Appendix 6. Pre-construction Rare Plant Surveys

INTERIM REPORT
PRE-CONSTRUCTION RARE PLANT SURVEYS
SITE C CLEAN ENERGY PROJECT

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Contents

1.0 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 pre-construction 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 pre-construction rare plant surveys in previously unsurveyed areas of the proposed transmission line and 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 will be 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 pre-construction surveys was completed in the summer and fall of 2015, with the second season finished in the fall of 2016. This was followed by a third season of pre-construction surveys in the summer and fall of 2017. This interim report documents the methods and results of the work completed through the end of the 2017 field season.

1.2 Scope

The goals of the study are:

- 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 Areas Targeted for Pre-construction Surveys

Pre-construction rare plant surveys are being conducted in:

- the proposed Project Access Road corridor running from Jackfish Road to the Dam Site;
- the additional aggregate extraction area at the Portage Mountain site;
- the proposed access road extension at the Portage Mountain site;

- 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 85th Avenue industrial site;
- the proposed conveyor corridor from the 85th Avenue industrial site to the dam site;
- the 204 hectare (ha) Rutledge mitigation parcel along Highway 29 at Dry Creek; and
- the 423 ha Wilder Creek mitigation parcel located along the Peace River approximately six kilometres (km) downstream from Bear Flat.

Some of these areas were completed during the 2015 and 2016 field seasons. The 2017 work focussed on the Highway 29 realignment corridors, the transmission line corridor and the proposed access roads.

2.0 METHODS

2.1 Prefield Review

The investigation began with a prefield review designed to collect and analyze existing data. This information was 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" were 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 2017); and
- species on the B.C. Ministry of Environment's provincial Red or Blue lists (BCCDC 2017).

Since 2005, BC Hydro has been performing rare plant surveys in the Project area—defined as the area within which Terrestrial Ecosystem Mapping was completed to support 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 was based heavily on element occurrence data collected over the last 11 years in the Project area. Currently, 45 different rare plant taxa are known to occur in the Project area. Consequently, these 33 vascular plants, 11 lichens, and 1 moss formed the basis of the target species list for the work, comprising the rare species with the highest likelihood of occurrence.

Before each of the 2015, 2016 and 2017 field seasons, the dataset of all B.C. vascular plants, mosses, and lichens was downloaded from the Ministry of Environment's Species and Ecosystem Explorer (BCCDC 2017) and added to the Project rare plant database. This dataset served as the reference for B.C. plant statuses, as well as providing the scientific and common plant names used in this report. Queries were run on the dataset to extract a list of the rare plant species considered to potentially occur in the Peace River Regional District and the Boreal Black and White Spruce Biogeoclimatic Zone. Each species on this list was further reviewed to determine its potential for occurrence within the areas targeted for survey.

Aerial imagery, contour information, and Project maps were reviewed to predict the habitat types present in the areas proposed for survey. General plant communities were determined, and the locations of possible high-suitability rare plant habitat were noted.

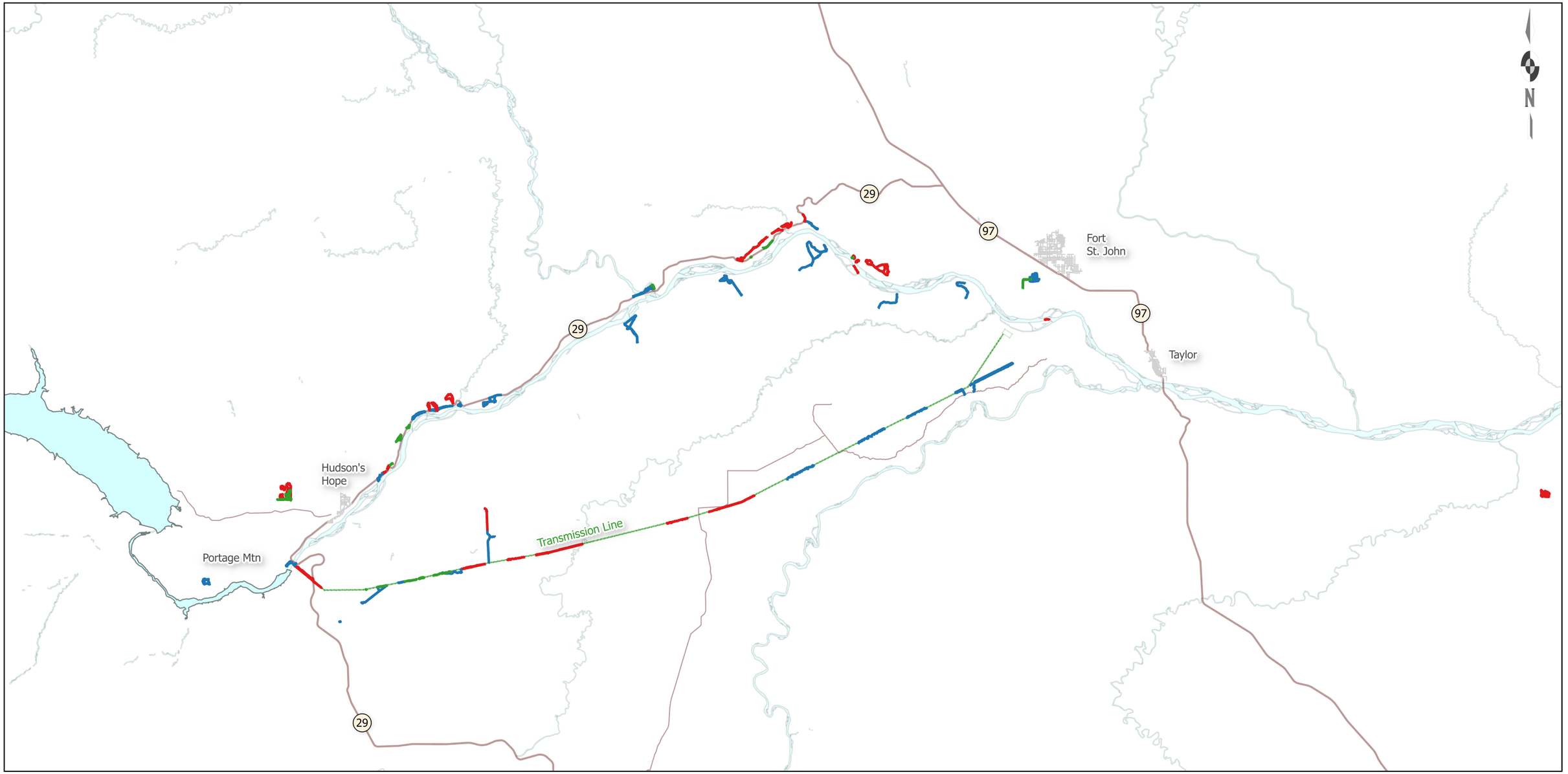
All the above data were compiled to produce a list of target rare plant species with potential for occurrence within the proposed survey areas. It should be noted that the target list is used as a working guideline and can never be an exhaustive list of all potential rare plants for a given area. For this reason, botanists consider all described plant taxa while conducting surveys.

In order to refine their search images for the target taxa, the surveyors studied photographs, herbarium specimens, and species descriptions in various published references (Hitchcock, et al. 1955; Cronquist, et al. 1977; Flora of North America Editorial Committee 1993; Goward, et al. 1994; McCune and Goward 1995; Douglas, et al. 1998a; Goward 1999; Brodo, et al. 2001; CNALH 2016a) and online databases (Klinkenberg 2017; NatureServe 2017). In addition, they reviewed similar data for species that might be confused with the target taxa. Tables of summary identification characteristics were prepared for field use. The goals were to maximize detectability of the target species and to reduce observer bias during the surveys. The final field plan was designed to guide the methods, coverage, and timing of the rare plant surveys. Seasonal timing was based on the predicted phenologies of the target species.

2.2 Field Survey

In 2015, field surveys were performed between June 30 and September 7. A total of 42 surveyor-days were spent on the ground in 2015, covering a total survey distance of 209.8 km (Figure 1). In 2016, field surveys were conducted between June 20 and August 23. Field work consisted of 36 surveyor-days, covering a total survey distance of 165.6 km. In 2017 the surveys were conducted between June 23 and August 12, with a total of 51.7 km of survey transect covered.

For all three years, the surveys were performed by two senior-level rare plant botanists—both of whom have been working with the flora of the Project area for the past seven years. The surveyors primarily used a targeted-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 and Klinkenberg 2012). The surveyors, working together or separately, walked the length of the targeted 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 or Portage Mountain sites, the surveyors conducted meander transects to cover the entire area.



Map Notes:

1. Based on surveys completed through September 2017.
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

Rare Plant Survey Routes
- 2015
- 2016
- 2017

Map Scale 1:650000

0 10 20 30 40 50 km

SITE C CLEAN ENERGY PROJECT

BC hydro

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Figure 1
Pre-construction Rare Plant Survey Routes

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When using the targeted-meander search pattern:

- 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 or 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 in a non-linear feature); and
- surveyors attempt to traverse a representative cross-section of all low-suitability rare plant habitat within the unit.

The targeted-meander survey technique is habitat-directed: that is, it preferentially covers high-suitability ecosystems over the more common low-suitability habitats (MacDougall and 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 targeted-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 traversed habitat with a low potential for rare plant occurrence, the botanists drove slowly along the corridor in a Utility Terrain Vehicle (UTV or side-by-side), scanning both sides for rare plants and pockets of high-suitability rare plant habitat. This procedure was only conducted in corridors where the majority of habitat was low-probability, and at a speed of approximately five kilometres per hour. If high-potential rare plant habitat was encountered—such as wetlands or rock outcrops—the surveyors exited the UTV and surveyed the habitat on foot. In 2015, 5.1% of the total 209.8 km traversed was surveyed from UTV—the rest was walked. In 2016 only 1.0% of the total 165.6 km survey distance was covered by UTV. In 2017, none of the transects were surveyed 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 targeted-meander survey technique described above was used in the mitigation parcels, certain areas of suitable habitat were not covered.

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

When target rare plants were found during the field work, element occurrence data were recorded on a B.C. Conservation Data Centre (BCCDC) rare plant survey form (BCCDC 2012). This information was later transcribed into digital format to facilitate analysis of the sites. Digital photographs were taken of both the individual plants and of the surrounding habitat. Consistent with both the B.C. Resource Information Standards Committee guidelines and the rare plant survey guidelines on the B.C. E-Flora website (RIC 1999; Penny and Klinkenberg 2012), a voucher specimen was collected when doing so would not compromise the viability of the population. At each vascular rare plant site, GPS units were used to record the boundary of the occurrence to facilitate mitigation planning.

Delimitation of "Element Occurrences"—referred to herein simply as "occurrences"—was 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 BCCDC 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 were typically grouped into a single occurrence when they were located closer than one kilometre from another plant of the same species. In some cases, occurrences were composed of two or more discrete patches—also referred to as "sites" in this report—spread out over a large area. These patches were mapped separately to facilitate mitigation planning, but were recorded as a single occurrence when the patches were closer than one kilometre to each other.

3.0 RESULTS

3.1 Prefield Review

The 2017 prefield review identified 184 rare taxa thought to have potential for occurrence within the areas to be surveyed (Table 1). Of these, 94 are vascular plants, 51 are mosses, and 39 are lichens. All of the species are on the B.C. Ministry of Environment's Blue or Red Lists (102 Blue and 82 Red); three are considered to be of possible conservation concern by COSEWIC (all three Threatened); and two are listed in Schedule 1 of the Species at Risk Act (both Threatened).

Table 1: Rare plant taxa with potential for occurrence within the areas to be surveyed

Taxon	Common Name	BC List	COSEWIC	SARA
VASCULAR PLANTS				
Acorus americanus	American sweet-flag	Red	-	-
Alopecurus magellanicus	alpine meadow-foxtail	Red	-	-
Anemone canadensis	Canada anemone	Blue	-	-
Antennaria neglecta	field pussytoes	Blue	-	-
Arctophila fulva	pendantgrass	Blue	-	-
Artemisia alaskana	Alaskan sagebrush	Blue	-	-
Artemisia herriotii	Herriot's sage	Red	-	-
Astragalus umbellatus	tundra milk-vetch	Blue	-	-
Atriplex gardneri var. *gardneri*	Gardner's sagebrush	Red	-	-
Avenula hookeri	spike-oat	Blue	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Boechera sparsiflora	stretching suncress	Red	-	-
Botrychium ascendens	upswept moonwort	Blue	-	-
Botrychium crenulatum	dainty moonwort	Blue	-	-
Botrychium lineare	Linear-leaf moonwort	Blue	-	-
Botrychium montanum	mountain moonwort	Red	-	-
Botrychium paradoxum	two-spiked moonwort	Red	-	-
Botrychium simplex var. *compositum*	least moonwort	Blue	-	-
Botrychium spathulatum	spoon-shaped moonwort	Blue	-	-
Braya glabella ssp. *glabella*	smooth northern-rockcress	Red	-	-
Calamagrostis montanensis	plains reedgrass	Blue	-	-
Carex bicolor	two-coloured sedge	Blue	-	-
Carex heleonastes	Hudson Bay sedge	Blue	-	-
Carex lapponica	Lapland sedge	Red	-	-
Carex sprengelii	Sprengel's sedge	Red	-	-
Carex torreyi	Torrey's sedge	Red	-	-
Carex xerantica	dry-land sedge	Blue	-	-
Chenopodium hians	gaping goosefoot	Red	-	-
Chrysosplenium iowense	Iowa golden-saxifrage	Red	-	-
Cirsium drummondii	Drummond's thistle	Blue	-	-
Descurainia sophioides	northern tansymustard	Blue	-	-
Drosera linearis	slender-leaf sundew	Red	-	-
Elymus lanceolatus ssp. *psammophilus*	sand-dune wheatgrass	Blue	-	-
Epilobium halleanum	Hall's willowherb	Blue	-	-
Epilobium hornemannii ssp. *behringianum*	Hornemann's willowherb	Blue	-	-
Epilobium saximontanum	Rocky Mountain willowherb	Red	-	-
Erigeron pacalis	Peace daisy	Red	-	-
Geum triflorum var. *triflorum*	old man's whiskers	Red	-	-
Glyceria pulchella	slender mannagrass	Blue	-	-
Helianthus nuttallii ssp. *rydbergii*	Nuttall's sunflower	Red	-	-
Hesperostipa spartea	porcupinegrass	Blue	-	-
Impatiens aurella	orange touch-me-not	Blue	-	-
Lomatium foeniculaceum var. *foeniculaceum*	fennel-leaved desert-parsley	Red	-	-
Lomatogonium rotatum	marsh felwort	Blue	-	-
Lupinus kuschei	Yukon lupine	Blue	-	-
Luzula rufescens	rusty wood-rush	Red	-	-
Malaxis brachypoda	white adder's-mouth orchid	Blue	-	-
Micranthes nelsoniana var. *carlottae*	dotted saxifrage	Blue	-	-
Ophioglossum pusillum	northern adder's-tongue	Blue	-	-
Oxytropis campestris var. *davisii*	Davis' locoweed	Blue	-	-
Oxytropis maydelliana	Maydell's locoweed	Blue	-	-
Packera ogotorukensis	Ogotoruk Creek butterweed	Red	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Pedicularis parviflora	small-flowered lousewort	Red	-	-
Pedicularis verticillata	whorled lousewort	Blue	-	-
Penstemon gormanii	Gorman's penstemon	Blue	-	-
Penstemon gracilis	slender penstemon	Red	-	-
Physaria arctica	arctic bladderpod	Blue	-	-
Physaria didymocarpa ssp. *didymocarpa*	common twinpod	Blue	-	-
Pinguicula villosa	hairy butterwort	Blue	-	-
Plantago eriopoda	alkali plantain	Blue	-	-
Polemonium boreale	northern Jacob's-ladder	Blue	-	-
Polygala senega	Seneca-snakeroot	Red	-	-
Polypodium sibiricum	Siberian polypody	Red	-	-
Potamogeton perfoliatus	perfoliate pondweed	Blue	-	-
Potentilla arenosa ssp. *arenosa*	scree cinquefoil	Red	-	-
Potentilla furcata	forked cinquefoil	Red	-	-
Potentilla pulcherrima	pretty cinquefoil	Red	-	-
Prenanthes racemosa	purple rattlesnake-root	Red	-	-
Pyrola elliptica	shinleaf wintergreen	Blue	-	-
Ranunculus cardiophyllus	heart-leaved buttercup	Red	-	-
Ranunculus pedatifidus ssp. *affinis*	birdfoot buttercup	Blue	-	-
Ranunculus rhomboideus	prairie buttercup	Red	-	-
Rorippa calycina	persistent-sepal yellowcress	Red	-	-
Rorippa sinuata	spreading yellowcress	Red	-	-
Rosa arkansana	Arkansas rose	Blue	-	-
Rumex arcticus	arctic dock	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	-	-
Schizachyrium scoparium	little bluestem	Blue	-	-
Selaginella rupestris	rock selaginella	Red	-	-
Senecio sheldonensis	Mount Sheldon butterweed	Blue	-	-
Silene drummondii var. *drummondii*	Drummond's campion	Blue	-	-
Silene ostenfeldii	Taimyr campion	Blue	-	-
Silene repens	pink campion	Red	-	-
Sphenopholis intermedia	slender wedgegrass	Blue	-	-
Sphenopholis obtusata	prairie wedgegrass	Red	-	-
Stuckenia vaginata	sheathing pondweed	Blue	-	-
Symphyotrichum falcatum var. *commutatum*	white prairie aster	Red	-	-
Tephroseris palustris	marsh fleabane	Blue	-	-
Thalictrum dasycarpum	purple meadowrue	Red	-	-
Thermopsis rhombifolia	prairie golden bean	Red	-	-
Townsendia hookeri	Hooker's townsendia	Red	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Utricularia ochroleuca	ochroleucous bladderwort	Blue	-	-
MOSSES				
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	1-T
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	-	1-T
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	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
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 grayi	gray's pixie-cup	Red	-	-
Cladonia parasitica	fence-rail pixie	Red	-	-
Collema bachmanianum	Caesar's tarpaper	Red	-	-
Collema coniophilum	crumpled tarpaper	Red	T	-
Collema multipartitum	protracted tarpaper	Red	-	-
Fulgensia bracteata	goldnugget sulphur	Blue	-	-
Fulgensia bracteata	goldnugget sulphur	Blue	-	-
Fulgensia desertorum	desert sulphur	Red	-	-
Heterodermia speciosa	smiling centipede	Red	-	-
Lempholemma polyanthes	mourning phlegm	Blue	-	-
Leptogium intermedium	fourty-five vinyl	Blue	-	-
Leptogium plicatile	starfish vinyl	Blue	-	-
Leptogium pseudofurfuraceum	concentric vinyl	Blue	-	-
Leptogium schraderi	collapsing vinyl	Red	-	-
Leptogium tenuissimum	birdnest vinyl	Red	-	-
Peltigera degenii	lustrous pelt	Red	-	-
Peltigera evansiana	peppered pelt	Red	-	-
Phaeophyscia adiastola	granulating shadow	Red	-	-
Phaeophyscia hirsuta	smiling shadow	Red	-	-
Phaeophyscia hispidula	whiskered shadow	Red	-	-
Phaeophyscia kairamoi	five o'clock shadow	Blue	-	-
Phaeophyscia nigricans	least shadow	Red	-	-
Physcia biziana	frosted rosette	Blue	-	-
Physcia dimidiata	exuberant rosette	Red	-	-
Physcia stellaris	immaculate rosette	Blue	-	-
Physcia tribacia	beaded rosette	Red	-	-
Physciella chloantha	downside shade	Blue	-	-
Punctelia perreticulata	galactic speckleback	Red	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Ramalina sinensis	threadbare ribbon	Blue	-	-
Squamarina cartilaginea	pea-green dimple	Red	-	-
Squamarina lentigera	snow-white dimple	Red	-	-
Thyrea confusa	candied gummybear	Blue	-	-
Usnea cavernosa	pitted beard	Blue	-	-
Usnea glabrata	lustrous beard	Blue	-	-
Usnea glabrescens	spotted beard	Blue	-	-
Usnea trichodea	deadman's beard	Red	-	-
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*

3.2 Field Survey

The 2015 field surveys found 34 new sites of 14 different rare plant species—11 vascular plants and 3 lichens (Table 2 and Figure 2). 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 are on the B.C. Ministry of Environment's Red list, with the remaining 9 being on the Blue list. None of the taxa are listed on Schedule 1 of the Species at Risk Act, or are considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2017).

In 2016, 88 new sites of 13 different rare plant species were found—10 vascular plants and 3 lichens (Table 2 and Figure 2). 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 are on the B.C. Red list, while the remaining 8 are on the Blue list. None of the 2016 taxa are listed on Schedule 1 of the Species at Risk Act, or are considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2017).

In 2017, three new sites of two different lichen species were found (Table 2 and Figure 2). One of the sites was considered to be an extension of a previously reported occurrence, and two are new occurrences. Both taxa found in 2017 are on the B.C. Blue list, and neither 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 2017).

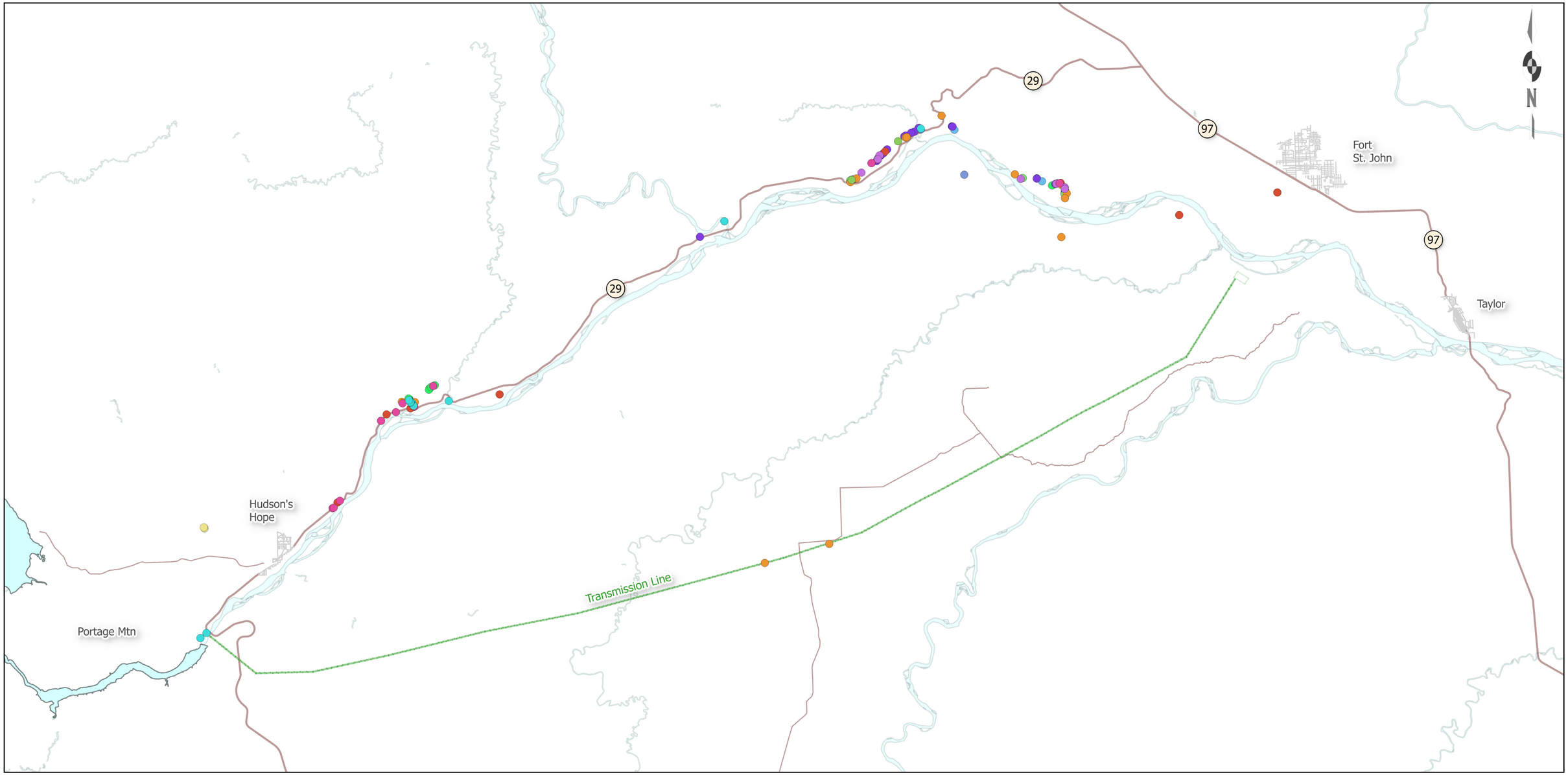
In total, 123 new sites of 17 rare plant taxa were documented. Over the course of the three survey years, the investigators recorded 442 vascular plant, bryophyte, and lichen taxa (Appendix 1).

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

Taxon	Common Name	Sites Found	BC List
VASCULAR PLANTS			
Artemisia herriotii	Herriot's sage	4	Red
Avenula hookeri	Spike-oat	1	Blue
Calamagrostis montanensis	plains reedgrass	14	Blue
Carex sprengelii	Sprengel's sedge	2	Red
Carex torreyi	Torrey's sedge	1	Red
Carex xerantica	dry-land sedge	2	Blue
Geum triflorum var. *triflorum*	old man's whiskers	26	Red
Oxytropis campestris var. *davisii*	Davis' locoweed	1	Blue
Penstemon gracilis	slender penstemon	7	Red
Polypodium sibiricum	Siberian polypody	3	Red
Potentilla pulcherrima	pretty cinquefoil	9	Red
Silene drummondii var. *drummondii*	Drummond's campion	3	Blue
Sphenopholis intermedia	slender wedgegrass	12	Blue
LICHENS			
Physcia biziana	frosted rosette	18	Blue
Physcia stellaris	immaculate rosette	9	Blue
Ramalina sinensis	threadbare ribbon	11	Blue
Usnea cavernosa	pitted beard	1	Blue

Table notes:

- *B.C. List (B.C. Ministry of Environment): Red = Endangered, Threatened, or Extirpated; Blue = Special Concern*



Map Notes:

1. Based on surveys completed through September 2017.
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.

- *Artemisia herriotii*
- *Avenula hookeri*
- *Calamagrostis montanensis*
- *Carex sprengelii*
- *Carex xerantica*
- *Drosera linearis*
- *Geum triflorum var. triflorum*
- *Pedicularis parviflora*
- *Penstemon gracilis*
- *Physcia biziana*
- *Physcia stellaris*
- *Potentilla pulcherrima*
- *Ramalina sinensis*
- *Silene drummondii var. drummondii*
- *Sphenopholis intermedia*
- *Usnea cavernosa*

Map Scale 1:250000

0 10 20 km

SITE CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING environmental consulting services

Figure 2
Rare Plant Sites Found During Pre-construction Surveys

Date	October 11, 2017	DWG NO	2017-10-11-0002	Revision 0

Most of the rare taxa found during the pre-construction surveys had been documented previously in other occurrences during the baseline surveys performed for the Project environmental impact assessment. The Sprengel's sedge, frosted rosette, and pitted beard finds, however, represent new rare species documented in the Project area. In addition, although old man's whiskers and pretty cinquefoil had been documented in the Project area during the baseline studies, they were not officially listed by the B.C. Conservation Data Centre at the time, and so were not treated in the impact assessment.

Species descriptions for the 17 rare plant taxa recorded during the pre-construction surveys are presented below. The sections also contain summary information on the new sites documented in 2015, 2016 and 2017. Information on additional occurrences located 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 2015);
- 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 2017).

3.2.1 Artemisia herriotii (Herriot's sage)

Herriot's sage (Figure 3) is an aromatic perennial herb in the Asteraceae (sunflower family) that grows on plains, dry ridges, and gravelly shores (Gray and Fernald 1950). In B.C., Herriot's sage is known only from the Peace River region (BCCDC 2017). The taxon ranges across northern Alberta, and south in the U.S. to Minnesota and South Dakota (Gray and Fernald 1950). Herriot's sage is ranked as an S2 (Imperilled) species in B.C., and is on the provincial Red list (BCCDC 2017). An assessment of global rank for Herriot's sage has not yet been published (see below).

It should be noted that the taxonomy of Herriot's sage is uncertain, and little is known about the taxon's precise habitat requirements and global range. Herriot's sage is not recognized in Illustrated Flora of British Columbia. The best published description of Herriot's sage dates from 1950 (Gray and Fernald 1950), and the species is also briefly mentioned in the Flora of Canada (Scoggan 1979). The name Herriot's sage is listed as a synonym of Aleutian mugwort (*Artemisia tilesii* ssp. *elatior*) in Flora of Alberta (Moss and Packer 1983) and in Rare Vascular Plants of Alberta (Kershaw, et al. 2001). Herriot's sage is also listed as a synonym of western mugwort (*Artemisia ludoviciana* ssp. *ludoviciana)* in the Flora of North America (Shultz 2006), and on the NatureServe Explorer website (NatureServe 2017).

Figure 3: *Artemisia herriotii* (Herriot's sage)

Four sites of Herriot's sage were recorded in the areas surveyed in 2015 and 2016 (Figure 2). Rare plant surveys in 2015 located one new occurrence of the taxon on loose open soil in a steep draw above the south shore of the Peace River. 50–250 plants were observed in an approximate area of 1,000 square metres (m^2). Herriot's sage was a dominant species at the site; associated species included prairie sagewort (*Artemisia frigida*) and various native shrubs.

Two other new sites discovered in 2015 were determined to be extensions of previously reported nearby occurrences. In the Halfway River Highway Realignment section, fewer than 50 Herriot's sage plants were found in scattered patches totaling some 20 m^2, extending from the open shoreline into shrubby riparian woodland. This site was found to be approximately 600 metres (m) from an occurrence reported in 2011. East of Bear Flat, a patch of Herriot's sage was observed in a seep on both sides of a proposed access road route. Here, 50–250 large plants dominated an area of roughly 200 m^2 within a shrubby opening in a recently burned grassland-woodland mosaic. This site was located approximately 340 m downslope of an occurrence first reported in 2005.

Finally, one new occurrence of Herriot's sage was found in 2016 in the Cache Creek Highway Realignment area. A single plant was discovered growing on an open gravel bar floodplain along Cache Creek. Associated species included low native shrubs and a mix of native and non-native herbs.

3.2.2 Avenula hookeri (spike-oat)

Spike-oat (Figure 4), a bristly-headed perennial grass, inhabits mesic to dry open slopes, meadows, and forest clearings, in the montane and subalpine zones (Douglas, et al. 1998a; Tucker 2007). In B.C., the species is found primarily in the Peace River area, but has also been reported from the far north near Liard River (BCCDC 2017). The native distribution of spike-oat extends north into Yukon and the Northwest Territories, east to Manitoba, and south in the U.S. through parts of Minnesota, South Dakota, Montana, Wyoming, Colorado, and New Mexico. The taxon is also found across much of Asia (Wu and Phillips 2006; Tucker 2007; NatureServe 2017). In addition, spike-oat is reported as an introduced species in Vermont and Québec (Magee and Ahles 2007; NatureServe 2017).

Spike-oat is ranked S3 (Vulnerable) by the B.C. Conservation Data Centre, and is on the province's Blue list (BCCDC 2017). NatureServe ranks spike-oat G5 (Secure) globally—although in Wyoming the species is ranked S1S2 (Critically Imperilled or Imperilled), in Yukon S2 (Imperilled), and Minnesota S3 (Vulnerable) (NatureServe 2017).

Figure 4: *Avenula hookeri* (spike-oat)

One new occurrence of spike-oat was located during the 2016 rare plant survey work (Figure 2). The species was collected in the Cache Creek Highway Realignment section in an open meadow of native herbs and low shrubs near the west edge of Cache Creek canyon.

3.2.3 Calamagrostis montanensis (plains reedgrass)

Plains reedgrass is a tufted perennial grass found on dry grassland slopes, shrub flats, and in open forests in the montane and steppe zones (Hitchcock, et al. 1969; Douglas, et al. 2001). The species is known from the southeast corner of B.C. as well as from the Peace River area, and is distributed across the prairie provinces to Manitoba, and south in the U.S. to Minnesota, South Dakota, Colorado and Idaho (BCCDC 2007; BCCDC 2017; NatureServe 2017).

Plains reedgrass is ranked S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2017). Across its global range, the taxon is considered Secure (G5), although Manitoba, Minnesota, and Wyoming also rank the species as S3 (Vulnerable) (NatureServe 2017).

Fourteen new sites of plains reedgrass were documented during the 2015 and 2016 rare plant surveys (Figure 2). In the Dry Creek Highway Realignment section, one occurrence covering approximately ten square metres containing fewer than 50 plants was found in an opening of native grassland in 2015. The following year three more patches of plains reedgrass, found roughly 600 metres to the northwest in the Rutledge mitigation parcel, were added to the 2015 Dry Creek occurrence. These three patches covered approximately 30 m^2 in total, and contained fewer than 50 plants. At all four sites, the terrain consisted of steep south- to southwest-facing slopes with moderate soil disturbance from animal trails. The dominant associated species included a variety of native herbs as well as low native shrubs. A similar occurrence was also recorded at the east end of the Rutledge mitigation parcel, where four patches of plains reedgrass were observed scattered across steep grassland slopes. Fewer than 50 plants were seen in a total area of approximately 112 m^2. More soil disturbance was evident in this occurrence, including a small excavated area at a seep; associated species consisted of a mix of native and non-native herbs as well as low native shrubs.

Figure 5: *Calamagrostis montanensis* (plains reedgrass)

Further east, another small occurrence was recorded in 2015, on a disturbed grassland slope approximately 15 m above a proposed access road route east of Bear Flat. Here, fewer than 50 plains reedgrass plants were found in scattered patches, covering a total approximate area of 20 m^2. The final two new occurrences were discovered just over one kilometre apart in the Wilder Creek mitigation parcel in 2016. Two very small patches, each roughly one square metre in size and containing fewer than 50 plains reedgrass plants, were located at the western end of the mitigation parcel. In the eastern end, three small patches were found, also containing fewer than 50 plants in total. Habitat and associated species were similar across the entire area: moderately sloped south-facing hillsides supporting a grass and shrubland community dominated by native plant species. Despite the road tracks and agricultural fields at the base of the hillside, disturbance across the slopes appeared limited to occasional animal trails.

3.2.4 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 drooping seed 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. 2001; Ball and Reznicek 2002). In B.C., Sprengel's sedge is reported from two locations near William's Lake, and one location in the Peace River region (prior to 2015) (BCCDC 2017; Klinkenberg 2017). 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 and Reznicek 2002; NatureServe 2017).

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

Sprengel's sedge has a rank of S2 (Imperilled) in B.C., and is on the provincial Red list (BCCDC 2017). Across much of North America the taxon is classed as Secure (G5) or Apparently Secure (G4), but is considered rare on the western, southern, and eastern edges of its range: S3 (Vulnerable) in Quebec, Pennsylvania, Illinois, Montana and Wyoming; S2 (Imperilled) in New Brunswick, Maine, Ohio, and Colorado; S1 (Critically Imperilled) in Missouri and Alaska, and SH (Possibly Extirpated) in Delaware (NatureServe 2017).

Two occurrences of Sprengel's sedge were located in the areas surveyed during 2015 and 2016 (Figure 2). Rare plant surveys in 2015 recorded the species east of Bear Flat in a proposed access road route through recently burned grassland-open woodland habitat. Several plants were observed in an area of less than one square metre, along a trail in an old road track near a calcareous seep. The area showed signs of moderate to heavy disturbance, and weedy plant species were abundant.

During the 2016 survey work, Sprengel's sedge was located in a shrubby, moist draw on a grassland slope in the Wilder Creek mitigation parcel. Many vigorous fruiting plants were found growing in an area of approximately eleven square metres in very wet soil in nearly full shade. The dominant associated species consisted of native plants, and the habitat appeared undisturbed except for a small animal trail.

3.2.5 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. 2001; Ball and Reznicek 2002). In B.C. the species is found only in the Peace River area, where it is known from a limited number of occurrences

(BCCDC 2017; Klinkenberg 2017). 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 2017).

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

Torrey's sedge is ranked S2S3 (Imperilled or Vulnerable) in B.C. and is on the province's Blue list (BCCDC 2017). The species is ranked G4 (Apparently Secure) globally, although Colorado and Wisconsin rank it S1 (Critically Imperilled), Ontario and Wyoming rank it S2 (Imperilled), and Alberta and Montana rank it S3 (Vulnerable) (NatureServe 2017).

One site of Torrey's sedge—found to be an extension of a previously reported occurrence—was located in 2015 (Figure 2). A single plant was discovered in the Industrial 85th district south of Fort St. John, approximately 525 m from an occurrence documented in 2011. The Torrey's sedge plant was found growing under a small powerline by a road, in an open, weedy corridor. Non-native grasses and forbs were the dominant associated species at the site and many forms of soil and vegetation disturbance were observed in the area.

3.2.6 Carex xerantica (dry-land sedge)

Dry-land sedge (Figure 8), a perennial herb with silvery-gold heads, is found in xeric steppe and montane habitats such as dry grasslands and hillsides, open forests, and rock outcrops (Douglas, et al. 2001; Ball and Reznicek 2002). The 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 2017; Klinkenberg 2017). There is some disagreement on the taxon's global range. Douglas et al. (2001) 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 (2017) reports the sedge from as far north as Yukon and Alaska, and as far south as New Mexico.

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

Dry-land sedge is classed as S2S3 (Imperilled or Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2017). 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 Ontario, Nebraska, and New Mexico; and S3 (Vulnerable) in Alberta, Manitoba, and Minnesota. Saskatchewan ranks the species S4 (Apparently Secure) and the remaining six jurisdictions where it is reported to occur do not rank the sedge (Montana, North and South Dakota, Utah, Colorado, and Arizona) (NatureServe 2017).

Two occurrences of dry-land sedge were documented during rare plant survey work in 2015 and 2016 (Figure 2). East of Bear Flat, a small patch roughly 10 m^2 in size was found on a disturbed, dry grassland slope near a proposed access road route. Approximately 30 dry-land sedge plants were observed growing in a community of native and non-native herbs and native low shrubs. Further east, in the Wilder Creek mitigation parcel, a second occurrence was located on a hillcrest in a grassy opening within shrubby upland woods. Fewer than 50 dry-land sedge plants were found in an approximate area of 17 m^2. At this site, the plant community consisted of a mix of native herbs and low shrubs, and disturbance appeared relatively minimal.

3.2.7 Geum triflorum var. *triflorum (old man's whiskers)*

Old man's whiskers (Figure 9) is a low, soft-hairy perennial herb of the Rosaceae (rose family) that is found growing on dry to mesic slopes and bluffs, and in grasslands, meadows, prairies, and open woodlands (Douglas, et al. 1999; Rohrer 2014). Variety *triflorum* is differentiated from variety *ciliatum* by small differences in the leaves and style, and by geographic range (Rohrer 2014). In B.C., variety *triflorum* is restricted to the Peace River region, where it has been reported from eight locations prior to 2015, mostly on the dry grassland breaks above the Peace River (BCCDC 2017; Klinkenberg 2017). Old man's whiskers variety *triflorum* is distributed across North America as far east as New York state, and as far south as Arizona, New Mexico, and Illinois (Rohrer 2014; NatureServe 2017).

Figure 9: *Geum triflorum* var. *triflorum* (old man's whiskers)

Old man's whiskers variety *triflorum* is ranked S1S3 (Critically Imperilled or Vulnerable) in B.C., and is on the province's Red list (BCCDC 2017). The taxon is classed as S2 (Imperilled) in New York State, but otherwise is considered globally Secure (G5) or Apparently Secure (G4) (NatureServe 2017).

Seven occurrences (comprising 26 separate patches) of old man's whiskers variety *triflorum* were documented in the areas surveyed during the rare plant survey work in 2015 and 2016 (Figure 2).

The first occurrence was found on a bench near the west end of the Halfway River Highway Realignment section, where 50–250 plants were growing in an approximately 100 m^2 area of native low-shrub and dry meadow habitat.

The remaining six occurrences of old man's whiskers variety *triflorum* were located in an approximately 16-kilometre-long span along the south-facing breaks on the north shore of the Peace River, from above

the west end of Watson Slough east through the Wilder Creek mitigation parcel. The six occurrences were found on dry, sloping to level open grass and shrubland, within a mosaic of upland aspen woodlands; all sites were subject to a variety of moderate disturbance types.

Three of these occurrences were recorded west of Cache Creek, in and near the Highway 29 Realignment section, where several hundred plants were observed in 13 patches covering approximately 11,154 m^2 in total. East of Bear Flat, in a proposed access road route, one occurrence of fewer than 50 plants was found in an area of approximately 10 m^2. Finally, in the Wilder Creek mitigation parcel, two occurrences of old man's whiskers variety *triflorum* were discovered. Many hundreds of plants were located in 11 patches covering a total approximate area of 903 m^2.

3.2.8 Oxytropis campestris var. *davisii (Davis' locoweed)*

Davis' locoweed (Figure 10), also known as Davis' oxytrope, 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 (Welsh 1991; Douglas, et al. 1999). Variety *davisii* is restricted to northeast B.C. and adjacent Alberta and the Northwest Territories, where it can be locally abundant (Welsh 1991; BCCDC 2017; NatureServe 2017).

Davis' locoweed is classed S3 (Vulnerable) by the BCCDC, and is on the provincial Blue list (BCCDC 2017). Globally, the variety is also ranked as Vulnerable (T3), due to its limited range. Alberta lists Davis' locoweed as S2? (Imperilled; uncertain ranking); and the Northwest Territories has not yet ranked the taxon (NatureServe 2017).

One new site of Davis' locoweed was discovered in the Halfway River Highway Realignment section during the 2015 rare plant survey work (Figure 2). The site was determined to be an extension of an occurrence reported in 2011, located approximately 900 m farther up the Halfway River. The 2015 site consisted of 50–250 Davis' locoweed plants covering roughly 100 m^2 in scattered clusters across a larger area of mixed woodland on the Halfway River floodplain. Associated species included native shrubs and trees and a variety of native and non-native herbs. Disturbance from past flood events and from recreational usage were observed.

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

3.2.9 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. 2000; Freeman and 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 in the northeast part of the province (Hitchcock, et al. 1959; BCCDC 2017; Klinkenberg 2017; NatureServe 2017).

Slender penstemon is ranked S2 (Imperilled) in B.C., and is on the province's Red list (BCCDC 2017). The species' global status is Secure (G5) (NatureServe 2017). Of the remaining 17 jurisdictions where it is known to occur, only four rank slender penstemon with any degree of rarity—Alberta and Wyoming as S3 (Vulnerable), and Iowa and Michigan as S1 (Critically Imperilled) (NatureServe 2017).

Seven sites of slender penstemon were recorded in 2015 and 2016 (Figure 2). East of Bear Flat, near a proposed access road route, a small patch approximately five square metres in size was found in 2015. The slender penstemon plants were growing near a stand of low native shrubs on a dry grassland slope. This site was found to be roughly 520 m west of—and therefore an extension to—an occurrence reported in 2005.

The remaining six sites of slender penstemon were documented during the 2016 rare plant survey work. Near the west end of the Cache Creek Highway Realignment section, one occurrence of four patches totalling approximately 126 m^2 was discovered. Here, 50–250 plants were observed growing with

predominantly native graminoids and forbs in disturbed dry meadow openings near stands of low native shrubs. In the Wilder Creek mitigation parcel, two small occurrences were also located in shrub-grassland habitat: one occurrence consisted of a single slender penstemon plant, and three plants were found at the second occurrence.

Figure 11: *Penstemon gracilis* (slender penstemon)

3.2.10 Polypodium sibiricum (Siberian polypody)

Siberian polypody (Figure 12) is a leathery-leaved evergreen fern in the Polypodiaceae (polypody family). The taxon grows in montane regions on dry to mesic rock outcrops (Haufler, et al. 1993; Douglas, et al. 2000). In B.C. prior to 2011, Siberian polypody was only known from two unconfirmed reports to the north and west of Fort St. John: one near the Beatton River and one near Williston Reservoir (BCCDC 2017; Klinkenberg 2017). Rare plant surveys conducted for the Site C environmental impact assessment located additional populations on Bullhead and Portage Mountains west of Hudson's Hope (Hilton, et al. 2013). The fern's global range extends across large portions of the boreal regions of Canada, Alaska, and Asia. The species has also been found in southern Greenland (Haufler, et al. 1993).

Siberian polypody is on the Red list in B.C., and is ranked S2? (Imperilled; uncertain ranking) (BCCDC 2017). Although Siberian polypody is tentatively considered Secure globally (G5?), most of the North American jurisdictions that report a status for the taxon rank it as rare: SH (Possibly Extirpated) in Québec; S1 (Critically Imperilled) in Ontario; S2 (Imperilled) in Alaska and Yukon; and S3 (Vulnerable) in Alberta (NatureServe 2017).

Figure 12: *Polypodium sibiricum* (Siberian polypody)

Three new sites of Siberian polypody were recorded in 2015 near a proposed access road route on Portage Mountain (Figure 2). All three patches were determined to constitute an extension to an occurrence reported in 2012 that is mapped starting 120 m to the north, along the same cliff system. 50–250 additional plants were found growing in mixed upland forest on shaded boulders, rock outcrops and at the base of a dry cliff; the approximate total areal coverage of the three new patches was 21 m^2. Associated species included native trees, shrubs, and herbs, and evidence of disturbance was minimal.

3.2.11 Potentilla pulcherrima (pretty cinquefoil)

Pretty cinquefoil (Figure 13), a perennial herb of the Rosaceae (rose family), has distinctive two-toned leaf faces which are green above and white below. The species grows at moderate to higher elevations in a variety of open, dry to moist habitats including meadows, grasslands, woodlands, roadsides and waste places (Douglas, et al. 1998a; Ertter, et al. 2014). In B.C., pretty cinquefoil is documented from the Peace River region, and from sites in the south-central and south-east part of the province (Douglas, et al. 2002). The taxon ranges east into Ontario and Minnesota, and extends south through the western U.S. into mountainous regions of California, Arizona, New Mexico, Colorado and western South Dakota (NatureServe 2017).

In addition, pretty cinquefoil has been introduced into various disturbed sites in the eastern U.S., with populations reported from Connecticut and New Hampshire (Ertter, et al. 2014; NatureServe 2017).

Figure 13: *Potentilla pulcherrima* (pretty cinquefoil)

Pretty cinquefoil is currently ranked S2? (Imperilled; uncertain ranking) in B.C., and is on the Red list for the province (BCCDC 2017). The species is reported as Globally Secure (G5) and most other North American jurisdictions do not provide a rank(NatureServe 2017). The exceptions are California S1 (Critically Imperilled), Ontario S2 (Imperilled), and Saskatchewan and Wyoming S4 (Apparently Secure) (NatureServe 2017).

Four occurrences (comprising nine patches) of pretty cinquefoil were documented during the rare plant survey work in 2016, all on the lower south-facing breaks of the north shore of the Peace River near Wilder and Cache Creeks (Figure 2).

Two of the occurrences were located in the Cache Creek Highway Realignment section. The largest consisted of four patches with an areal coverage of roughly 1,605 m^2, observed along a vegetated dirt road on a bench near a cultivated field. Some 250–1,000 pretty cinquefoil plants were growing in and along the road in open weedy meadow habitat. Associated species included native and non-native herbs as well as low native shrubs. The second occurrence from the Cache Creek Realignment section consisted of fewer than 25 plants in an area of approximately 31 m^2. This site was located at the interface between a fallow cultivated field and upland aspen woodland. Both the Cache Creek occurrences appeared to have moderate levels of disturbance, mostly due to agricultural activities.

The remaining two occurrences of pretty cinquefoil were discovered 10 km to the east in the Wilder Creek mitigation parcel. One occurrence of approximately 175 m^2 was found along a vegetated dirt road at the edge of a fallow hay field. Here, 50–250 pretty cinquefoil plants were growing in and near the road among non-native grasses and forbs. Vehicle disturbance appeared to be light at this location. A second

occurrence was recorded on level to sloping shrubby grassland above a cultivated field. Fewer than 50 pretty cinquefoil plants were observed in three patches covering an approximate area of 42 m^2. Associated species included native and non-native herbs as well as low native shrubs.

3.2.12 Silene drummondii var. *drummondii (Drummond's campion)*

Drummond's campion (Figure 14) is a taprooted perennial herb in the Caryophyllaceae (pink family). It is found in dry shrubland, meadows, and woodland openings, and on hillsides and prairies, from the steppe to alpine zones (Douglas, et al. 1998b; Morton 2005). In B.C., Drummond's campion occurs in a number of locations east of the Coast-Cascade Mountains (BCCDC 2017; Klinkenberg 2017). Variety *drummondii* extends north into the Northwest Territories, east to Ontario and south through much of the U.S. Midwest and West, as far as Arizona and New Mexico (Morton 2005; NHIC 2016; NatureServe 2017). In addition, disjunct occurrences of the taxon are reported for Maryland (NatureServe 2017).

Figure 14: *Silene drummondii* var. *drummondii* (Drummond's campion)

Drummond's campion variety *drummondii* is ranked S3? (Vulnerable; uncertain ranking) by the BCCDC, and is on the provincial Blue list (BCCDC 2017). NatureServe classifies Drummond's campion variety *drummondii* as Secure globally (G5T5).

It should be noted that there is disagreement on the scientific naming of Drummond's campion, which creates confusion in terms of understanding the conservation rankings. The NatureServe website provides not only maps and ranks for the name *Silene drummondii*, but also for three varieties, including variety *drummondii* (NatureServe 2017). The BCCDC recognizes only the taxon *Silene drummondii* variety

drummondii (BCCDC 2017). The Flora of North America recognizes two subspecies, of which subspecies *drummondii* is the more widespread prairie taxon (Morton 2005). Finally, the Ontario Natural Heritage Resource Centre follows the naming provided by the Flora of North America (NHIC 2016), but NatureServe displays the Ontario ranking only in their species information and omits it from their variety subset information (NatureServe 2017).

With this in mind, the following sub-national rankings apply for Drummond's campion: Ontario S1 (Critically Imperilled); Manitoba and Minnesota S3 (Vulnerable); and Alberta, Saskatchewan, and Wyoming S4 (Apparently Secure) (NatureServe 2017).

Three new sites of Drummond's campion were discovered during the rare plant survey work in 2015 and 2016 (Figure 2). The one site located in 2015, near a proposed access road route on Portage Mountain, was determined to be an extension of an occurrence reported in 2012. The new site, found approximately 900 m to the south along the same cliff system, consisted of fewer than 50 plants scattered at the base of a dry cliff in a small area of about five metres square. The site was in partially open upland forest, and supported a diverse variety of native shrubs and herbs.

In 2016, two occurrences were found in the Cache Creek Highway Realignment section. Near the west end of the section, fewer than 50 Drummond's campion plants were found scattered across a sloping area of approximately 19 m^2, in a grassy opening in shrubby upland woodland. Associated species were predominantly native low shrubs and herbs, although various disturbance types were noted in the nearby area. Farther east, in a narrow opening at the edge of disturbed, mixed upland forest, five Drummond's campion plants were found in an area of about three square metres. The immediate plant community consisted of native low shrubs and native herbs.

3.2.13 Sphenopholis intermedia (slender wedgegrass)

Slender wedgegrass (Figure 15), a perennial with long seed heads, is a member of the Poaceae (grass family). The species grows in moist meadows, along streambanks, and around lakes and ponds in the steppe and montane zones (Douglas, et al. 2001; Daniel 2007). It is known from numerous locations in eastern and southern B.C., and occurs in all Canadian and U.S. jurisdictions except Nunavut, Labrador, California, and Hawaii (Daniel 2007; BCCDC 2017; Klinkenberg 2017; NatureServe 2017).

Slender wedgegrass is ranked S3 (Vulnerable) in B.C. and is on the province's Blue list (BCCDC 2017). Other jurisdictions where the species is considered rare are Alaska, Newfoundland, and Prince Edward Island (S1 Critically Imperilled); Yukon, Montana, Wyoming, and North Carolina (S2 Imperilled); and Alberta, Illinois, and Québec (S3 Vulnerable). Globally the taxon is ranked as Secure (G5) (NatureServe 2017).

Twelve sites of slender wedgegrass were documented in 2015 and 2016 (Figure 2). One occurrence in two patches was located in the transmission line corridor at Peace Canyon Dam. Here, 50–250 plants were discovered on the banks of Portage Creek on both sides of a small road, and another 50–250 plants were observed along two other small unnamed creeks roughly 500 m to the southwest. Areal coverage for the sites totalled approximately 80 m^2. Associated species included a diverse mix of native shrubs and native

and non-native herbs, and the surrounding plant community consisted of fragmented mixed upland forest.

Figure 15: *Sphenopholis intermedia* (slender wedgegrass)

Continuing east, one occurrence comprising seven patches was recorded along a roughly one-half kilometre section of Dry Creek in the Rutledge mitigation parcel. Here, 50–250 slender wedgegrass plants were found scattered and clumped in a weedy herbaceous riparian community shaded by native shrubs and bordered by mixed upland forest. Total areal coverage for all seven patches was approximately 167 m^2.

At the mouth of Farrell Creek, one occurrence of slender wedgegrass was discovered in the Highway Realignment section. At this site, 50–250 plants were observed on an open, active floodplain in an area of approximately 100 m^2. Associated species consisted of predominantly non-native herbs as well as native shrubs and tree seedlings. Similarly, a small occurrence of slender wedgegrass was recorded at the edge of the Halfway River Realignment section, on active floodplain near the mouth of the river. Fewer than 50 plants were found growing in a roughly 10 m^2 area, in and around a pile of woody debris. The floodplain plant community was composed of a mix of native and non-native herbs and scattered small native shrubs and saplings.

Finally, a small slender wedgegrass occurrence was also documented in the Cache Creek Highway Realignment section, above the mouth of Cache Creek. A patch of fewer than 50 plants were found scattered on an active gravel floodplain on the west side of the creek. Areal coverage for the slender

wedgegrass was approximately 17 m^2. Associated species included native shrubs and saplings and predominantly non-native herbs.

3.2.14 Physcia biziana (frosted rosette)

Frosted rosette, a small grayish foliose lichen, is distinguished by the dense powdery coating that covers its entire upper surface (Figure 16). In addition, a chemical test aids in separating the taxon from morphologically similar species. Frosted rosette is found on bark or rock in open, dry habitats (Goward, et al. 1994; McCune and Goward 1995; Brodo, et al. 2001; Brodo 2016; CNALH 2016b). In B.C., frosted rosette is reported from numerous locations in the south-central section of the province, as well as two sites in the extreme southeast (Goward, et al. 1994; Brodo, et al. 2001; Klinkenberg 2017). Globally, the species has been collected throughout much of the central and western U.S. and northern and central Mexico, and has been documented from scattered locations in Eurasia and Africa. One occurrence has been observed in Vermont in the eastern U.S., and two sites have been reported in other parts of Canada: one occurrence on Lake Ontario, and one occurrence in the Rocky Mountains north of Jasper, Alberta (CNALH 2016b).

Figure 16: *Physcia biziana* (frosted rosette)

Frosted rosette has a rank of S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2017). The species is also considered rare in Alberta (S1S2 Critically Imperilled or Imperilled) and in Ontario (S1S3 Critically Imperilled or Vulnerable). Frosted rosette has not been ranked by other Canadian or U.S. jurisdictions; globally the taxon is considered Secure (G5) (NatureServe 2017).

Twelve occurrences (comprising 18 patches) of frosted rosette were observed in the areas surveyed (Figure 2). During rare plant surveys in 2015, the species was collected in three locations: one on the southern outskirts of the town of Fort St. John in the Industrial 85th district, and two on the south shore of the Peace River north of the Moberly River along proposed access road routes. At all three sites, the lichen was growing on the bark of live aspen trees (*Populus tremuloides*) in open, disturbed mixed upland woodlands along or near road tracks.

During the 2016 survey work, nine occurrences of frosted rosette were documented in 15 patches. Two sites were located south of the Peace River in the transmission line corridor near Jackfish Road. One frosted rosette lichen was collected off the bark of a live pussy willow tree (*Salix discolor*) in disturbed mesic shrubland at the south edge of the right-of-way. The second occurrence was recorded north of the right-of-way in a shady riparian woodland, where several frosted rosette thalli were observed on the bark of live alder trees (*Alnus* sp.).

The remaining seven occurrences were all found above the north shore of the Peace River, between Farrell Creek Road and Wilder Creek. At the Rutledge mitigation parcel, one occurrence was located in three patches in deciduous shrub woodland near hayfields and in Dry Creek canyon. Frosted rosette lichens were collected off the bark of live and dead deciduous trees and shrubs. In the Cache Creek Highway Realignment section, four occurrences (comprising five patches) were documented in disturbed upland woodland and shrubland habitats near fields and various roads including Highway 29. Frosted rosette thalli were collected off the bark of live aspen trees and also observed on the bark of dead choke cherry shrubs (*Prunus virginiana*).

Finally, in the Wilder Creek mitigation parcel, one large occurrence was found in an upland woodland and shrub-grassland mosaic on slopes above agricultural fields. This occurrence consisted of four patches containing numerous frosted rosette thalli, which were growing on live aspen trees as well as on the bark of live and dead deciduous shrubs. In addition, just to the west of the Wilder Creek mitigation parcel, a smaller occurrence was discovered. Here, four thalli were observed growing in similar open habitat on the same kinds of substrates.

This group of occurrences of frosted rosette in the B.C. Peace region represent a 400 km northward extension of the taxon's mapped global range, and a 700 km northward range extension in the province of B.C. (CNALH 2016b).

3.2.15 Physcia stellaris (immaculate rosette)

Immaculate rosette (Figure 17) is a small foliose lichen that forms light grey circular clusters bearing darker, round fruiting bodies. The taxon grows on tree bark, particularly of deciduous trees, in open woodlands. Immaculate rosette is morphologically very similar to, and sympatric with, both *Physcia aipolia* (hoary rosette) and *Physcia alnophila* (outward-looking rosette), and must be separated from these taxa by a chemical test (Goward, et al. 1994; McCune and Goward 1995; Brodo, et al. 2001; Brodo 2016; CNALH 2016c). In B.C., immaculate rosette is reported from a few scattered locations in the northwest, northeast, and south-central parts of the province (Goward, et al. 1994; Brodo, et al. 2001;

CNALH 2016c; Klinkenberg 2017). The taxon's global range encompasses much of North America, and also extends to Eurasia, Australia, and South America (Brodo, et al. 2001; CNALH 2016c).

Figure 17: *Physcia stellaris* (immaculate rosette)

Immaculate rosette is ranked S3 (Vulnerable) in B.C., and is on the province's Blue list (BCCDC 2017). The taxon is also classed S3S4 (Vulnerable or Apparently Secure) in Saskatchewan, but otherwise is considered to be globally Secure (G5) (NatureServe 2017).

Eight occurrences (comprising 9 patches) of immaculate rosette were located in the areas surveyed during rare plant work in 2015 and 2016 (Figure 2). Four of the 2015 occurrences (totaling five patches) were discovered in the Highway Realignment sections near Lynx and Farrell Creeks. A fifth occurrence was recorded in the Industrial 85th site on the southwest outskirts of the town of Fort St. John. The final occurrence from the 2015 surveys was observed above the south shore of the Peace River north of the Moberly River, near a proposed access road route. The immaculate rosette individuals were all growing on the bark of live and dead deciduous trees and shrubs in disturbed mixed upland woodlands.

Two occurrences of the lichen were found during the 2016 survey work: immaculate rosette specimens were collected in the Cache Creek Highway Realignment section and also in the Wilder Creek mitigation parcel. At both sites the taxon was discovered growing on dead aspen bark in shrubby, mixed upland woodland near fields and road tracks.

3.2.16 Ramalina sinensis (threadbare ribbon)

Threadbare ribbon (Figure 18) is a small, pale green fruticose lichen. The thallus grows outward from a single point of attachment into a branching fan shape, which is tipped by cup-like fruiting bodies. The taxon is found on the bark of trees and shrubs in open habitats (Goward 1999; Brodo, et al. 2001; CNALH 2016d). In B.C., threadbare ribbon is known from only a few locations in the northeast part of the province (Goward 1999; Brodo, et al. 2001). Globally, the species is reported from across much of North America, as well as a few sites in Eurasia and one in Australia (Brodo, et al. 2001; CNALH 2016d).

Figure 18: *Ramalina sinensis* (threadbare ribbon)

Threadbare ribbon has a rank of S2S3 (Imperilled or Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2017). A few other Canadian jurisdictions also class the species as rare: S3S4 (Vulnerable or Apparently Secure) in Alberta; S3 (Vulnerable) in Northwest Territories; and S1S3 (Critically Imperilled or Vulnerable) in Yukon Territory (NatureServe 2017). The taxon's global rank is G4G5 (Apparently Secure or Secure) (NatureServe 2017).

Seven occurrences (comprising 12 patches) of threadbare ribbon were discovered in the areas surveyed during the pre-construction surveys (Figure 2). All the occurrences were located above the north shore of the Peace River. The largest site, west of Lynx Creek in Realignment sections on both sides of Highway 29, was nearly one kilometre in length and consisted of two patches. The main site was documented in 2015, and extensions to the occurrence were added in 2016 and 2017. Many threadbare ribbon thalli were observed in disturbed upland woodland habitat at this location, on the bark and twigs of aspen, balsam poplar (*Populus balsamifera*), and white spruce (*Picea glauca*).

Further east, three occurrences of threadbare ribbon were recorded in the Rutledge mitigation parcel and adjacent Highway Realignment sections. The westernmost occurrence was found in a wet stream draw just north of Highway 29, where one specimen was collected off a balsam poplar trunk in 2015. The second occurrence consisted of four patches, scattered from a turnout on the south side of Highway 29 through the west end of the Rutledge mitigation parcel as far as Dry Creek canyon. Two of the patches were documented in 2015, and two in 2016. All threadbare ribbon individuals were observed growing on the dead twigs of aspen trees and various deciduous shrubs in highly fragmented mixed upland woodland near roads and fields. Finally, at the east end of the Rutledge mitigation parcel, one threadbare ribbon specimen was collected off a dead choke cherry twig on a south-facing slope in shrub-grassland habitat.

The remaining two occurrences of threadbare ribbon were found over 30 km east; one in the Cache Creek Highway Realignment section, and one in the Wilder Creek mitigation parcel. On a bench west of Cache Creek above Watson Slough, two individuals were observed on the trunk of a live aspen tree at the edge of disturbed mixed upland woods by a road track along a field. In the Wilder Creek mitigation parcel, one specimen was collected off an aspen branch in a small wooded draw below a large agricultural field.

3.2.17 Usnea cavernosa (pitted beard)

Pitted beard, a filamentous pale green fruticose lichen, is found hanging loosely from tree branches in open forests (Figure 19). In B.C., pitted beard has been recorded in scattered locations throughout the province (Brodo, et al. 2001; CNALH 2017; Klinkenberg 2017). The species' global range extends across much of northern North America, with additional sites in the western U.S. and Mexico. One record is also reported from Eurasia (Brodo, et al. 2001; McCune and Geiser 2009; CNALH 2017).

Pitted beard has a rank of S2S3 (Imperilled/Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2017). Three other jurisdictions also class the species as rare: S3 (Vulnerable) in Saskatchewan; S1S3 (Critically Imperiled/Vulnerable) in Nunavut; and S1 (Critically Imperiled) in Montana (NatureServe 2017). The taxon's global status is G5 (Secure) (NatureServe 2017).

One occurrence of pitted beard was recorded in the areas surveyed (Figure 2). The rare plant surveys in 2016 and 2017 collected the species in several locations in a potential mitigation parcel located northwest of Hudson's Hope. The habitat consisted of disturbed moist woodlands, where the pitted beard individuals were found growing on the twigs of coniferous trees.

Figure 19: *Usnea cavernosa* (pitted beard)

4.0 DISCUSSION

4.1 Coverage

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 targeted-meander 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 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.

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6.0 APPENDICES

Appendix 1: Plant and lichen species recorded during the 2015–2017 surveys

VASCULAR PLANTS

Acer glabrum var. *douglasii*
Achillea alpina
Achillea millefolium var. *lanulosa*
Achnatherum nelsonii ssp. *dorei*
Achnatherum richardsonii
Aconitum delphiniifolium
Actaea rubra
Agropyron cristatum ssp. *pectinatum*
Agrostis capillaris
Agrostis exarata
Agrostis scabra
Alisma triviale
Allium cernuum var. *cernuum*
Allium schoenoprasum var. *sibiricum*
Alnus incana ssp. *tenuifolia*
Alnus viridis ssp. *crispa*
Alopecurus aequalis
Amelanchier alnifolia
Anaphalis margaritacea
Androsace septentrionalis
Anemone cylindrica
Anemone multifida var. *multifida*
Anemone patens ssp. *multifida*
Anemone virginiana var. *cylindroidea*
Antennaria howellii ssp. *canadensis*
Antennaria howellii ssp. *petaloidea*
Antennaria microphylla
Antennaria parvifolia
Antennaria racemosa
Antennaria rosea
Apocynum androsaemifolium var. *androsaemifolium*
Aralia nudicaulis
Arctostaphylos uva-ursi
Arnica chamissonis
Arnica cordifolia
Artemisia biennis
Artemisia campestris ssp. *pacifica*
Artemisia dracunculus
Artemisia frigida
Artemisia herriotii
Asparagus officinalis
Astragalus alpinus var. *alpinus*
Astragalus americanus
Astragalus canadensis
Astragalus eucosmus
Astragalus laxmannii var. *robustior*
Astragalus tenellus
Athyrium filix-femina ssp. *cyclosorum*
Avenula hookeri
Beckmannia syzigachne
Betula neoalaskana
Betula papyrifera
Bidens cernua
Boechera divaricarpa
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*
Callitriche palustris
Campanula rotundifolia
Capsella bursa-pastoris
Cardamine oligosperma var. *oligosperma*
Carex aenea
Carex aquatilis var. *aquatilis*
Carex atherodes
Carex aurea
Carex bebbii
Carex brunnescens
Carex concinna
Carex crawfordii
Carex deweyana var. *deweyana*
Carex diandra
Carex disperma
Carex inops ssp. *heliophila*
Carex interior
Carex microptera
Carex obtusata
Carex pellita

Carex retrorsa
Carex rossii
Carex siccata
Carex sprengelii
Carex tenera
Carex torreyi
Carex utriculata
Carex vaginata
Carex xerantica
Castilleja miniata
Castilleja miniata var. *fulva*
Cerastium arvense
Cerastium nutans
Chenopodium album
Chenopodium album ssp. *striatum*
Chenopodium desiccatum
Chenopodium pratericola
Chenopodium simplex
Cicuta douglasii
Cicuta virosa
Cinna latifolia
Cirsium arvense
Cirsium foliosum
Clematis occidentalis ssp. *grosseserrata*
Coeloglossum viride var. *virescens*
Collomia linearis
Comandra umbellata var. *umbellata*
Conyza canadensis
Corallorhiza maculata
Corallorhiza striata var. *striata*
Corallorhiza trifida
Cornus canadensis
Cornus stolonifera
Corydalis aurea
Corylus cornuta
Crepis tectorum
Cystopteris fragilis
Dactylis glomerata
Danthonia spicata
Deschampsia cespitosa ssp. *cespitosa*
Descurainia sophia
Dracocephalum parviflorum
Dryas drummondii
Drymocallis convallaria
Dryopteris expansa
Elaeagnus commutata
Eleocharis mamillata ssp. *mamillata*
Eleocharis palustris
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 ssp. *ciliatum*
Epilobium hornemannii ssp. *hornemannii*
Equisetum arvense
Equisetum fluviatile
Equisetum hyemale
Equisetum hyemale ssp. *affine*
Equisetum palustre
Equisetum pratense
Equisetum scirpoides
Equisetum sylvaticum
Equisetum variegatum ssp. *variegatum*
Erigeron caespitosus
Erigeron glabellus ssp. *pubescens*
Erigeron philadelphicus
Erysimum cheiranthoides
Eurybia conspicua
Eurybia sibirica
Fallopia convolvulus
Festuca rubra ssp. *rubra*
Festuca saximontana
Fragaria vesca var. *bracteata*
Fragaria virginiana
Fragaria virginiana var. *platypetala*
Galium boreale
Galium triflorum
Geocaulon lividum
Geum aleppicum
Geum macrophyllum ssp. *perincisum*
Geum triflorum var. *triflorum*
Glyceria grandis var. *grandis*
Glyceria striata
Gnaphalium uliginosum

Goodyera repens
Grindelia squarrosa var. *quasiperennis*
Gymnocarpium dryopteris
Hedysarum boreale
Heracleum maximum
Hesperostipa comata ssp. *comata*
Hesperostipa curtiseta
Heuchera richardsonii
Hieracium umbellatum ssp. *umbellatum*
Hierochloë hirta ssp. *arctica*
Hippuris vulgaris
Hordeum jubatum ssp. *jubatum*
Juncus alpinoarticulatus ssp. *americanus*
Juncus balticus ssp. *ater*
Juncus bufonius
Juncus dudleyi
Juncus nodosus
Juniperus communis
Koeleria macrantha
Lactuca serriola
Lappula occidentalis var. *occidentalis*
Lappula squarrosa
Lathyrus ochroleucus
Lecanora impudens
Lemna minor
Lepidium densiflorum var. *densiflorum*
Leucanthemum vulgare
Leymus cinereus
Leymus innovatus
Limosella aquatica
Linaria vulgaris
Linnaea borealis
Linum lewisii ssp. *lewisii*
Lithospermum incisum
Lonicera dioica var. *glaucescens*
Lonicera involucrata
Lotus corniculatus
Maianthemum canadense
Maianthemum racemosum ssp. *amplexicaule*
Maianthemum stellatum
Matricaria discoidea
Medicago lupulina
Medicago sativa
Medicago sativa ssp. *falcata*
Melica smithii
Melilotus alba
Melilotus officinalis
Mentha arvensis
Mertensia paniculata var. *paniculata*
Mitella nuda
Moehringia lateriflora
Monarda fistulosa var. *menthaefolia*
Monotropa uniflora
Muhlenbergia glomerata
Mulgedium pulchellum
Myriophyllum sibiricum
Nassella viridula
Oplopanax horridus
Opuntia fragilis
Orobanche fasciculata
Orthilia secunda
Orthilia secunda var. *secunda*
Orthocarpus luteus
Oryzopsis asperifolia
Osmorhiza berteroi
Oxytropis campestris var. *davisii*
Oxytropis sericea var. *speciosa*
Oxytropis splendens
Packera paupercula
Packera plattensis
Packera streptanthifolia
Pascopyrum smithii
Pedicularis groenlandica
Penstemon gracilis
Penstemon procerus var. *procerus*
Persicaria amphibia var. *emersa*
Persicaria lapathifolia
Petasites frigidus var. *palmatus*
Petasites frigidus var. *sagittatus*
Phalaris arundinacea
Phleum pratense
Picea glauca
Pinus contorta var. *latifolia*
Piptatherum pungens
Plantago major
Platanthera aquilonis
Platanthera huronensis
Platanthera orbiculata

Platanthera sp.
Poa compressa
Poa glauca
Poa glauca ssp. *glauca*
Poa nemoralis ssp. *interior*
Poa palustris
Poa pratensis ssp. *pratensis*
Poa secunda
Polygonum achoreum
Polygonum aviculare
Polygonum douglasii
Polypodium sibiricum
Populus balsamifera
Populus tremuloides
Potamogeton gramineus
Potamogeton pusillus ssp. *tenuissimus*
Potentilla gracilis var. *fastigiata*
Potentilla hippiana
Potentilla norvegica
Potentilla pensylvanica var. *pensylvanica*
Potentilla pulcherrima
Prosartes trachycarpa
Prunus pensylvanica
Prunus virginiana ssp. *melanocarpa*
Puccinellia distans
Puccinellia nuttalliana
Pyrola asarifolia
Pyrola chlorantha
Ranunculus aquatilis var. *diffusus*
Ranunculus cymbalaria
Ranunculus macounii
Ranunculus sceleratus var. *multifidus*
Rhinanthus minor
Rhododendron groenlandicum
Ribes oxyacanthoides ssp. *oxyacanthoides*
Rorippa palustris
Rorippa palustris ssp. *palustris*
Rosa acicularis ssp. *sayi*
Rubus idaeus ssp. *strigosus*
Rubus parviflorus var. *parviflorus*
Rubus pubescens
Rubus pubescens var. *pubescens*
Rumex crispus
Rumex occidentalis
Rumex triangulivalvis
Salix arbusculoides
Salix bebbiana
Salix discolor
Salix drummondiana
Salix interior
Salix lasiandra var. *lasiandra*
Salix planifolia
Salix prolixa
Salix pseudomonticola
Salix pseudomyrsinites
Salix pyrifolia
Salix scouleriana
Salix serissima
Sanicula marilandica
Saxifraga tricuspidata
Schizachne purpurascens
Schoenoplectus tabernaemontani
Scirpus microcarpus
Scutellaria galericulata
Selaginella sibirica
Senecio vulgaris
Shepherdia canadensis
Silene drummondii var. *drummondii*
Sisymbrium altissimum
Sisyrinchium montanum
Sium suave
Solidago lepida var. *salebrosa*
Solidago multiradiata
Solidago simplex var. *simplex*
Sonchus arvensis
Sonchus arvensis ssp. *uliginosus*
Sorbus scopulina var. *scopulina*
Sparganium emersum
Sparganium natans
Sphenopholis intermedia
Spiraea betulifolia ssp. *lucida*
Stachys palustris
Stellaria borealis
Stuckenia pectinata
Symphoricarpos albus
Symphoricarpos occidentalis
Symphyotrichum ciliolatum
Symphyotrichum ericoides var. *pansum*

Symphyotrichum lanceolatum var. *hesperium*
Symphyotrichum puniceum var. *puniceum*
Tanacetum vulgare
Taraxacum officinale
Thalictrum venulosum
Thinopyrum intermedium
Thlaspi arvense
Tragopogon dubius
Trifolium hybridum
Trifolium pratense
Tripleurospermum inodorum
Triticum aestivum
Turritis glabra
Typha latifolia
Urtica dioica ssp. *gracilis*
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium oxycoccos
Vaccinium vitis-idaea ssp. *minus*
Verbascum thapsus
Veronica beccabunga ssp. *americana*
Veronica peregrina var. *xalapensis*
Viburnum edule
Vicia americana
Viola adunca var. *adunca*
Viola canadensis var. *rugulosa*
Woodsia scopulina

BRYOPHYTES

Ceratodon purpureus
Hylocomium splendens
Marchantia polymorpha
Pleurozium schreberi
Preissia quadrata
Ptilium crista-castrensis

LICHENS

Bryoria fuscescens
Bryoria lanestris
Caloplaca cerina
Caloplaca holocarpa
Cetraria ericetorum
Cladonia carneola
Cladonia pocillum
Collema furfuraceum
Diploschistes muscorum
Enchylium tenax
Endocarpon pusillum
Evernia mesomorpha
Flavocetraria cucullata
Hypogymnia occidentalis
Hypogymnia physodes
Lathagrium undulatum var. *granulosum*
Leptogium saturninum
Lobaria pulmonaria
Melanelixia subaurifera
Melanohalea septentrionalis
Melanohalea subolivacea
Parmelia fraudans
Parmelia sulcata
Parmeliopsis ambigua
Parmeliopsis hyperopta
Peltigera aphthosa
Peltigera britannica
Peltigera elisabethae
Peltigera extenuata
Peltigera lepidophora
Peltigera leucophlebia
Peltigera neckeri
Phaeophyscia orbicularis
Phaeophyscia sciastra
Phaeophysia 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
Umbilicaria americana

Usnea filipendula
Usnea lapponica
Usnea scabrata
Usnea sp.
Usnea substerilis
Vulpicida pinastri
Xanthomendoza fallax
Xanthoparmelia wyomingica

Appendix 7. Site C Western Toad Management Procedure

Site C Western Toad Management Procedure

This management procedure is applicable only during construction on access roads, the transmission line right-of-way, and areas within 250 m of wetlands. However, in all construction areas impacts to amphibians must be mitigated as described in §4.17 of the Site C CEMP, including through the implementation of barriers, setback buffers, and salvage and relocation, as appropriate and at the direction of a Qualified Environmental Professional.

Core Period: June 01 to August 15 – At this time juvenile western toads (**Figures 1, 3, and 4**) disperse from breeding sites (shallow margins of lakes, ponds, or wetlands) into foraging sites (other wetlands, riparian areas along streams, or upland sites). Large numbers of toads might be encountered on roads and at work sites. Juvenile western toad observations ≥10 individuals have occurred within the Project area from June 1 until August 15; the anticipated duration for western toad dispersal is approximately 11 weeks – the "core dispersal period".

During the core dispersal period, a Qualified Environmental Professional (QEP) must survey:

- **all Project Access Roads prior to crews driving to site,**
- **all Project Access Roads prior to the first daily site delivery; and**
- **all daily Work Sites before work commences.**

Caution Periods: April 01 – May 31; August 16 – September 30 – Adult western toads (**Figure 2**) and juveniles (**Figure 1**) may occur on Access Roads and at Work Sites during their "breeding period" or "foraging period."

The breeding window is when adults start to move from hibernation areas to breeding sites (shallow margins of lakes, ponds, or other wetlands). Toads often move at night, when temperatures are cooler, and especially after a rainfall. The breeding window coincides with days where the minimum temperature doesn't drop below 0°C AND the maximum temperature is above 10°C. In the Project area, the breeding period is April 01 – May 31.

The foraging window is when adults and juveniles move from breeding sites to foraging areas to prepare for hibernation. As with the breeding window, toads tend to be more active at night, especially following a rainfall. Toads can be found foraging year-round, but the key foraging period is August 16 – September 30.

During the caution period, before any work starts, the contractor must contact the QEP to provide the work location and start date. The contractor's QEP must conduct an Access Road / Work Site sweep to determine if toads are likely to be present, before work starts. The contractor's QEP can give an "all clear" window for up to one week after this sweep during the caution period. The contractor's QEP must be notified to re-assess the area if one week or more has passed since the previous "all clear."

Hibernation Period: October 01 – March 31 - Western toads are not anticipated to be on work sites or roads.

Figure 1. Juvenile western toads are small and can be difficult to detect if dispersal is limited to a few individuals.

Figure 2. Adult western toad traveling to breeding site.

Figure 3. Sub-adult western toad.

Figure 4. Mass dispersal event of juvenile western toads.

Site C Western Toad Management Procedure

This management procedure outlines how BC Hydro and its contractors will remain compliant with EAC conditions 16 and 19 pertaining to western toads, a federally and provincially listed species at risk. It applies only during construction on access roads, transmission line rights-of-way, and off-site areas within 250 m of wetlands. However, all construction activities must mitigate for amphibians as described in §4.17 of the Site C CEMP.

A QEP with western toad survey experience, employed by the contractor, must survey for toads:

- before any work along project access roads during the core dispersal period (June 01 to August 15).
- at work sites within the transmission line right-of-way (towers, roads, laydown, pull-sites, offices, staging areas) and any project-related off-site areas within 250 metres of wetlands.
- along existing project access roads adjacent to wetlands during the caution period (breeding and foraging windows, April 01 – May 31 and August 16 – September 30, respectively).

On the direction of the contractor's QEP, contractors may be required to alter their schedule.

Access Road and Work Site Sweep Methods

During the core dispersal period, and during the caution periods (April 01 - May 31 and August 16 - September 30), the contractor's QEP must conduct a road and work site sweep prior to heavy traffic use on access roads, and construction activities at transmission towers and transmission access routes. Once the road and work site sweeps have finished, the contractor's QEP will determine if western toads are at risk of direct mortality. If there is determined to be no risk to dispersing toads, work will be allowed to commence.

Road sweeps must be conducted by vehicle travelling at 35-55 km/h (as appropriate given QEP experience and road/weather conditions) with the contractor's QEP in the passenger seat looking for dispersing western toads on the road and road verges. Road sweeps can commence at dawn using headlights on low beam for illumination (see *RISC Standard for Pond Breeding Amphibians*).

Work site and adjacent wetland area sweeps / searches must be conducted on foot by the contractor's QEP using a search pattern (zig-zag, grid or transect) that considers observability, terrain, searcher safety and search area coverage. Maximum survey effort is 1 ha/hour time constrained searches, as per the *RISC Standard for Pond Breeding Amphibians*.

The contractor' QEP will maintain awareness of best management practices for western toads, including the BC *Guidelines for Amphibians during Development* and *BMP - Amphibian and Reptile Salvages* and revisions.

Toad Sweep Crew Tool Kit

2 x 30km/h road signs, 20 x 0.5 m stakes, 3 x hammer/mallet, 200 m landscaping fabric (minimum 0.5 m width), 1 x box cutter, 2 x shovel, 5 x pit trap buckets (2 gal, ~9" diameter, ~9" depth), 2 x bucket lids with holes (for translocation), 100 x nitrile gloves (various sizes), 5 x work gloves, 1 L unscented bleach, 4 gallon water.

Stop Work Procedure

All road and work site sweeps must be conducted by the contractor's QEP. If dispersing western toads are confirmed within 20 m of access roads or construction, the contractor's QEP must halt traffic and construction activities at the dispersal site and initiate the steps described before work recommences. Qualified personnel under the direction of the contractor's QEP will install temporary barrier fences along the road or around construction at the dispersal site. Barrier fences will be of UV stabilized material, woven or solid to prevent small toads passage, and 0.5 m high and curved or L-shaped at the top (with the fence lip facing away from the road) to prevent toads from climbing over the fence. Barrier fences must be arranged in a wedge or zig-zag pattern to funnel amphibians into traps and must extend 50 to 100 m beyond the last trap at either end of the fence. Trapped toads will be translocated away from the road or work site in buckets to continue dispersal (see "Translocation"). Personnel requirements depend on the size and spatial extent of the dispersal. Speed restrictions of 30 km/h in the area 50 m either side of the dispersal site must be applied and maintained for the duration of the dispersal event. A sweep must confirm dispersing western toads have vacated the area before the contractor's QEP can approve the commencement / re-commencement of construction at the dispersal site, and lift the speed restriction.

Translocation

If dispersing western toads are observed on any roads, or at tower construction sites, the contractor's QEP will determine the direction of dispersal. All toads potentially affected by traffic or construction must be captured, translocated, and released by the contractor's QEP; in the direction of dispersal and to a safe area within 200 m (and at least 50 m from) the capture site. Translocated individuals will not be placed in any specific habitat type, but sub-optimal habitats (e.g., drill pads, rock outcrops) will be avoided. During translocations the contractor's QEP must maintain hygiene when handling amphibians, including following established procedures to prevent the spread of amphibian chytrid fungus, as described below. If individuals are translocated >200 m from point of capture, survival monitoring must be completed by the contractor's QEP as per *Wildlife Act* permit FJ16-226024.

If a mass dispersal (>100 individuals during a 24-hour period) requiring relocation of toads (as above) is identified over three consecutive years in the same location, consideration will be given to installing a permanent crossing structure to separate dispersing toads from traffic. Crossings will be appropriately designed culverts or structures achieving separation, and including well-maintained guidance fencing to direct toads into the structure, see *Guidelines for Amphibians during Development* (pg. 23). Such mitigation will be directed by the QEP and BC Hydro's Representative and will be an extra to the contract, to be managed via the contract change process.

Disinfectant and Hygiene

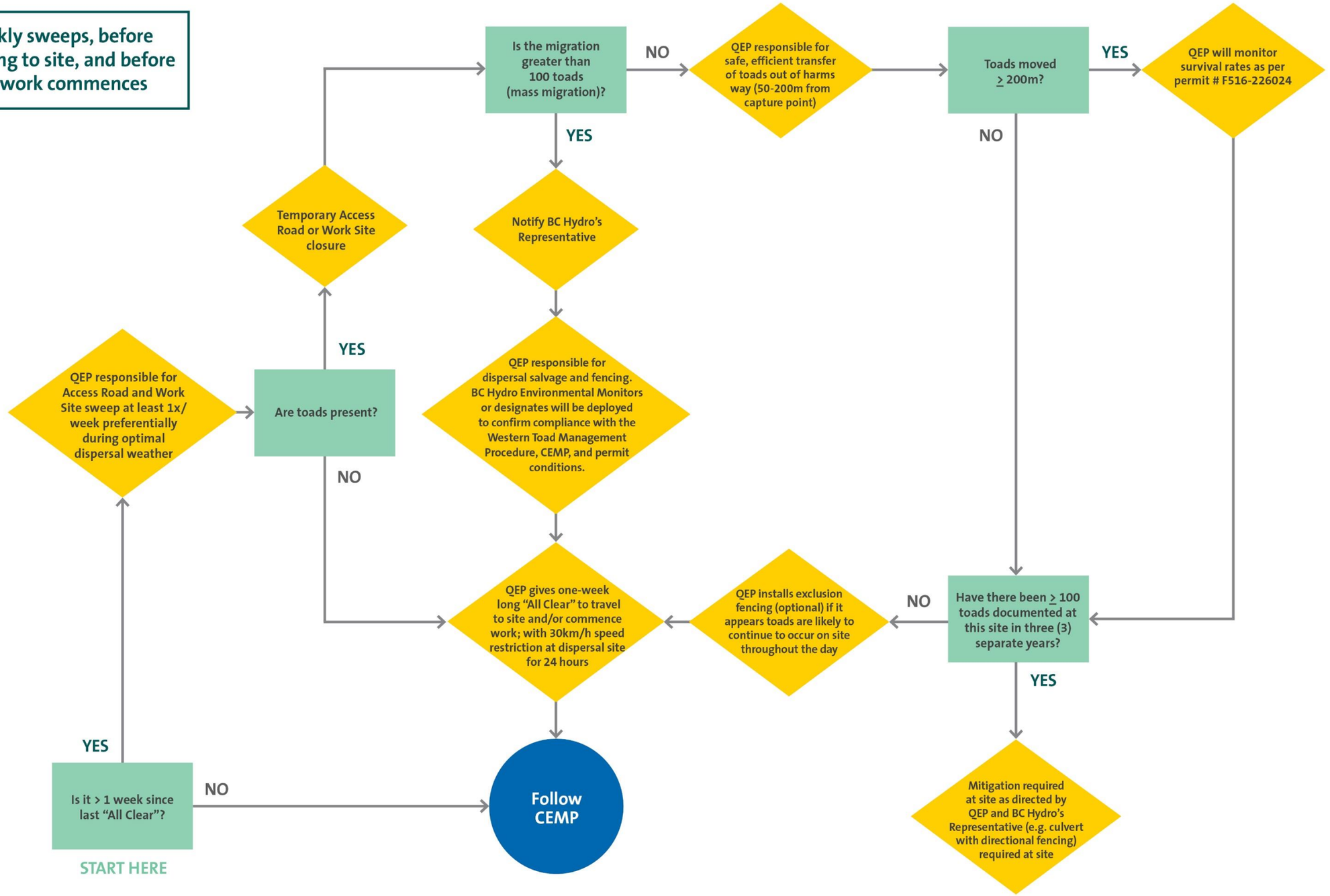
Handlers must wear clean, new vinyl or nitrile gloves during salvages, as per BC's *Standard Operating Procedures: Hygiene Protocols for Amphibian Fieldwork*. Gloves must be changed when moving to another translocation site. Buckets used for transferring individuals must be disinfected using a household bleach and water mixture at 32 ml / 1 litre of water (or 3.5 cups bleach to one tall bucket / 25 litre of water).

July 21, 2017

Western Toad Caution Period
(April 1 – May 31, August 16 – September 30)

BC Hydro
Power smart

Weekly sweeps, before travelling to site, and before any work commences

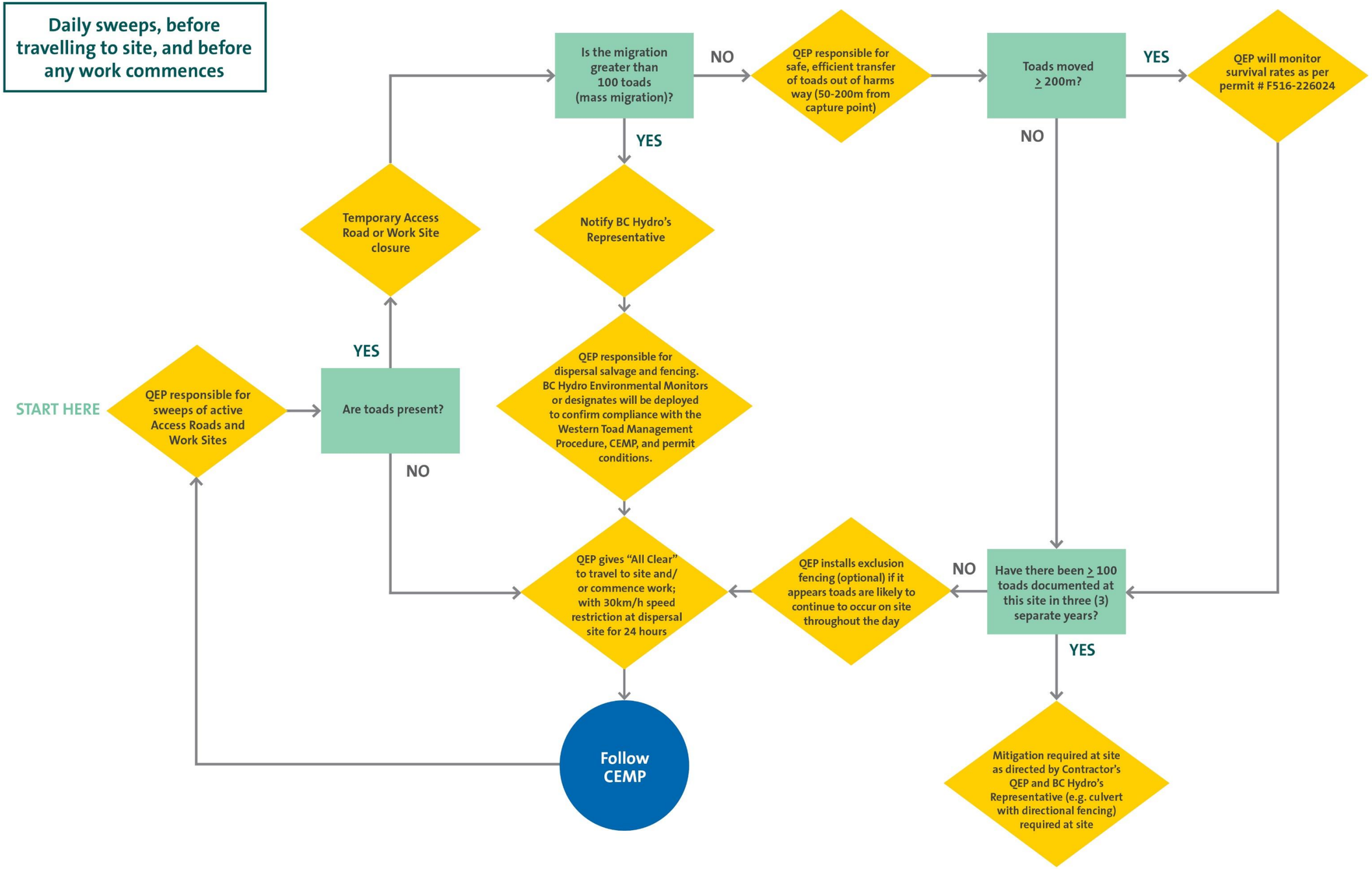


July 21, 2017

Western Toad Core Dispersal Period
(June 1 – August 15)

BC Hydro
Power smart

Daily sweeps, before travelling to site, and before any work commences



July 21, 2017

Appendix 8. Bat monitoring at Portage Mountain Quarry

MEMORANDUM

Date:	March 12, 2018
To:	Brock Simons, R.P.Bio., Site C Wildlife Lead
From:	Felix Martinez-Nunez, R.P.Bio. and Charlie Palmer, P.Biol., R.P.Bio.
File:	398-173.10
Re:	**Bat Monitoring at Portage Mountain Quarry: Site C Wildlife Monitoring BCO 95055**

1.0 INTRODUCTION

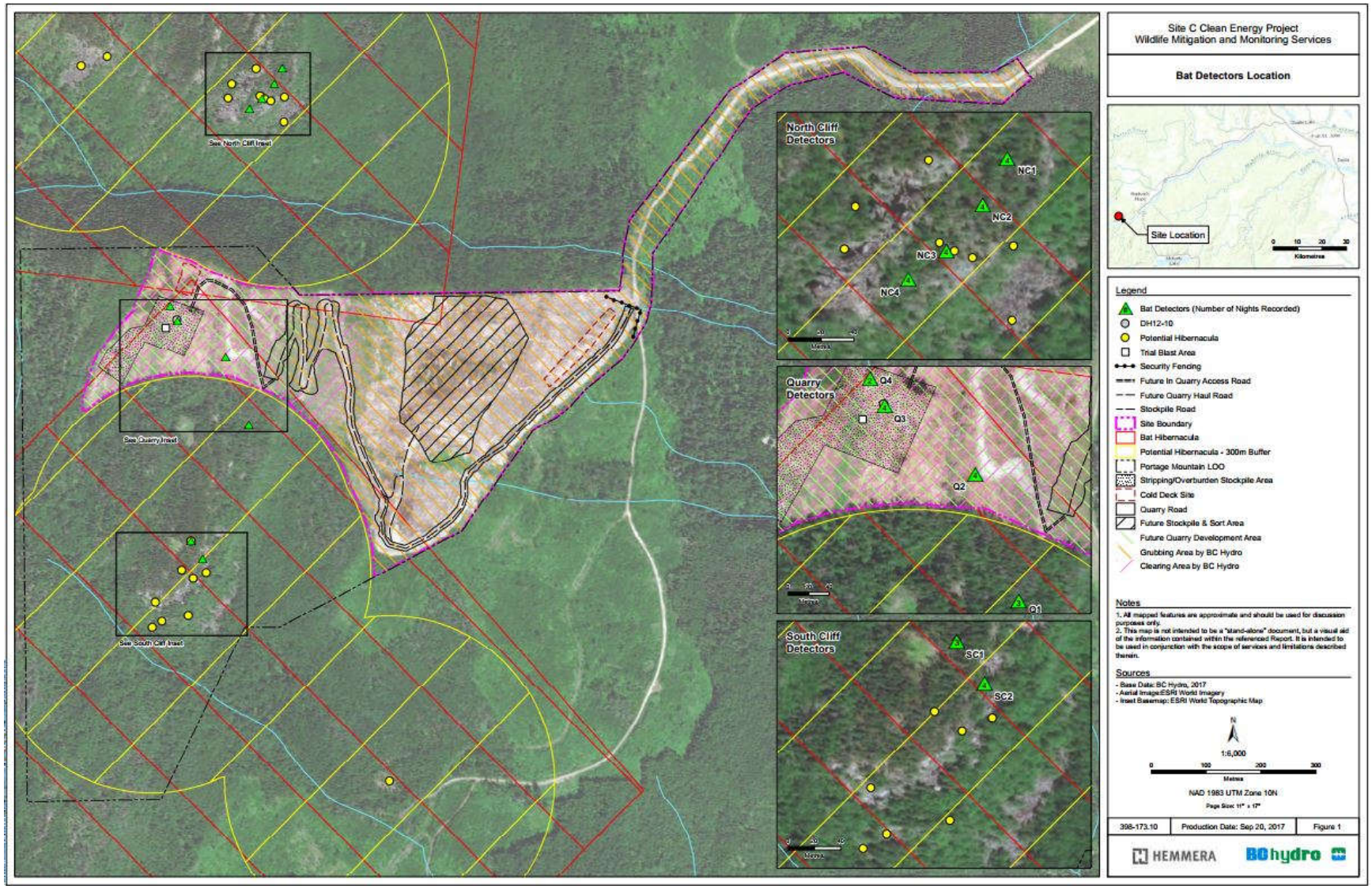
1.1 BACKGROUND AND PURPOSE

The work presented in this report provides results of bat investigations conducted from 31 July to 10 August 2017 in and around the Portage Mountain Quarry (**Figure 1**) to determine whether bat maternity roosts may be present. Specifically, this document reports on work conducted to identify the presence of breeding females and pups and therefore the potential use of the quarry and sixteen known hibernacula (Keystone 2014) as maternity colonies. Combinations of habitat screens, visual emergence surveys and remote acoustic detection were used to achieve these objectives.

Portage Mountain has been identified as a rock quarry to provide material for construction work as part of BC Hydro's Site C Clean Energy Project. However, several sites within Portage Mountain were previously identified as bat hibernacula (Sarell and Alcock 2016), which require mitigation to avoid and minimise effects due to activities at the quarry. The harvesting portion of the quarry was shifted to an area of Portage Mountain that is at least 300 m from identified hibernacula, and a temporal restriction on quarrying activity was established from September 15 to May 15 to minimise effects from blasting operations during the bat-sensitive winter hibernation period (BC Hydro 2017*a*).

This work addresses regulatory concern over the potential for maternity roosts in the newly-selected quarry site and known hibernacula.

Figure 1. Study area showing the locations of previously identified hibernacula.



1.2 STUDY AREA AND SCOPE

The study area is the Portage Mountain Quarry area (BC Hydro 2017*b*) and adjacent known hibernacula (**Figure 1**). The study area consists of a series of exposed cliff and crag faces at east to southeast aspects, with minimal fracturing and crevices, each from approximately two to seven metres in height. The cliffs are located within boreal forest dominated by spruce and aspen. A more detailed description of the cliff features can be found in section 3.0.

This report focuses on one group of bats from the up to eight species of bat present at Portage Mountain (Sarell and Alcock 2016; **Table 1**), species within the genus myotis. Bat species in the genus myotis share some commonalities in their habitat requirements, and they contain the only federally and provincially-listed species at risk that could be present; little brown myotis (*Myotis lucifugus*), and northern myotis (*M. septentrionalis*). They also have similar call characteristics, which makes them difficult to distinguish unless the acoustic calls are clear. As such, this group containing little brown myotis, long-eared myotis (*Myotis evotis*), northern myotis and long-legged myotis (*Myotis volans*) will be treated as a group. To be precautionary, the presence of any myotis species will be assumed to indicate presence of the at-risk little brown or northern myotis bats.

Table 1. Bat species previously noted as present at Portage Mountain (from Sarell and Alcock 2016).

Scientific Name	Common Name	BC Status	SARA Status
Myotis evotis	Long-eared Myotis	Yellow	no status
Myotis lucifugus	Little Brown Myotis	Yellow	Schedule 1 Endangered
Myotis septentrionalis	Northern Myotis	Blue	Schedule 1 Endangered
Myotis volans	Long-legged Myotis	Yellow	no status
Lasionycteris noctivagans	Silver-haired Bat	Yellow	no status
Lasiurus borealis	Eastern Red Bat	unknown	no status
Lasiurus cinereus	Hoary Bat	Yellow	no status
Eptesicus fuscus	Big Brown Bat	Yellow	no status

1.3 PEACE DISTRICT MYOTIS LIFE CYCLE

Bat species in the genus myotis have the following life cycle timing in the Peace District, an understanding of which is necessary for establishing interactions and recommending mitigation and monitoring (dates derived from Hemmera staff personal observations, and Holroyd and Craig 2016):

- Emergence from hibernacula begins in April, and full emergence is in about mid to late April, based on observations of relatively high activity levels.

- Breeding female bats occupy maternal roosts in early to mid-May. Pups appear to be born asynchronously with records of newborn pups in the last week of June through to the third week of July.
- Females leave the maternity roosts by mid-August, and before their pups, to seek out colder locations to accumulate fat for the winter. Juvenile bats might occupy maternity roosts until October, but this observation only comes from artificial bat maternity roosts (e.g., bat houses and buildings).
- Non-breeding females and males roost away from the maternity colonies in summer and fall.
- Swarming congregations indicated by increased fall activity, is typically noted from early August and mid-September.
- Bats enter hibernation in early November.

1.4 OBJECTIVE AND BIOLOGICAL ASSUMPTIONS

The objective of this bat study is to determine whether bat maternity roosts may be present at Portage Mountain Quarry. To achieve this objective using emergence survey and acoustic monitoring methods a combination of the following assumptions that are indicative of a maternity roost were used:

1. Greater than ten bats emerging from crevices will be considered indicative of a maternity roost. While maternity roosts with fewer bats have been observed in artificial roosts (pers. obs.), Naughton (2012) suggests males and non-reproductive females of northern myotis roost in groups of less than ten. Ten or more bats emerging from crevices will be considered as a potential maternity colony if other characteristics are noted (e.g., emergence timing and habitat features as per points 2 and 3 below). Males roost in cooler places singly or in small groups (Hamilton and Barclay 1994, Naughton 2012, Holroyd and Craig 2016), while females roost in larger numbers (Nagorsen and Brigham 1993, Garroway and Broders 2007), possibly because the warm conditions required for maternity colonies are less common on the landscape, and clustering achieves the higher temperatures required by pregnant and nursing females (Burnett and August 1981, Hamilton and Barclay 1994, also see point 3 below). No literature source provides a minimum number of bats that constitute a maternity roost. For little brown bats maternity roost occupancy can be in the hundreds or thousands of bats. Ten was chosen based on personal observations and the desire to distinguish between male and non-breeding female summer roosts, which are small colonies or individual roosts, and the generally larger maternity roosts.
2. Emergence timing for breeding female bats is at or near dusk because the burden of pregnancy and nursing requires them to end their daytime fast immediately at dusk. Males and non-breeding females can delay their emergence as their energy demands are not so critical that they need to take advantage of the total dusk to dawn dark period (Kurta et al. 1989).
3. Crevices where emergence is noted are warmer than other surrounding crevice locations. Females need a high body temperature for fetal development and milk production, and warm conditions in the maternity colony support this (Nagorsen and Brigham 1993). Evidence of warmer crevice conditions being required for (and hence indicating) maternity roosts is given by the disproportionate use of thermoregulation during daily torpor by breeding female bats

and male bats. Breeding female bats use thermoregulation less during daily torpor than do male or non-pregnant females (Hamilton and Barclay 1994). This implies that a warm maternity roost that also allows clustering (behavioural thermoregulation) can reduce pregnant female bat energy expenditures and increase reproductive fitness (Kerth 2008, Willis and Brigham 2007, Sedgeley 2001). It is suspected that male bats, because they do not share the burden of reproduction, frequently enter daily torpor to conserve energy and minimize their nighttime feeding duration needs, which is consistent with the tendency of male bats to roost in cooler sites away from breeding females (Nagorsen and Brigham 1993), and with their later emergence from roosts (point 2 above).

4. Maternity roost occupation in the study area occurs from mid-May to mid-August.

A key assumption for the conduct of this work is that emergence of bats immediately before or following dusk, and in numbers greater than ten during the mid-May to mid-August period, constitutes a maternity colony. Warmer conditions in and around crevices where more than ten bats emerge will be used as secondary evidence of maternity roost presence.

This method does not require the issuance of a permit for bat capture and recognises the challenge of accessing the cliff faces at Portage Mountain where the quarry and the hibernacula are located.

2.0 METHODS

The combination of two survey methods and habitat assessments was used to assess the presence of maternity roosts.

2.1 EMERGENCE COUNTS

Emergence count methods complied with BC provincial guidelines, as outlined in the Inventory Methods for Bats: Standards for Components of British Columbia Biodiversity No. 20 (RIC 1998). To assess maternity roost use within the Portage Mountain study area, physical inspections for roosting bats, or bat sign (e.g. feces) and emergence counts were conducted. The surveyed sites were selected based on previously identified hibernacula (Keystone 2014, Sarell and Alcock 2016) and on the following criteria:

- any exposed cliff face in the quarry area; and
- within the known hibernacula locations north and south of the quarry area with all of these criteria:
  - low vegetation clutter (i.e., no shading and hence warmer, and easier flight paths for bats, particularly newly volant pups);
  - south or southwest facing rock features (warmer because higher solar insolation); and
  - high or steep rock faces to prevent predator access.

Emergence counts were conducted from July 31 to August 10, 2017. Each count was conducted 30 minutes before dusk and continued until approximately one hour after dusk, when visibility became a limiting factor or when bats started to return to the roost. Each site was surveyed twice during two consecutive days. Surveyors positioned themselves with a view of the cliff and the light backdrop of the sky to backlight and provide contrast against which to see emerging bats (**Figure 2**).

Emergence counts were conducted with the aid of hand held acoustic detectors (Echo Meter Touch and Echo Meter Touch 2 Pro, Wildlife Acoustics) that detect and record high-frequency echolocation calls emitted by bats. The use of ultrasonic recording devices improves the efficacy of detection of emerging bats, and allows acoustic monitoring of bat activity within an approximate 50-100 m radius of the monitoring location (Limpens and McCracken 2004). Analysis of acoustic recordings also informs species or species-group identification.

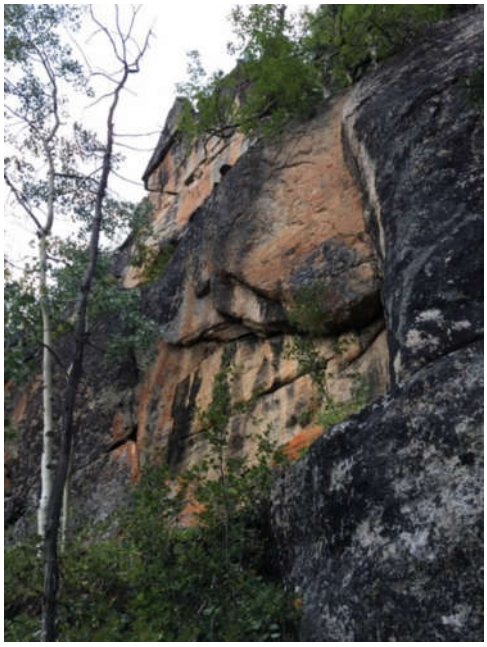


Figure 2. Example of rock facing cliff where emergence counts were conducted.

2.2 ACOUSTIC SURVEILLANCE

Five SM4 (Wildlife Acoustics Inc.) bat detectors suited with SMM-A2 ultrasonic microphones (Wildlife Acoustics Inc.) were deployed at each of the sites of emergence counts (i.e., north cliff, quarry and south cliff). Emergence counts and acoustic detections were most often conducted concurrently, however on some nights different sites were monitored by each technique to increase the size of the area surveyed during the emergence period.

To assess maternity roost activity acoustic monitors were installed concurrent to emergence timing. The detectors were deployed within cleared areas at least 10 m away from clutter (e.g. bushes, branches heavy cluttered canopy) to increase the chance that high-quality recordings would be captured. The bat detectors were suited with SMM-A2 (Wildlife Acoustics) ultrasonic microphones deployed at heights of at least 4 m above ground to avoid any noise or reflection from understory vegetation (**Figure 3**). Microphones were calibrated before field deployment to ensure the sensitivity was within optimal range and the gain was set to 24 dB. The bat detectors were programed to record acoustic calls in zero-

crossing format at a sample rate of 192 kHz with a high-pass filter of >16 kHz and division ratio of 8. Nightly acoustic sampling was scheduled from dusk to dawn, starting 30 minutes before sunset and finishing 30 minutes after sunrise.

Figure 3. Example of setup of bat detector installed on the north cliff (PBM-PM337-NH).

2.2.1 Acoustic Data Analysis

Data from acoustic monitoring stations were analyzed using AnalookW (Titley Electronics, Ballina, NSW, Australia) following conservative protocols for classification of acoustic calls and bat identification. Noise and ambient records were excluded from the dataset using a bat/noise filter in AnalookW. Bat acoustic data were automatically categorized using filters created using acoustic parameters for targeted species (**Table 2**). Non-targeted species (i.e., hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), and big brown bats (*Eptesicus fuscus*) were grouped in one category called “Bat”. Calls detected with these filters were verified manually and compared to reference libraries collected from bats in western Canada (Lausen 2016). The acoustic analysis followed a conservative approach; only files with at least two echolocation pulses were included in the analysis.

The acoustic parameters used for the identification of each call were derived from accepted characteristics (**Table 2**, Lausen 2016). Ambiguous calls, impossible to identify to species level, were present in the acoustic data. All were within the frequency / echolocation range of little brown myotis and northern long-eared myotis. These calls were assigned into species-groups based on the call frequency only (**Table 2**). New information and updated guidance pertaining to acoustic identification will be incorporated into data analysis methods when such information becomes available; draft Resource Inventory Standard Committee (RISC) protocols are expected to be available for this purpose in March 2018.

Table 2. Acoustic characteristics used to analyse little brown myotis, northern long-eared myotis and the 30K-50K myotis species-group.

Species Groups						Scientific name		Acoustic parameters									
Myotis septentrionalis	*Myotis lucifagus*	contains myotis spp.				Bat (non-myotis spp.)		Duration (ms)		Fmax (kHz)		Fmin (kHz)		Characteristic Frequency (kHz)		Slope of Call Body (OPS)	
		50K	40K	35K	30K			Avg.	Range of Averages	Avg.	Range of Averages	Avg.	Range of Averages	Avg.	Range of Averages	Avg.	Range of Averages
						■	*Lasiurus cinereus*	9.5	7.2 - 13.5	34	24 - 42	21	18 - 23	22	20 - 24	29	13 - 57.5
						■	*Lasionycteris noctivagans*	7.3	4.9 - 12.1	37	28 - 49	25.5	23 - 27	27	25 - 28	36.5	11 - 73.5
					■	■	*Eptesicus fuscus*	7	3.3 - 13.3	41	26 - 62	25.5	21 - 31	27	21 - 32	48	12 - 135
			■	■	■		*Myotis evotis*	4.1	1.4 - 2.4	64	49 - 88	34	29 - 41	42.8	34.5 - 66.6	343	158 - 855
			■	■			*Myotis volans*	3.2	1.7 - 6.3	68	56 - 85	41	36 - 45	47	39 - 63	202	64 - 503
		■	■	■			*Lasiurus borealis*	*6.5*	*5 - 8*	*53*	*49 - 59*	*41*	*37 - 45*	*41*	*37 - 45*	*29*	*23 - 41*
	■	■	■	■			*Myotis lucifugus*	3.5	1.6 - 6.7	76.5	49 - 91	42	32 - 47	48	38 - 57	175	63 - 464
■		■	■				*Myotis septentrionalis*	1.9	1.0 - 2.7	71.5	51 - 81	42	38.5 - 44	51	45 - 57	354	211 - 484

FMax: Maximum Frequency, *FMin*: Minimum Frequency

Black cell = Bat categories assigned to groups of bats based on the frequency (kHz) of their calls

This classification key is supported by text-based descriptions of bat calls, available on request.

This is not a definite classification key. The parameters used in this analysis are based on limited information from bat acoustic work in BC.

3.0 RESULTS AND DISCUSSION

No roosts were identified within the quarry. Previous hibernacula habitat assessments (Sarell and Alcock 2016) and a 2016 assessment by D. Nagorsen (BC Hydro 2017*a*) indicated that the rock outcrops in the quarry (**Figures 4 and 5**) were reported to have low suitability for hibernating bats due to the lack of large crevices or rock fractures (Sarell and Alcock 2017). Regarding the needs of breeding female bats, the small size of the five outcrops and the lack of fracturing reported in the previous assessments also indicates low suitability for maternity roosts. The 2017 habitat assessments conducted during this study confirmed the earlier conclusions. The rock outcrops are small, less than 5 m high, and have very few fractures, fissures or crevices. Where there are fissures, ledges and fractures there is much evidence of pack rats, likely because the rock outcrops are short and non-vertical and therefore easily scalable by rodents. The rock outcrops in the quarry are east-facing (see blue shading in **Figure 6**), and three have overhanging or obscuring trees that shade the cliffs (**Figure 4**). The physical requirements for maternity roosts are not met by the rock outcrops in the quarry. Solar insolation and thermal momentum / mass required to produce and maintain warm conditions for maternity roosts is absent in these small rock features. Predator protection is minimal, as evidenced by abundant pack rat urine (**Figure 4**, also noted by Sarell and Alcock 2016).

In contrast, the cliffs to the north and south of the quarry area have physical properties suitable for harbouring summer maternity roosts. These cliffs are 10 - 20 m tall, vertical, and face south or southwest (orange shading in **Figure 6**). This aspect, plus the large size and absence of obscuring trees (**Figures 2, 3 and 7**), can provide the necessary thermal energy and mass for bats to establish maternity colonies. Fracturing, fissures and crevices are abundant, particularly behind the prominent flakes and within vertical corners common on the cliffs. Pack rat evidence in these areas is minimal and largely confined to the lower portion of the cliffs.

The King Gething Mine adits (**Figure 4**) on the lower slopes of Portage Mountain were visited. However, the absence of any physical features required for maternity roosts suggested no potential for maternity roosting and as such no further monitoring of these features was conducted.

Figure 4. Three of the quarry area cliff / crags surveyed in July / August 2017. Note habitat features that reduce maternity roost suitability; small size and height and obscuring vegetation. Lower right, a King Gething Mine adit.

Current knowledge of the habitat needs for bat maternity roosts is sparse, especially for northern myotis. This survey was based on the best available information, including from areas outside the Peace District, to predict which habitat has potential for being used (see also section 1.4).

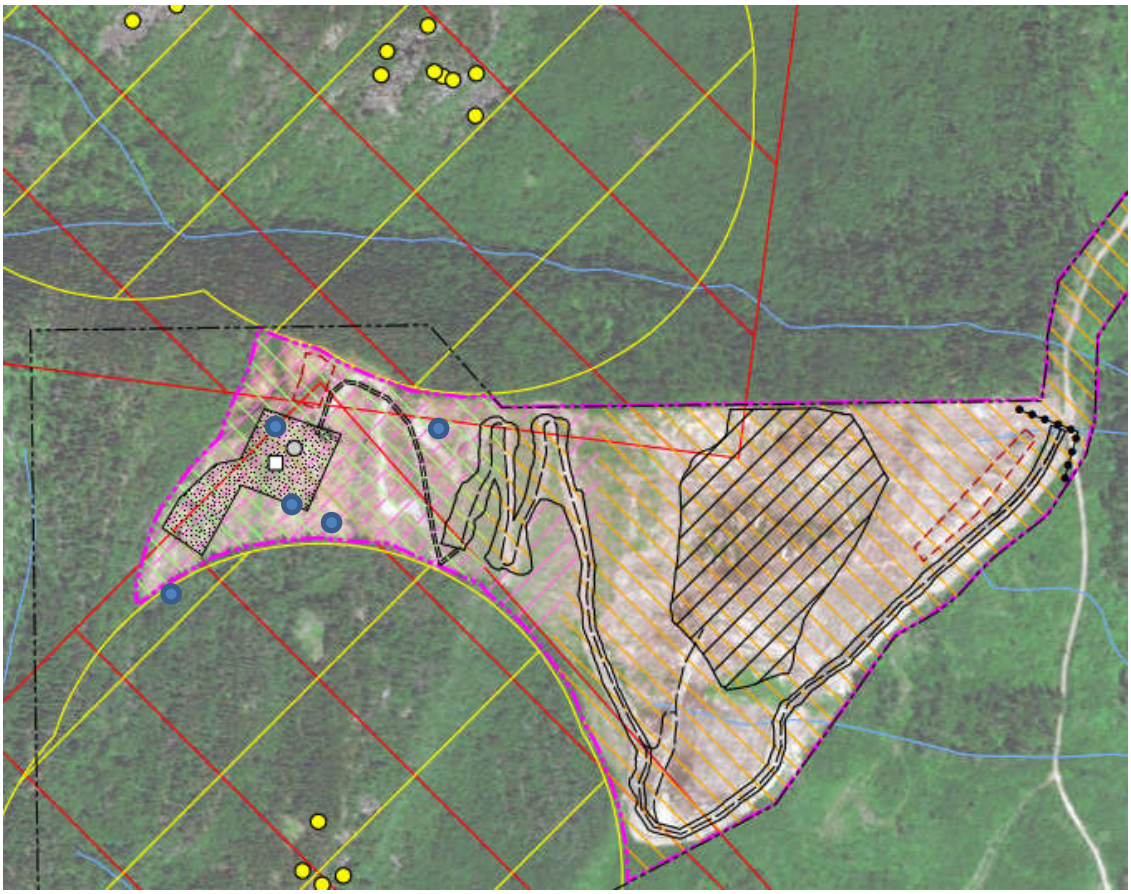


Figure 5. Quarry area crag locations surveyed with acoustic detectors and emergence surveys (blue circles) and previously identified hibernacula (yellow circles, Keystone 2014).

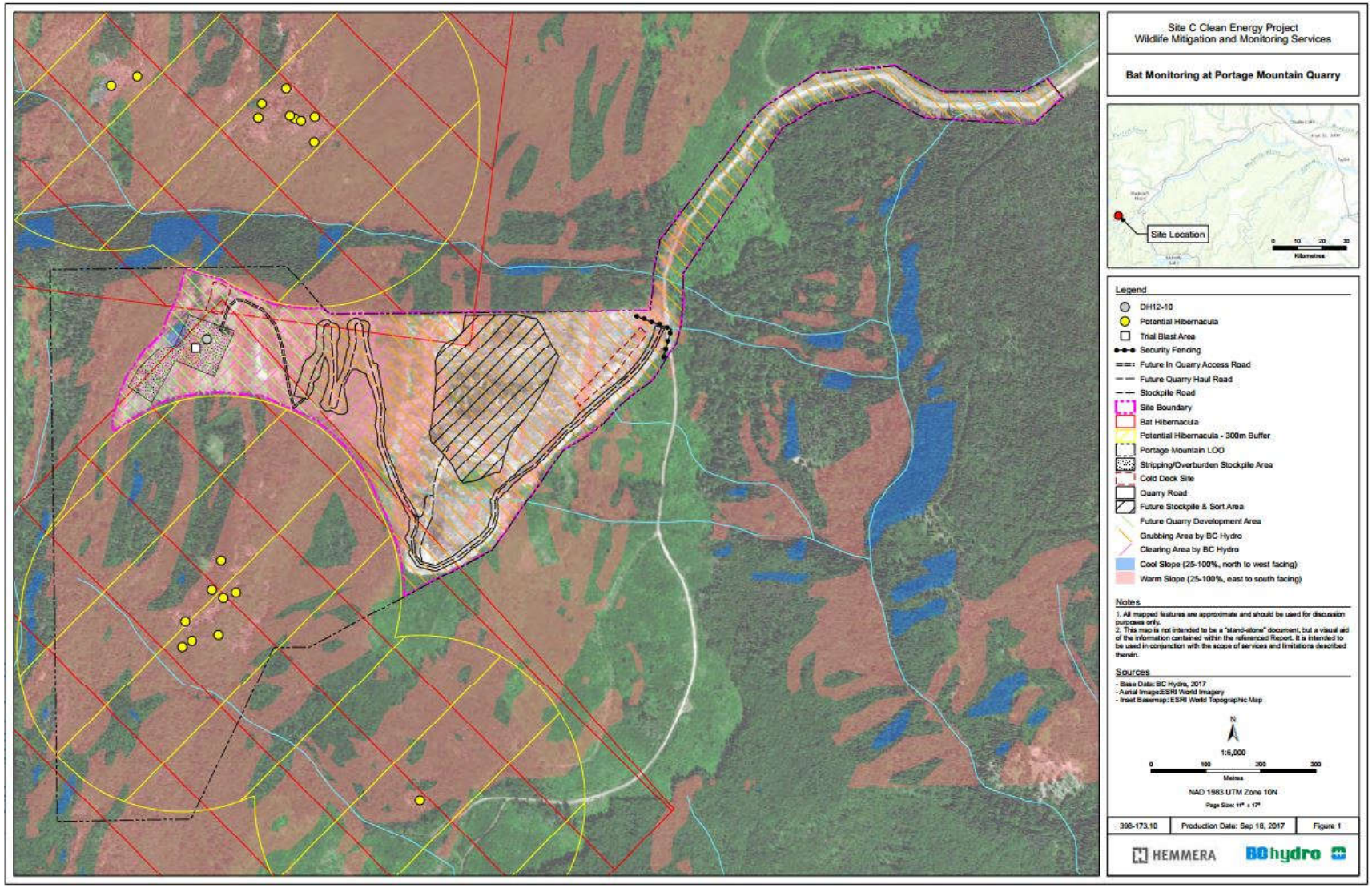


Figure 6. Study area showing cold and warm aspects. The red polygons indicate areas that are 25-100% south facing. Note quarry locations are outside the warm south-facing quadrants.

Figure 7. The north cliffs. Note lack of tree shading and large size with high thermal mass.

Thirty-two emergence counts were conducted across the study area during the 31 July to 10 August survey period (**Table 3**). Each emergence count was conducted by an experienced and trained bat biologist, and lasted a minimum of 60 minutes (a minimum of 32 hours of combined surveys). Cliffs in the quarry and at the north and south cliffs were surveyed. Because emergence duration is short (60-90 mins starting at dusk, ~2115 hrs) multiple surveys of each cliff were required to observe bat movement patterns and to successively focus observations on the suspected location of maternity roosts.

In the quarry area, very few bats were seen during the emergence period (max = 4 on August 1), and all observations were of bats that appeared to be commuting to the spruce bog on the upper platform of the cleared forest area. No bats were observed emerging from the quarry area cliffs. Bats were infrequently noted during emergence surveys on hand-held detectors (max = 6 on August 3), but few of the calls were close enough to surveyors at the cliffs or of high enough quality for positive identification to be made.

Table 3. Emergence count surveys completed, by location, Portage Mountain Quarry, 2017.

Date	Location			Weather	
	Quarry	South Cliffs	North Cliffs	Wind (Beaufort)	Temperature (ºC)^
July 31	2	-	-	1	17
August 1	2	1	-	1	16
August 2	-	3	-	1	13
August 3	4	-	-	2	17
August 4	-	4	-	2	16
August 5	-	4	-	2	20
August 6	-	-	4	3	12
August 7	-	-	4	2	20
August 8*	-	-	-	-	-
August 9	-	-	2	2	20
August 10	-	-	2	2	20

^ Temperature data were obtained from a handheld digital thermometer (Suunto).
* Full moon on August 8 precluded monitoring as bats are less active on full moon nights.

At the north and south cliffs observed bat activity was higher, and two sites within the south cliff were identified as probable maternity roosts (**Table 4**). These sites were located within an area of the south cliff with no trees and containing overlapping features with rock fissures (**Figure 8**). The cliff faces south with suspected high sun exposure, based on aspect (**Figure 6**) and the lack of obscuring vegetation. The bat observations at these two sites occurred shortly before or immediately at dusk (~2115 hrs), a behaviour that is likely associated with the need for female bats that might still be nursing young bats to end their daytime fast early (Kurta et al. 1989).

Table 4 Location and number of bats at two possible maternity roosts identified during August 2017.

Roost name*	Latitude	Longitude	Bats counted	Surveyed dates
9427G	55.973830	-122.118900	8	August 2
			8	August 4
			11	August 5
6287F	55.973201	-122.118900	10	August 4
			10	August 5

* The name for the sites was adopted from the closest previously identified hibernacula (Keystone 2014).

Eight bats were counted emerging from 9427G on August 2-4 and 11 on August 5. The number of bats counted emerging from 6287F was approximately ten, on both August 4 and 5. These two sites were located at close proximity to the previously identified hibernacula (Keystone 2014) 9427G and 6287F.

Figure 8. South cliff maternity roosts. Left, approximately eight bats counted near previously identified hibernacula 9427G (Keystone 2014). Right, approximately 10 bats counted near previously identified hibernacula 6287F.

Little brown myotis and northern long-eared myotis were detected starting at 2130 during emergence counts with the aid of hand-held bat detectors used by emergence surveyors at 9427G and 6287F. However, the first bat recorded by the SM4 bat detectors deployed closest to the suspected maternity roosts was observed almost 1-hour after emergence, ~2215 (**Figure 9**). Bat detectors were located on top of the cliff band where the probable roosts were identified, and despite the detectors being in recording range (< 50 m from sites), bats exited the roosts and flew away from the cliff and the microphone, and therefore were not detected by the stationary passive bat detectors during concurrent emergence counts. Four nights of passive acoustic monitoring were conducted between the suspected maternity roost locations; more acoustic surveys are necessary to better understand bat activity in the area. Similar results were observed from the detectors recording at the quarry (**Figure 10**) and north cliff (**Figure 11**); there were no detections before 2200. Detectors at the quarry recorded fewer calls and those calls were mostly later in the night as compared to the greater number and diversity of calls recorded at the north and south cliffs earlier in the night.

In the quarry area no bats were recorded on the passive bat detectors until 2200 hrs, almost an hour after emergence was observed at the south cliffs; a pattern consistent with non-maternity roost bat emergence / commuting behaviour. Conditions in the quarry are suitable for foraging, with standing water in one area of what appears to be formerly a perched spruce bog.

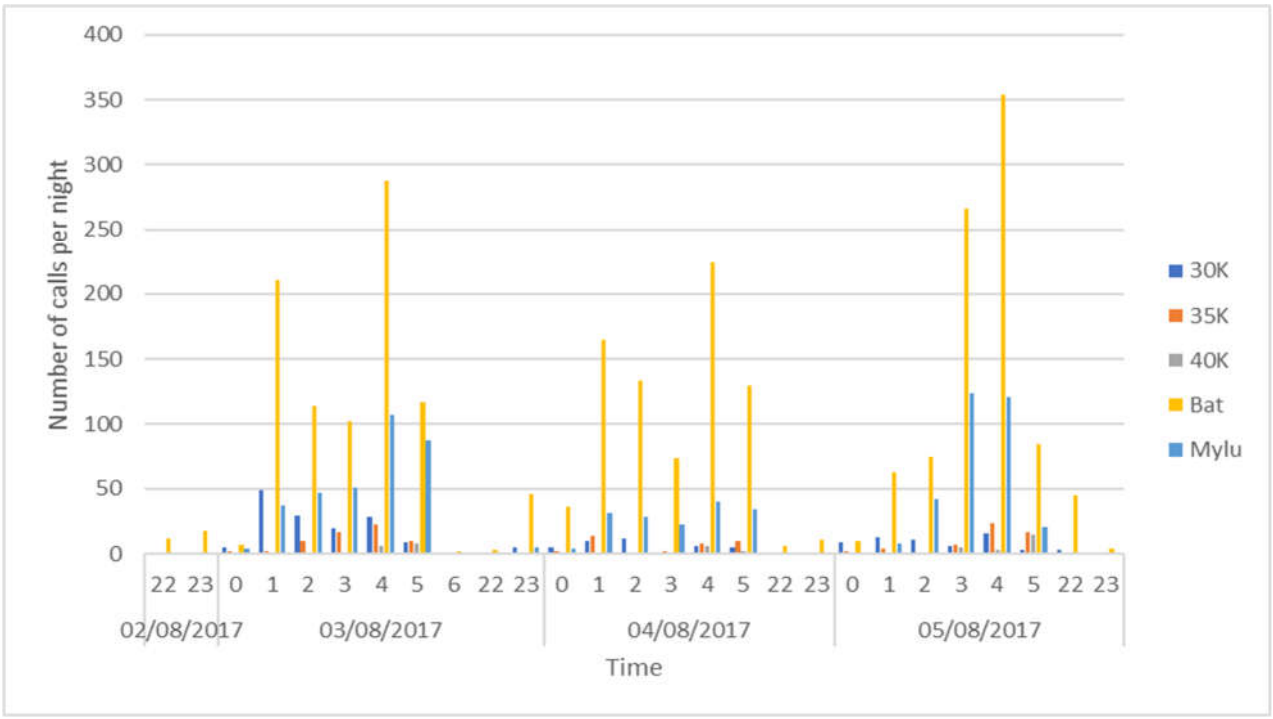


Figure 9. Acoustic activity pattern from bat detectors located in the south cliff near 9427G and 6287F.

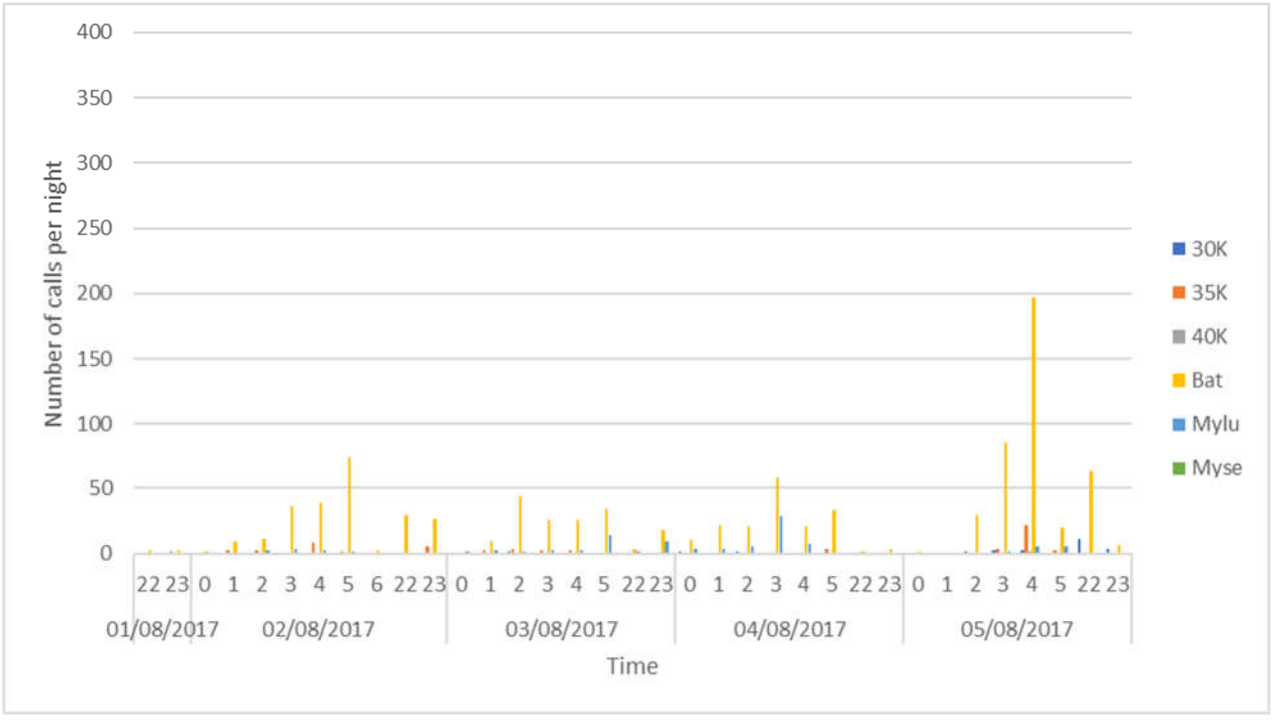


Figure 10. Acoustic activity pattern from bat detectors located at the quarry.

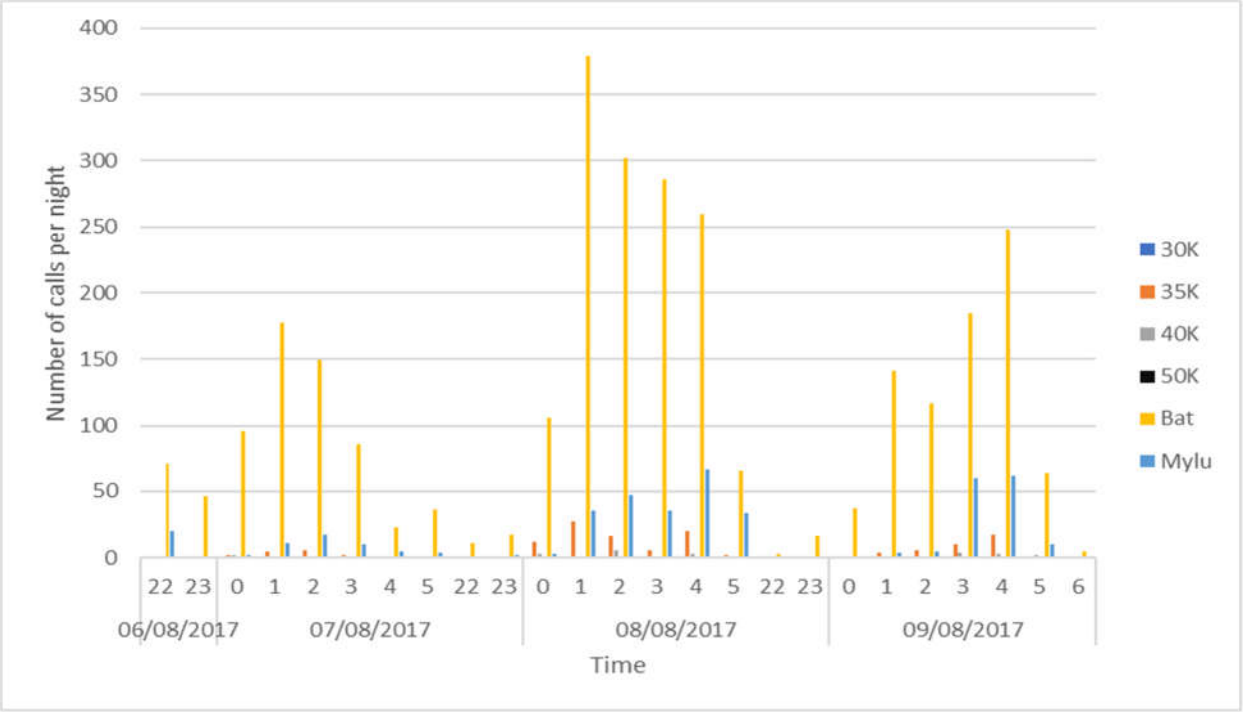


Figure 11. Acoustic activity pattern from bat detectors located at the north cliff.

4.0 CONCLUSION AND RECOMMENDATIONS

Physical conditions and bat observations suggest the presence of maternity or summer roosts within the cliff located south of the quarry location at Portage Mountain. This cliff is large, south-facing with high solar insolation and thermal momentum and has no shading vegetation. Emergence counts and bat detector observations of myotis species bats immediately after dusk at a habitat feature with characteristics of a maternity roost, and in numbers (~8-10 bats) that are at consistent with the minimum for a maternity roost (section 1.4), collectively suggest a potential myotis maternity colony is present.

In the quarry area the cliffs lacked the physical properties required for maternity roosts, and there were no behavioural observations or acoustic detections that supported maternity roost use.

At the north cliff there are physical properties that indicate strong potential for maternity roost presence, but behavioural observations of bats and acoustic detections were not indicative of such use.

The emergence counts, habitat inspections and acoustic surveys performed during this survey indicated that bats could be using the south cliff as maternity roosts. While there is no federally designated Critical Habitat for bat maternity roosts, these features are identified as important (Environment Canada 2015).

The mitigation currently in place to protect the hibernacula are as follows (BC Hydro 2017*a*):

- Blasting is prohibited within 300 m of bat hibernacula.
- Blasting is prohibited at the Portage Mountain Quarry from September 15 to May 15.

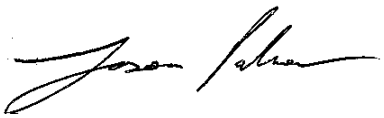
The suspected maternity roosts are ~500 m from the location of the quarry boundary and the period of activity in the maternity roosts is approximately mid-May to mid-August, which does not overlap with the current blasting restriction period. Physical separation between the maternity roosts and the quarry is greater than the 300 m buffer within which no blasting should occur (MFLNRO 2014), but within the 1 km setback from occupied bat roosts in which high risk activities like blasting are acceptable if sound concussion, shock wave and peak particle velocity remain below defined thresholds at the maternity roost (i.e., sound concussion of less than 150 decibels, shock waves of less than 15 p.s.i, and peak particle velocity of less than 15 mm / second; MFLNRO 2014, Holroyd and Craig 2016).

Acoustic studies (Drew et al. 2016, Horan and Frappell 2016) modelling the quarrying equipment and blasting to be used at Portage Mountain, and considering the local topography, have determined that at 300 m from the quarry the sound concussion, shock wave and peak particle velocity would be below BC Best Management Practice blasting thresholds for bats (MFLNRO 2014, Holroyd and Craig 2016). Peak particle velocity will be below 15 mm / second at 150 m (Horan and Frappell 2016). Sound attenuation at distances greater than 300 m, especially at the higher frequencies used by bats (i.e., >8 kHz), is greater than the power of equipment noise (Drew et al. 2016). The quarry activity is on a different aspect, and separated from the maternity roosts by ~500 m and dense mixed coniferous forest. The gully to the north of the quarry will reduce vibrations experienced at the northern hibernacula (Horan and Frappell 2016). These factors limit the potential for noise effects on bat occupancy.

The maternity roosts on the south cliffs appear to be small (approximately ten bats) and are spatially separated from quarrying activities. Modelling of noise and vibration 300m from the quarry, predicts that the impacts will be below BC provincial thresholds (MFLNRO 2014). Attenuation of noise and vibration at the greater distances where maternity roosts and hibernacula are located is predicted to reduce the effects further. The physical features used for maternity roosts are common in the local area. The south faces of Portage Mountain have a series of parallel cliff features, most much larger than those close to the quarry. Many alternative sites with maternity roost properties are suspected to be present nearby.

Current mitigation, especially the defined 300 m setback and achieving sound concussion of less than 150 decibels, shock waves of less than 15 p.s.i and a peak particle velocity of less than 15 mm / second will be adhered to. This mitigation is predicted to be sufficient to limit the impacts to bats using the south cliff as a maternity roost because the roosts are ~500 m from the quarry where noise and vibration impacts will be lower than the thresholds. Bats are expected to continue to use this feature for maternity roosting.

To confirm this assessment, and if necessary to recommend adaptations to mitigation, emergence monitoring in the mid-May to mid-August period is recommend during the period of quarry use. In addition, noise monitoring will be conducted to confirm the predictions of noise modelling regarding noise intensity at maternity roost and hibernacula locations during the May 2018 test blast, and during routine quarry operations. Ongoing presence of bats at the maternity roosts will be considered evidence of mitigation efficacy. Such presence will be ascertained through annual maternity roost emergence surveys and year-round bat acoustic monitoring.



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Appendix 9. Experimental Rare Plant Translocation Program 2017 Field Season Update

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UNIT 4 - 252 1ST STREET EAST
NORTH VANCOUVER BC V7L 1B3
PHONE: 604 803-7146

MEMORANDUM

DATE:	19 December 2017
TO:	Brock Simons, M.Sc., R.P.Bio.
FROM:	EcoLogic Consultants Ltd.
SUBJECT:	Site C Rare Plant Translocation Program – 2017 Field Season Update

OBJECTIVES OF 2017 FIELD PROGRAM

Per BC Hydro's *Site C Clean Energy Project Experimental Rare Plant Translocation Program*, EcoLogic Consultants Ltd. (EcoLogic), in collaboration with Twin Sisters Native Plant Nursery and Eagle Cap Consulting, has completed the field component of the 2017 scope of work. The key aspects of the 2017 field program were to identify source populations of the target plant species, characterize the site and plant community characteristics of the source populations, identify potential recipient locations and, where possible, collect seeds (or other propagules) to facilitate ex-situ propagation and eventual planting of propagated material.

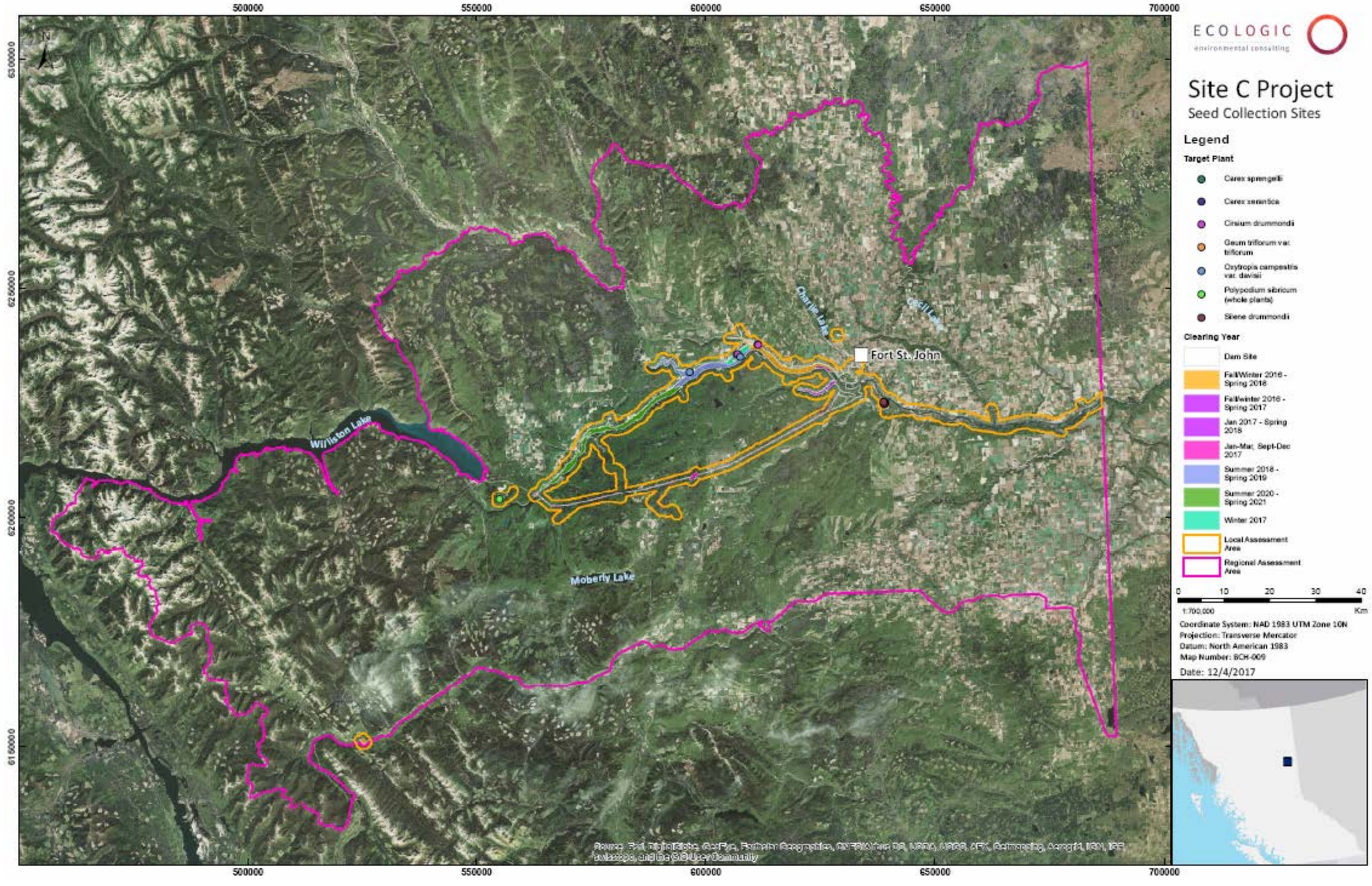
2017 FIELD PROGRAM RESULTS SUMMARY

TARGET SPECIES DETECTION AND SEED/PROPAGULE COLLECTION

During the 2017 field program, the field teams prioritized surveying areas scheduled for clearing in the fall and winter of 2017-18. The field teams visited 23 locations during the 2017 field program, searching for previously identified and located target species within spatial areas slated for clearing in the near term (e.g., Winter 2017-2018).

The teams were successful in collecting seeds (or whole plants in the case of *Polypodium sibiricum*) for seven of the target species (Figure 1). Field teams collected from *Carex sprengelii* (Sprengel's sedge), *Cirsium drummondii* (Drummond's thistle), *Geum triflorum* var. *triflorum* (old man's whiskers) *Oxytropis campestris* var. *davisii* (Davis' locoweed) *Polypodium sibiricum* (Siberian polypody), *Silene drummondii* var. *drummondii* (Drummond's campion), and *Carex xerantica* (dry-land sedge). Field teams divided each seed collection into two lots, with the exception of the *C. sprengelii* collection, which was not divided. Seed collections were delivered to Twin Sisters at the end of each field trip in July and August and to NATS Nursery in July and October.

Figure 1. Seed Collection Sites



The field teams focused on the collection of seeds over whole plants and cuttings in order to maximize the amount of propagules that could be collected, transferred, and grown locally at Twin Sisters. Initially, whole plant collections were planned for 2017 and were to be transported to Twin Sisters for care and maintenance. However, Twin Sisters later determined that its facility could not support whole plants in the 2017-2018 growing season. As a result, limited whole plant collections were conducted in 2017-2018, and the whole plants that were collected are now housed at NATS in Langley.

NATS and Twin Sisters are in the process of cleaning and stratifying the seeds. Depending on the species and seed type, seeds are either dried or cleaned following collection to ensure maximum viability. Cleaning involves the removal of waste material from the seed itself and includes the use of sieves, hand separation, water baths and drying, as appropriate. Stratification involves pretreating seeds to simulate natural conditions that a seed must endure before germination. Many native plant species require some form of a natural stratification procedure over the fall, winter and spring months in order to break the seed coat and germinate. It is necessary to mimic these natural processes in the nursery setting in order to achieve consistent germination. Seeds that do not require stratification will be stored until spring. The current seed inventory information available for each species is provided in Table 1.

Efforts at seed collection were not successful in all cases (5 out of 13 located target species), due to timing of seed production, inability to locate target species, and browse. Field staff, based upon their own experience with the target species and local climate, timed all visits in order to maximize the likelihood of seeds being ready for collection. There were, however, several instances where seeds of target species ripened earlier or later than expected. Target species not located are either no longer present at the site, not located during original surveys, or mis-identified during original surveys.

IDENTIFICATION OF RECIPIENT SITES

Site selection for rare plant translocation will be carried out using two methods. These will include selection of sites in the regional area that contain the target species (and thus being representative of the habitat associated with the target species), and identification of sites within the regional area that have the same site characteristics as those within the salvage area that contain the target rare plants.

Regional surveys conducted during 2017 identified multiple observations of target rare plants outside of areas slated for clearing or inundation. These sites will be eligible for future translocation activities as, since they already contain the target species, they will have suitable site characteristics for translocation of the same target species. Surveys in 2018 will include data collection at these areas to identify any microsite characteristics that could be important for target rare plant translocation.

Table 1. 2017 Seed Inventory

Target Plant Species	Nursery	Propagule Type	Seed Lot #	Dry Cleaned Weight (g)*	Est. Seeds per Gram	Supplier	Comment
Carex xerantica	NATS Nursery	seeds	EL-152-17	0.5	2000	Terry McIntosh	
Carex xerantica	NATS Nursery	seeds	EL-153-17	0.3	2000	Terry McIntosh	
Cirsium drummondii	NATS Nursery	seeds	EL-81-17	3.0	1140	Terry McIntosh	
Cirsium drummondii	NATS Nursery	seeds	EL-82-17	4.0	1140	Terry McIntosh	
Cirsium drummondii	NATS Nursery	seeds	EL-156-17	0.6	1140	Terry McIntosh	
Geum triflorum var. *triflorum*	NATS Nursery	seeds	EL-150-17	0.6	950	Terry McIntosh	
Oxytropis campestris var. *davisii*	NATS Nursery	seeds	EL-83-17	7.0	1000	Terry McIntosh	
Oxytropis campestris var. *davisii*	NATS Nursery	seeds	EL-151-17	0.4	1000	Terry McIntosh	
Silene drummondii var. *drummondii*	NATS Nursery	seeds	EL-154-17	0.1	3000	Terry McIntosh	
Sphenopolis intermedia	NATS Nursery	seeds	EL-155-17	0.2	n/a	Terry McIntosh	Slender Wedgegrass - blue-listed but not a target plant for the ERPT Program - do not propagate.
Polypodium sibiricum	NATS Nursery	whole plants	EL-RPT-012-17	n/a	n/a	Terry McIntosh	5 masses of rhizomes were salvaged and planted in 28 #1S pots, fronds with spore collected on Sept. 7, 2017 and are drying.
Cirsium drummondii	Twin Sisters Native Plant Nursery	seeds	TS170026	28.0	1140	Terry McIntosh	
Oxytropis campestris var. *davisii*	Twin Sisters Native Plant Nursery	seeds	TSH170002	40.0	1000	Terry McIntosh	
Carex xerantica	Twin Sisters Native Plant Nursery	seeds	TSH170003	3.0	2000	Terry McIntosh	

Target Plant Species	Nursery	Propagule Type	Seed Lot #	Dry Cleaned Weight (g)*	Est. Seeds per Gram	Supplier	Comment
Carex sprengelii	Twin Sisters Native Plant Nursery	seeds	TS170031	<1.0	in progress	Terry McIntosh	
Carex xerantica	Twin Sisters Native Plant Nursery	seeds	TS170054	<1.0	2000	Terry McIntosh	
Oxytropis campestris var. *davisii*	Twin Sisters Native Plant Nursery	seeds	TSH170006	8.0	1000	Terry McIntosh	
Cirsium drummondii	Twin Sisters Native Plant Nursery	seeds	TSH170007	3.0	1140	Terry McIntosh	
Glyceria striata - (Glyceria pulchella)	Twin Sisters Native Plant Nursery	seeds	TSH170008	<1.0	n/a	Terry McIntosh	voucher identified as *Glyceria striata* - do not propagate
*Silene drummondi*i var. *drummondii*	Twin Sisters Native Plant Nursery	seeds	TSH170009	0.2	3000	Terry McIntosh	
Carex xerantica	Twin Sisters Native Plant Nursery	seeds	TSH170010	4.0	2000	Terry McIntosh	
Danthonia intermedia (Avenula hookerii)	Twin Sisters Native Plant Nursery	seeds	TSH170011	8.0*	n/a	Terry McIntosh	voucher identified as *Danthonia intermedia* - do not propagate
Danthonia intermedia (Avenula hookerii)	Twin Sisters Native Plant Nursery	seeds	TSH170012	8.0*	n/a	Terry McIntosh	voucher identified as *Danthonia intermedia* - do not propagate
Danthonia intermedia (Avenula hookerii)	Twin Sisters Native Plant Nursery	seeds	TSH170013	8.0*	n/a	Terry McIntosh	voucher identified as *Danthonia intermedia* - do not propagate

** estimates based on the results from NATS*

In 2017, site data was collected from all sites where seed from rare plants was collected. This included plants found at Bear Flats, Area E, Halfway River, and Watson Slough. Data collected included site description data such as slope, aspect, moisture and nutrient regimes, slope position, slope shape, microtopography, and ecosystem classification. In 2018, existing mapping information regarding ecosystems and soils will be used to identify soils and ecosystems that are representative of those donor sites surveyed in 2017. Field surveys will then be undertaken to determine site eligibility for rare plant translocation.

RECOMMENDATIONS ARISING FROM 2017 FIELD PROGRAM

ADJUSTMENTS TO TARGET SPECIES LIST

Based on the results of the 2017 field season, and the research conducted to support it, the field team recommends that eight species be removed from the target species list:

- ***Artemisia herriotii*** Herriott's sage - This species is common throughout the Peace Valley, with the potentially affected populations representing a small proportion of the provincial populations.
- ***Avenula hookeri*** spike oat - This species is common within and outside of the Project footprint.
- ***Calamagrostis montanensis*** Plains reedgrass - This species is widespread and common within and outside of the Project footprint.
- ***Erigeron pacalis*** Peace daisy - The *E. pacalis* species identified in 2008 has not been re-located despite targeted rare plant surveys conducted in 2014, 2016 and 2017 at the specified site of *E. pacalis* along the Peace River.
- ***Geum triflorum* var. *triflorum*** old man's whiskers – An extremely common species in the region, and is expected to be downlisted as a species of concern in BC in the near future.
- ***Potentilla pulcherrima*** pretty cinquefoil - A common species in the region, and is expected to be downlisted as a species of concern in BC in the near future.
- ***Rorippa calycina (persistent-sepal yellowcress)***- Despite repeated searches over several years (2011, 2013, 2014, and 2017) by different botanists, none of the *R. calycina* identified in 2008 have been observed. Available evidence suggests that the three *R.calycina* occurrences reported in 2008 on the Peace River are not extant.
- ***Schizachyrium scoparium*** little bluestem - Existing reports in the Peace River region are all suspected of being erroneous, and it is likely that the species has been misreported as occurring in the area. No reports are supported by voucher specimens; the only known photographs of the species in the Peace appear to be of *Nassella viridula* (green needlegrass).

Based on the results of the 2017 field season, and the research conducted to support it, the field team recommends that one species be added to the target species list:

- ***Ranunculus rhomboideus*** prairie buttercup – This red-listed species has a very limited distribution in British Columbia. Several plants were detected in Watson Slough during the July 2017 field visit, but the seeds were already too mature to collect. It is recommended that the site be visited in June 2018 for seed collection.

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