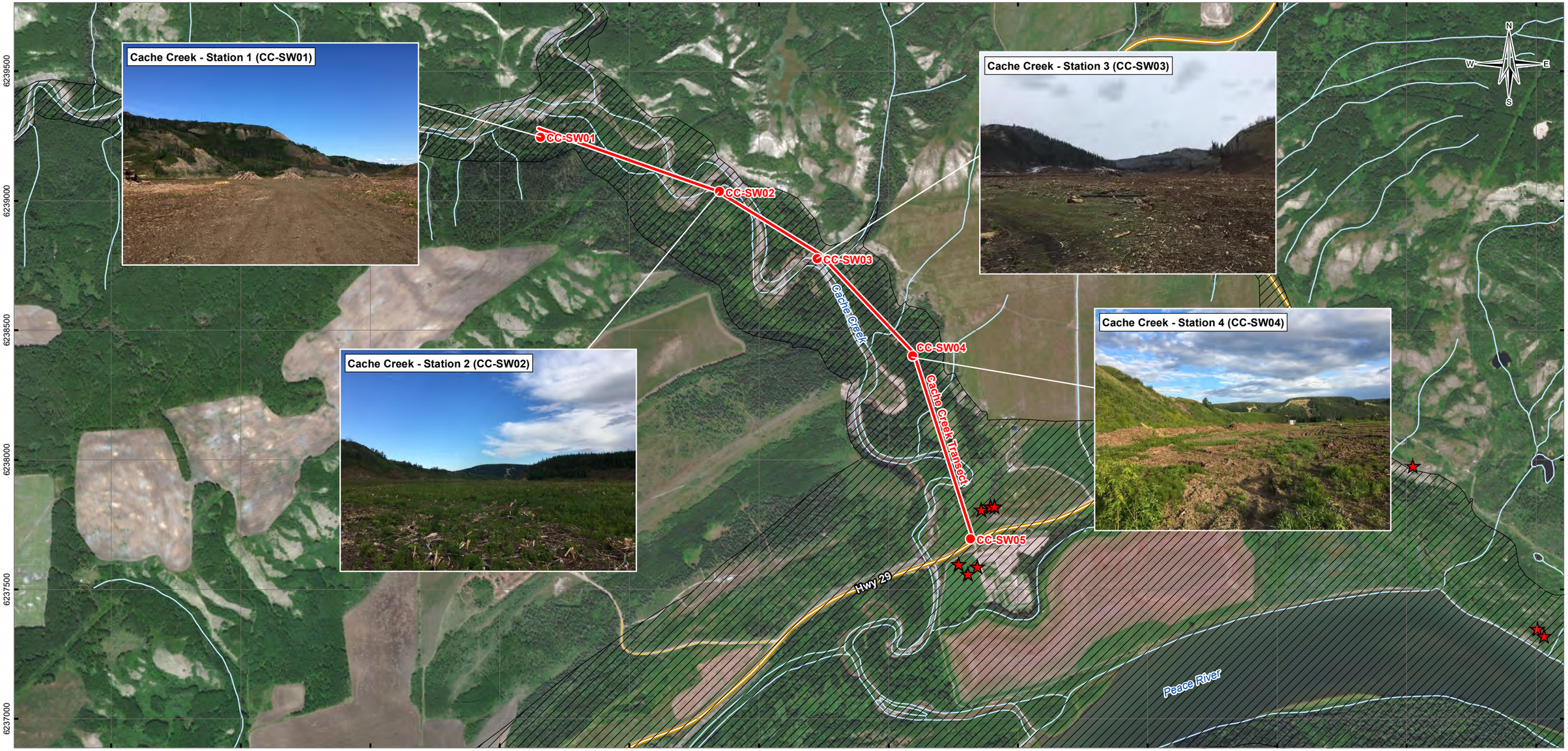
STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2019 ANNUAL REPORT

Bear Flats
Transect Stations

PROJECTION UTM Zone 10		**DATUM** NAD83		**CLIENT** BC hydro
Scale: 1:15,000 200 100 0 200 Metres				TETRA TECH
FILE NO. VENV03095-01_Figure02_BearFlats.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** BB	**APVD** CR	**REV** 0
DATE March 30, 2020	**PROJECT NO.** ENV.VENV03095-01			**Figure 2**

W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\Raptor\2019\VENV03095-01_Figure02_BearFlats.mxd modified 2020-03-30 by stephanie.leusink



LEGEND

- Northern Harrier Observation
- Cache Creek Transect Standwatch Station
- Cache Creek Transect
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody

NOTES
Base data source:
Imagery from ESRI; DigitalGlobe (2014/2016).

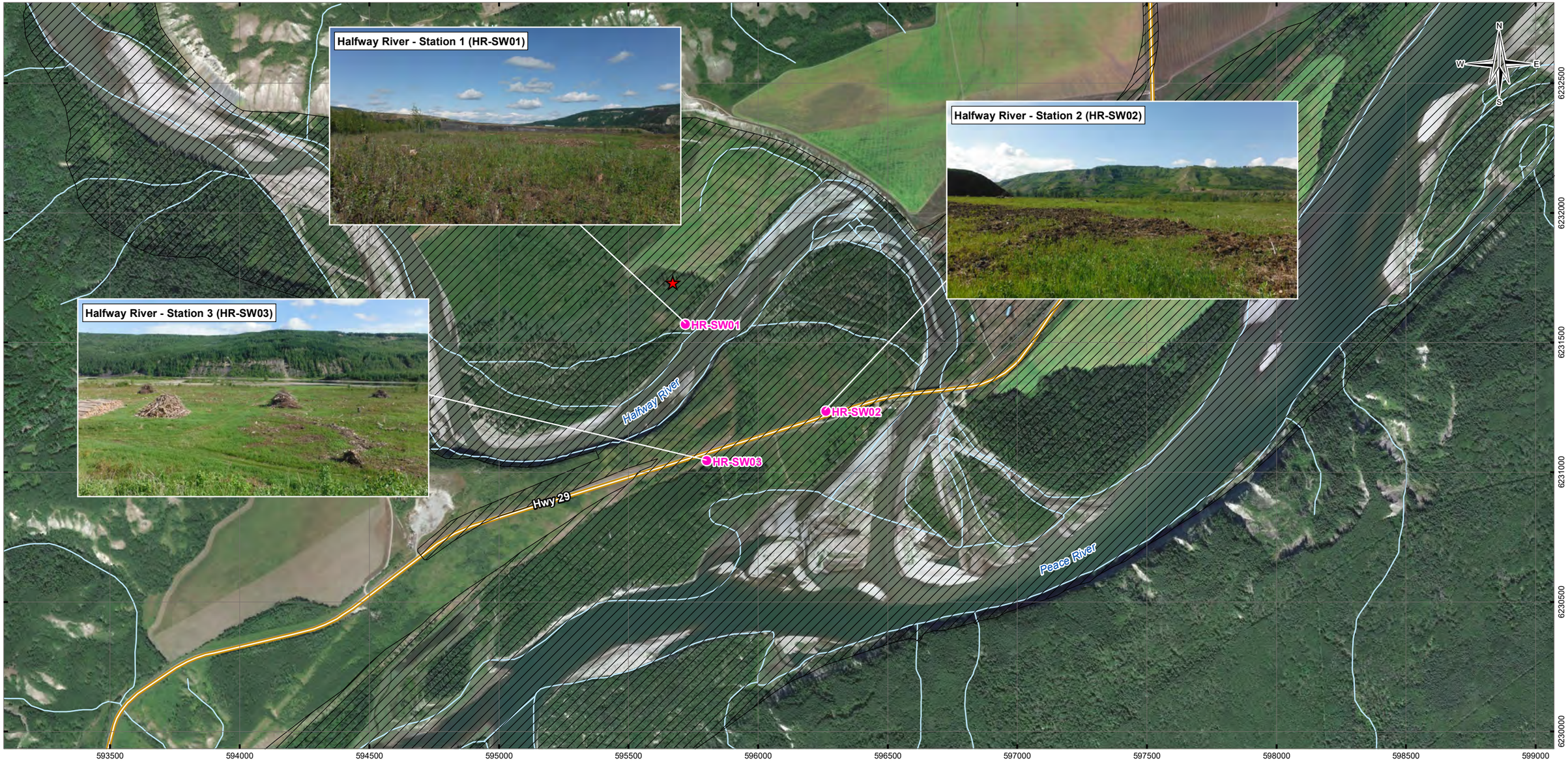
STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2019 ANNUAL REPORT

Cache Creek Transect Stations

PROJECTION UTM Zone 10			**DATUM** NAD83	**CLIENT** BC hydro
Scale: 1:15,000 — 200 100 0 200 — Metres				TETRA TECH
FILE NO. VENV03095-01_Figure03_CacheCreek.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** BB	**APVD** CR	**REV** 0
DATE March 30, 2020	**PROJECT NO.** ENV.VENV03095-01			**Figure 3**

W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\Raptor\2019\VENV03095-01_Figure03_CacheCreek.mxd modified 2020-03-30 by stephanie.leusink



LEGEND

- Northern Harrier Observation
- Halfway River Standwatch Station
- Project Footprint
- Highway
- Watercourse
- Waterbody

NOTES
Base data source:
Imagery from ESRI; DigitalGlobe (2012).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2019 ANNUAL REPORT

Halfway River Standwatch Stations

PROJECTION UTM Zone 10		**DATUM** NAD83		**CLIENT** BC hydro
Scale: 1:15,000 — 200 100 0 200 — Metres				TETRA TECH
FILE NO. VENV03095-01_Figure04_HalfwayRiver.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** BB	**APVD** CR	**REV** 0
DATE March 30, 2020	**PROJECT NO.** ENV.VENV03095-01			**Figure 4**

W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\Raptor\2019\VENV03095-01_Figure04_HalfwayRiver.mxd modified 2020-03-30 by stephanie.leusink

602000 603000 604000 605000 606000 607000 608000 609000

6237000 6236000 6235000 6234000

H29-SW02
Watson Rd
H29-SW05
Hwy 29
H29-SW04
H29-SW01
Peace River
N
W
E
S

LEGEND

- Northern Harrier Observation
- Highway 29 Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody

NOTES
Base data source:
Imagery from ESRI; DigitalGlobe (2012/2016).

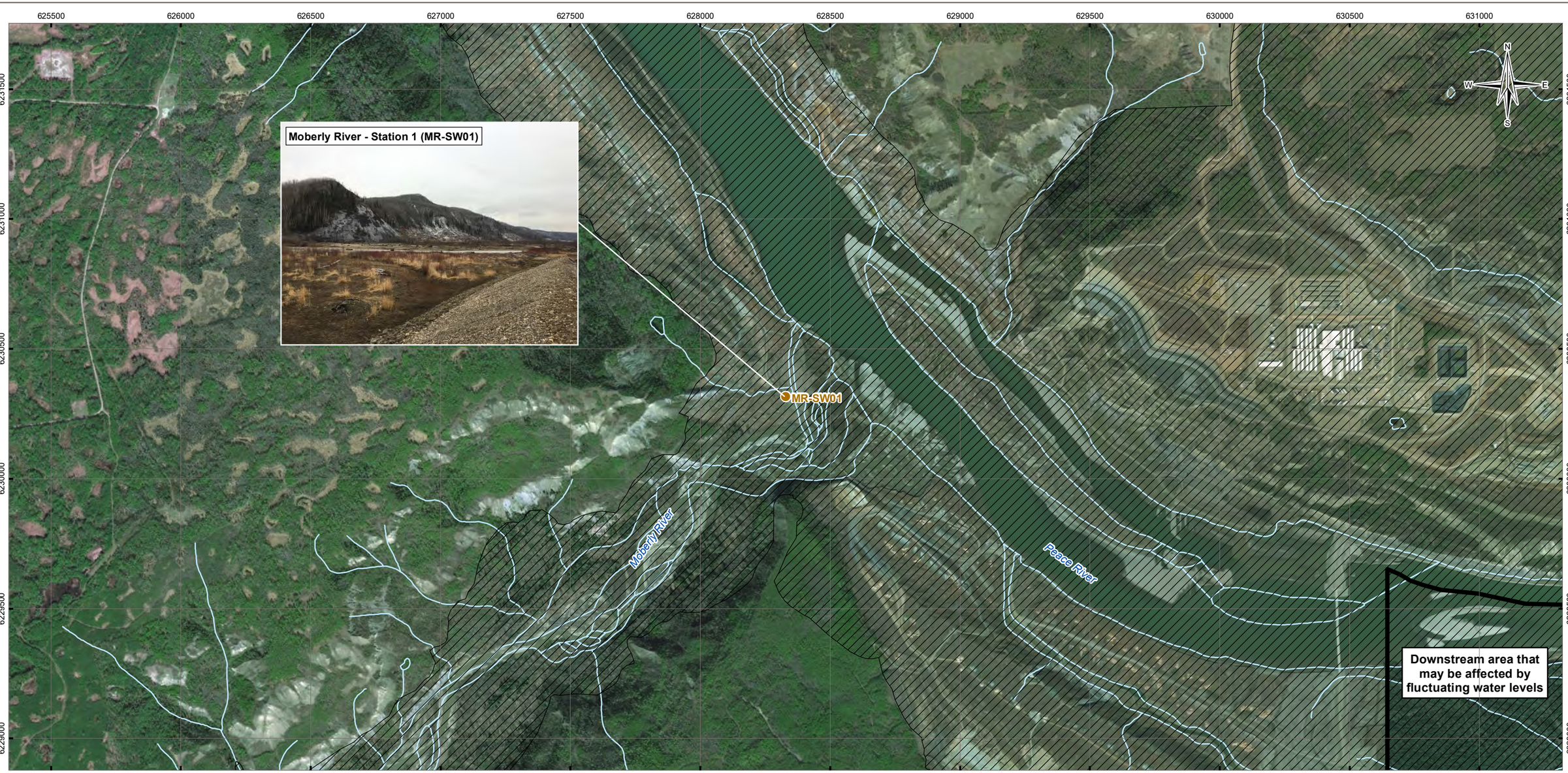
STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2019 ANNUAL REPORT

Highway 29 Standwatch Stations

PROJECTION UTM Zone 10				**DATUM** NAD83
Scale: 1:20,000 400 200 0 400 Metres				**CLIENT** BC hydro
FILE NO. VENV03095-01_Figure05_Hwy29.mxd				TETRA TECH
OFFICE Tt-VANC	**DWN** SL	**CKD** BB	**APVD** CR	**REV** 0
DATE March 30, 2020	**PROJECT NO.** ENV.VENV03095-01			**Figure 5**

W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\Raptor\2019\VENV03095-01_Figure05_Hwy29.mxd modified 2020-03-30 by stephanie.leusink



LEGEND

- Moberly River Standwatch Station
- Project Footprint
- Watercourse
- Waterbody

NOTES
Base data source:
Imagery from ESRI; DigitalGlobe (2016).

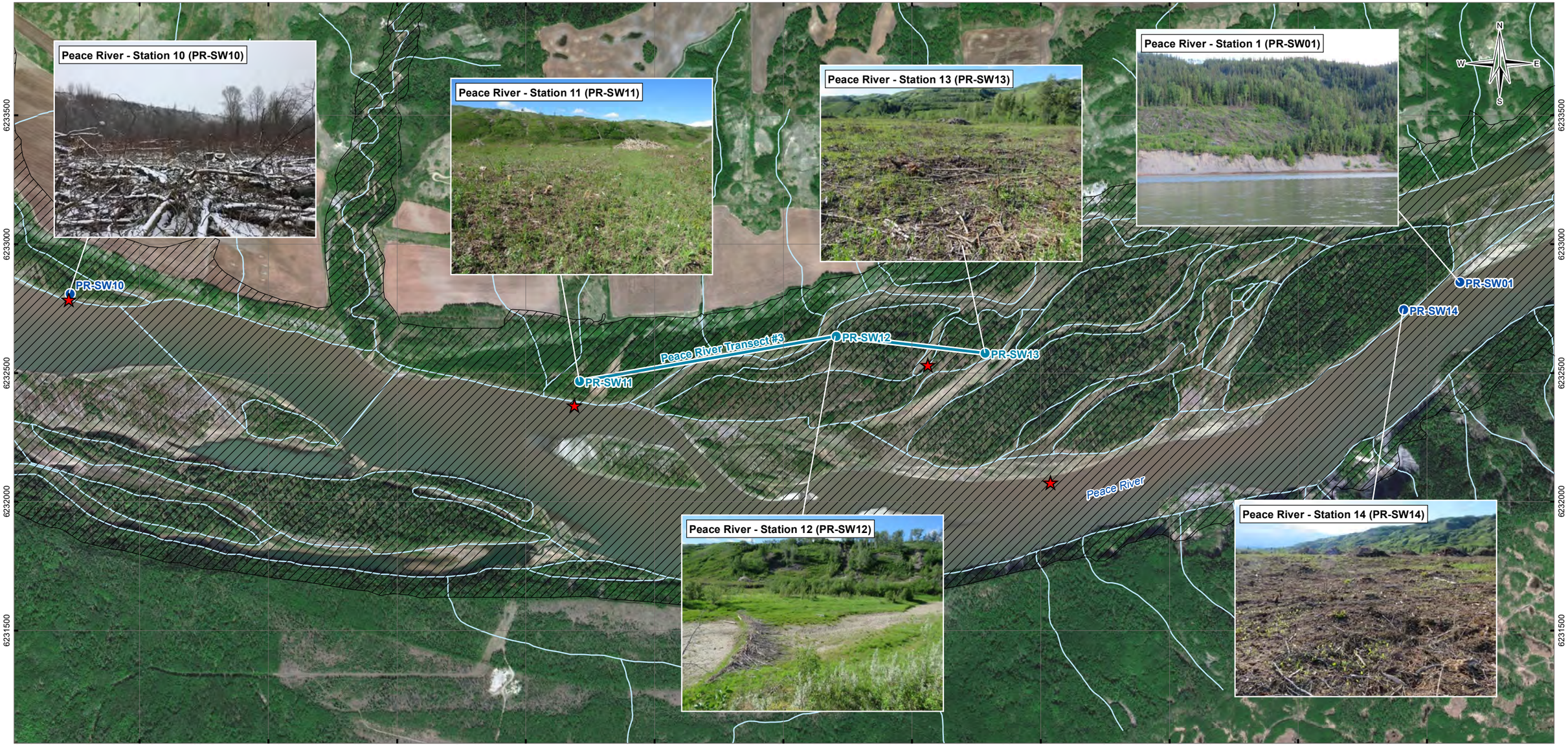
STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2019 ANNUAL REPORT

Moberly River Standwatch Station

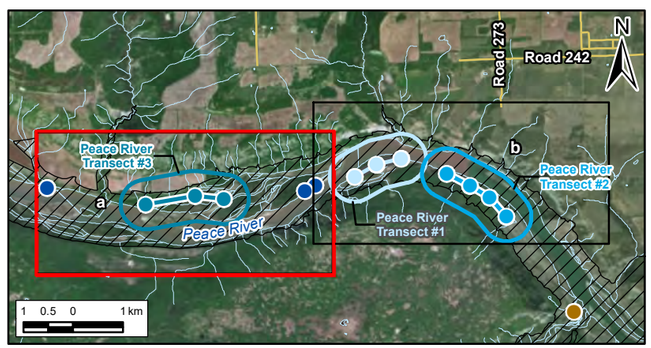
PROJECTION UTM Zone 10			**DATUM** NAD83		**CLIENT** BC hydro
Scale: 1:15,000 — 200 100 0 200 — Metres					TETRA TECH
FILE NO. VENV03095-01_Figure06_MoberlyRiver.mxd					
OFFICE TI-VANC	**DWN** SL	**CKD** BB	**APVD** CR	**REV** 0	**Figure 6**
DATE March 30, 2020	**PROJECT NO.** ENV.VENV03095-01				

W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\Raptor\2019\VENV03095-01_Figure06_MoberlyRiver.mxd modified 2020-03-30 by stephanie.leusink



LEGEND

- Northern Harrier Observation
- Peace River Standwatch Station
- Peace River Transect #3 Standwatch Station
- Peace River Transect #3
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
Imagery from ESRI; DigitalGlobe (2016).

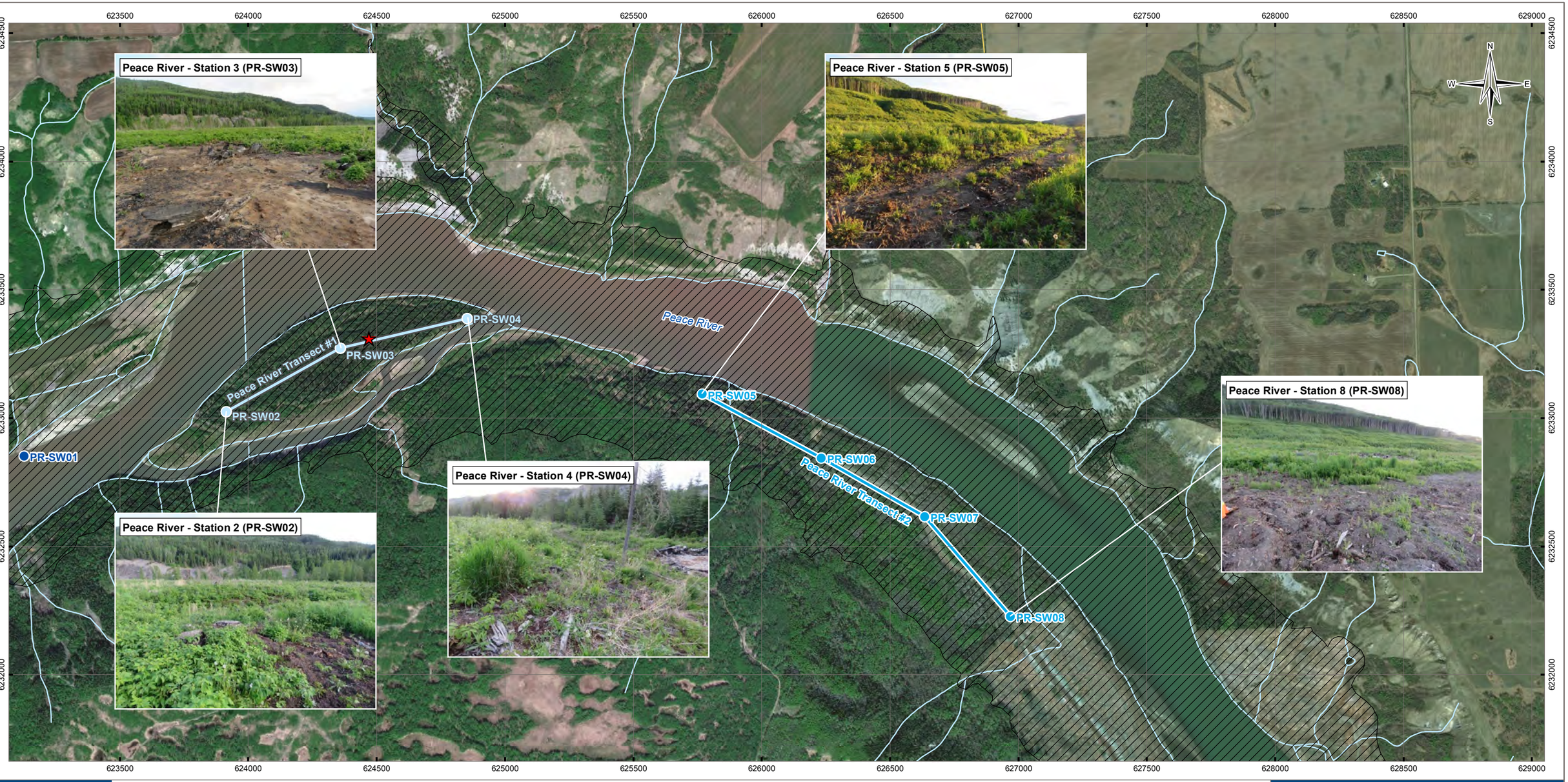
STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2019 ANNUAL REPORT

Peace River Standwatch and Transect Stations

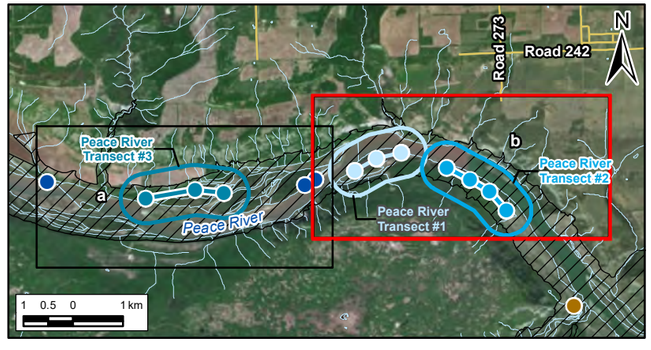
PROJECTION: UTM Zone 10	DATUM: NAD83			CLIENT: BC hydro
Scale: 1:15,000 (200 100 0 200 Metres)				TETRA TECH
FILE NO.: VENV03095-01_Figure07a_PeaceRiver.mxd				
OFFICE: Tt-VANC	DWN: SL	CKD: BB	APVD: CR	REV: 0
DATE: March 30, 2020	PROJECT NO.: ENV.VENV03095-01			Figure 7a

W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\Raptor\2019\VENV03095-01_Figure07a_PeaceRiver.mxd modified 2020-03-30 by stephanie leusink



LEGEND

- Northern Harrier Observation
- Peace River Standwatch Station
- Peace River Transect #1 Standwatch Station
- Peace River Transect #2 Standwatch Station
- Peace River Transect #1
- Peace River Transect #2
- Project Footprint
- Local Road
- Watercourse
- Waterbody



NOTES
Base data source:
Imagery from ESRI; DigitalGlobe (2015/2016).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2019 ANNUAL REPORT

Peace River Standwatch and Transect Stations

PROJECTION UTM Zone 10			**DATUM** NAD83	
Scale: 1:15,000 200 100 0 200 Metres				
FILE NO. VENV03095-01_Figure07b_PeaceRiver.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** BB	**APVD** CR	**REV** 0
DATE March 30, 2020	**PROJECT NO.** ENV.VENV03095-01			

CLIENT BC hydro

TETRA TECH

Figure 7b

W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\Raptor\2019\VENV03095-01_Figure07b_PeaceRiver.mxd modified 2020-03-30 by stephanie.leusink

APPENDIX A
INCIDENTAL WILDLIFE OBSERVATIONS

Table A.1: Incidental Wildlife Observed During Ground Nesting Raptor Surveys

Common Name	Scientific Name	BC List	COSEWIC/SARA [1]	Number Observed					
				Bear Flats	Cache Creek	Halfway River	Hwy 29	Moberly River	Peace River
Red-tailed Hawk	*Buteo jamaicensis*	Yellow	Not at Risk (May 1995)	1	3	-	-	-	-
Rough-legged Hawk	*Buteo lagopus*	Blue	Not at Risk (April 1995)	1	-	-	-	-	-
Great Horned Owl	*Bubo vigrinianus*	Yellow	-	-	-	-	1	-	1
Common Nighthawk	*Chordeiles minor*	Yellow	Special Concern /Threatened (April 2018)	1	2	-	-	-	-
Merlin	*Falco columbarius*	Yellow	Not at Risk (April 1985)	-	-	-	-	-	1
American Kestrel	*Falco sparverius*	Yellow	-	-	-	-	1	-	-
Bald Eagle	*Haliaeetus leucocephalus*	Yellow	Not at Risk (May 1984)	-	1	-	-	-	3

APPENDIX B
PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project manager, report reviewer
Camille Roberge, B.Sc. Tetra Tech Canada Inc.	Field data collection, data entry, report author
Elyse Hofs Tetra Tech Canada Inc.	Field data collection
Claudio Bianchini, R.P.Bio. Bianchini Biological Services	Field data collection
Damian Power Wolfhound Wildlife Services	Field data collection

APPENDIX C
LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

NATURAL SCIENCES

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of Saulteau EBA Environmental Services Joint Venture's (SEES JV) Client (the "Client") as specifically identified in the SEES JV Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). SEES JV does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by SEES JV.

Any unauthorized use of the Professional Document is at the sole risk of the user. SEES JV accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where SEES JV has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by SEES JV during the performance of the work are SEES JV's professional work product and shall remain the copyright property of SEES JV.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of SEES JV. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where SEES JV submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed SEES JV's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by SEES JV shall be deemed to be the original. SEES JV will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of SEES JV's Instruments of Professional Service shall not, under any circumstances, be altered by any party except SEES JV. SEES JV's Instruments of Professional Service will be used only and exactly as submitted by SEES JV.

Electronic files submitted by SEES JV have been prepared and submitted using specific software and hardware systems. SEES JV makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by SEES JV for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of SEES JV.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with SEES JV with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for SEES JV to properly provide the services contracted for in the Contract, SEES JV has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO SEES JV BY OTHERS

During the performance of the work and the preparation of this Professional Document, SEES JV may have relied on information provided by third parties other than the Client.

While SEES JV endeavours to verify the accuracy of such information, SEES JV accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to SEES JV at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

SEES JV is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL ISSUES

The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

1.8 NOTIFICATION OF AUTHORITIES

SEES JV professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by SEES JV of regulatory contravention may require that regulatory agencies and other persons be informed. The client agrees that notification to such bodies or persons as required may be done by SEES JV in its reasonably exercised discretion.