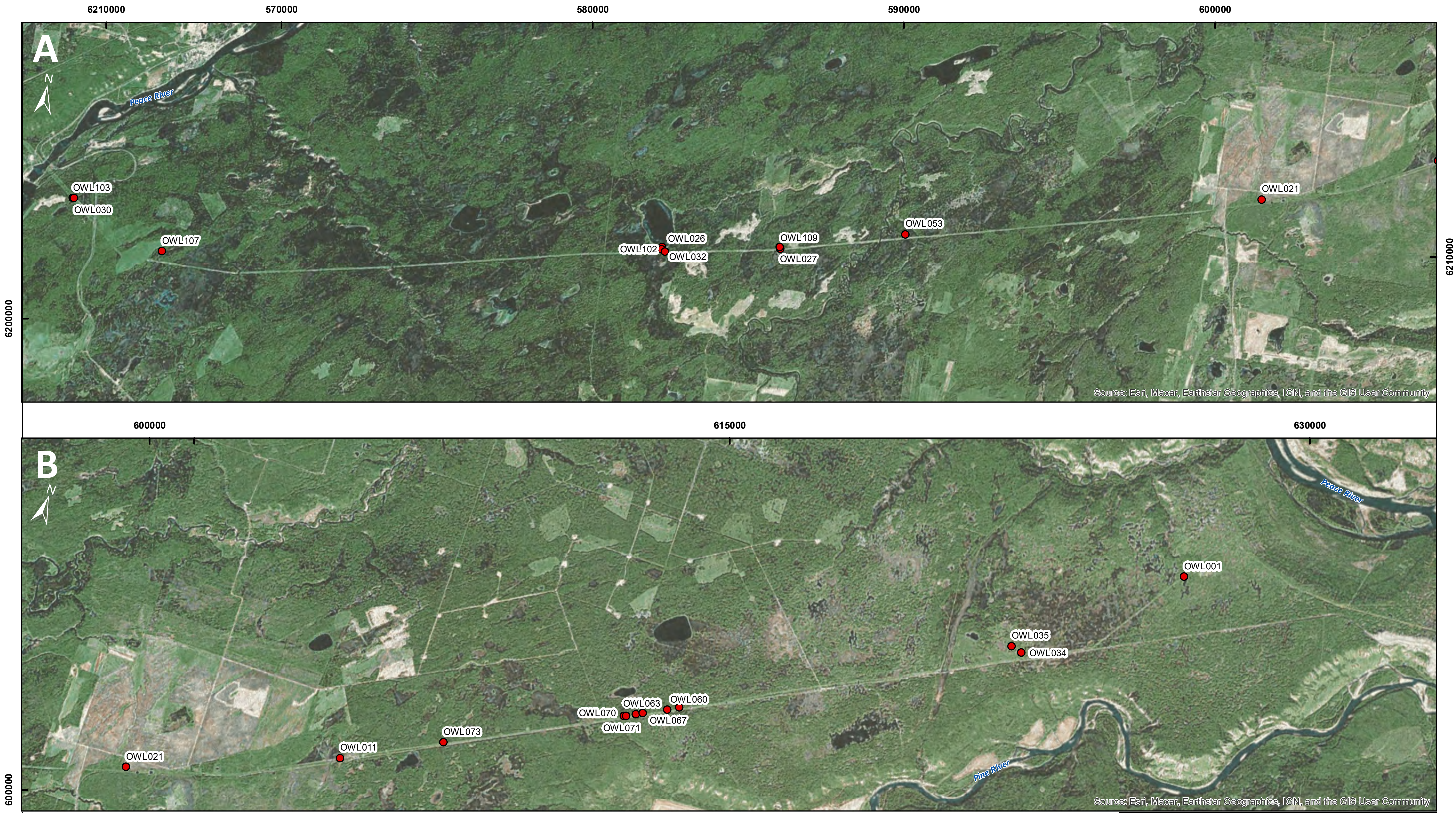


Site C Project

Location of 2022 Sample Sites

Figure 3.1-1

Legend

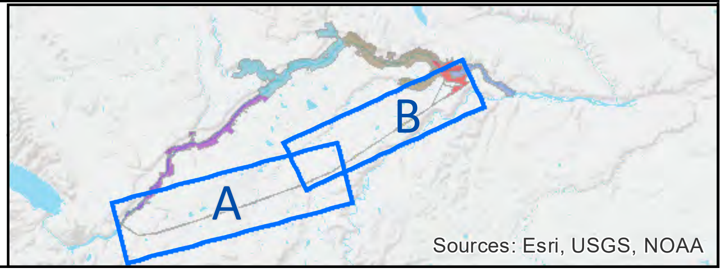
● 2022 Wetland Sample Sites

0 2 4 6 8 km

1:110,000

Date: 2023-02-23
Map Number: BCHWL-32
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC environmental consulting



3.2 ECOSYSTEM CLASSIFICATION AND MAPPING

The classification of one wetland was modified in 2022 (Table 3.2-1). Wetland OWL021 was previously called a Wm00 in 2020 based on the high level of disturbance from the construction of a tower pad and temporary road. In 2022 the field survey resulted in changing the classification to Wm03 due to an increase from 5% to 40% cover of the main Wm03 indicator, awned sedge (*Carex atherodes*).

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

Plot ID	2020 Site Association	2022 Site Association	2020 Wetland Type	2022 Wetland Type
OWL021	Wm00	Wm03	SE	SE

3.3 WETLAND SUMMARIES

3.3.1 Bog Overview

Two bogs were sampled in 2022, comprising one wetland type (BT) and two site associations (Table 3.3-1). All of the bogs were located in the transmission line right-of-way (ROW) and have been partially or entirely modified by clearing and/or grubbing from construction activities, and some have been modified by construction roads and tower pads.

The majority of wetland OWL109 is located outside of the ROW, including the sample plot location (Plates 3.3-1 to 3.3-2). No construction related disturbances were observed in the OWL109 sample plot, while shrub and tree regeneration were observed within the ROW. Wetland OWL035 was completely cleared and grubbed for transmission line construction. Shrubs and small trees are regenerating across most of OWL035 (Plates 3.3-3 to 3.3-4), with bare soil only observed on construction roads.

Table 3.3-1. Summary of Bogs Sampled in 2022

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)[(a)]	Successional Status(es)[(a)]	Hydrology
Bog	Wb05	BT	Black spruce - Water sedge - Peat-moss	1	Low Shrub	Young Seral / Old Climax	Permanently to Semi-permanently Flooded
	Wb09	BT	Black spruce – Common horsetail – Peat-moss	1	Low Shrub/ Tall Shrub	Young Seral	Permanently to Semi-permanently Flooded
Total				**2**			

(a) See Appendix A for structural stage and successional status descriptions

Plate 3.3-1. Wb05 Black spruce - Water sedge - Peat-moss bog at wetland OWL109 along the transmission line in 2020.

Plate 3.3-2. Wb05 Black spruce - Water sedge - Peat-moss bog at wetland OWL109 along the transmission line in 2022.

Plate 3.3-3. Wb09 Black spruce – Common horsetail – Peat-moss bog at wetland OWL035 along the transmission line in 2020.

Plate 3.3-4. Wb09 Black spruce – Common horsetail – Peat-moss bog at wetland OWL035 along the transmission line in 2022.

3.3.2 Fen Overview

One SE fen was sampled in 2022 (Table 3.3-2). The Wf01 fen (OWL034) had little change since the 2020 field survey. Adjacent shrubs that were cut for the transmission line are regenerating well, and the Wf01 wetland remains functional and in good condition (Plates 3.3-5 to 3.3-6).

Table 3.3-2. Summary of Fens Sampled in 2022

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)[(a)]	Successional Status(es)[(a)]	Hydrology
Fen	Wf01	SE	Water sedge - Beaked sedge	1	Graminoid	Disclimax	Permanently to Semi-permanently Flooded
Total				**1**			

(a) See Appendix A for structural stage and successional status descriptions

Plate 3.3-5. Wf01 Water sedge - Beaked sedge fen at OWL034 along the transmission line in 2020.

Plate 3.3-6. Wf01 Water sedge - Beaked sedge fen at OWL034 along the transmission line in 2022.

3.3.3 Marsh Overview

Eleven marshes were sampled in 2022 (Table 3.3-3) along the transmission line, comprising one wetland type (SE) and three site associations (Plates 3.3-7 to 3.3-12). Several of the marshes are bisected by temporary construction roads that are in various states of regeneration (patchy bare soil to high vegetation cover). Introduced species were generally limited and mostly occurred on the dry edges of the marshes and on construction roads and tower pads. Minor to moderate cattle use, including browsing and trampling, occurred in two of the marshes. The majority of the marshes had partial to complete removal of adjacent vegetation (trees and shrubs), with substantial shrub regeneration observed between 2020 and 2022.

Table 3.3-3. Summary of Marshes Sampled in 2022

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)[(a)]	Successional Status(es)[(a)]	Hydrology
Marsh	Wm01	SE	Beaked sedge - Water sedge	2	Graminoid	Disclimax	Permanently to Semi-permanently Flooded
	Wm03	SE	Awned sedge	8	Graminoid	Disclimax	Permanently to Semi-permanently Flooded

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)[a]	Successional Status(es)[a]	Hydrology
	Wm15	SE	Bluejoint - Beaked sedge	1	Graminoid	Disclimax	Permanently to Semi-permanently Flooded
Total				**11**			

(a) See Appendix A for structural stage and successional status descriptions.

Plate 3.3-7. Wm01 Beaked sedge - Water sedge marsh at WL073 along the transmission line in 2020.

Plate 3.3-8. Wm01 Beaked sedge - Water sedge marsh at WL073 along the transmission line in 2022.

Plate 3.3-9. Wm03 Awned sedge marsh at OWL070 along the transmission line in 2020.

Plate 3.3-10. Wm03 Awned sedge marsh at OWL070 along the transmission line in 2022.

Plate 3.3-11. Wm15 Bluejoint - Beaked sedge marsh at OWL011 along the transmission line in 2021.

Plate 3.3-12. Wm15 Bluejoint - Beaked sedge marsh at OWL011 along the transmission line in 2022.

3.3.4 Shallow Open Water Overview

Two shallow open water wetlands (OW wetland type) were assessed in 2022 along the transmission line (Table 3.3-4). Both of the OW communities were assessed as functional wetlands, with no apparent changes since the 2020 assessments (Plates 3.3-13 and 3.3-14).

Table 3.3-4. Summary of Shallow Open Water Sampled in 2022

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)[(a)]	Successional Status(es)[(a)]	Hydrology
Open Water	OW	OW	Shallow Open Water (unclassified)	2	Aquatic	NA	Permanently Flooded
Total				**2**			

(a) See Appendix A for structural stage and successional status descriptions.

Plate 3.3-13. Shallow Open Water at OWL001 along the transmission line in 2020.

Plate 3.3-14. Shallow Open Water at OWL001 along the transmission line in 2022.

3.3.5 Swamp Overview

Five swamps (WS wetland type) were sampled in 2022, comprising three site associations (Table 3.3-5). In general, significant shrub regeneration was observed in all of the disturbed swamps (Plates 3.3-15 to 3.3-18). The majority of the swamps were cleared and/or grubbed for construction, with the exception of OWL107 (Plates 3.3-19 to 3.3-20) which is located outside of the ROW. OWL053 is bisected by a permanent road built for construction. No new physical disturbances were noted, while cattle use and introduced species cover was variable.

Table 3.3-5. Summary of Swamps Sampled in 2022

Wetland Class	Site Association	Wetland Type	Description	No. Sampled	Structural Stage(s)[(a)]	Successional Status(es)[(a)]	Hydrology
Swamp	Ws00	WS	Swamp (unclassified)	2	Low Shrub, Tall Shrub	Young Seral, Secondary Seral	Seasonally to Intermittently Flooded
	Ws05	WS	MacCalla's willow - Beaked sedge	2	Tall Shrub	Young Seral	Seasonally to Intermittently Flooded
	Ws07	WS	Spruce - Common horsetail - Leafy moss	1	Old Mixed Forest	Old Climax	Permanently to Semi-permanently Flooded
Total				**5**			

(a) See Appendix A for structural stage and successional status descriptions

Plate 3.3-15. Ws00 Unclassified swamp at OWL030 along the transmission line in 2020.

Plate 3.3-16. Ws00 Unclassified swamp at OWL030 along the transmission line in 2022.

Plate 3.3-17. Ws05 MacCalla's willow - Beaked sedge swamp at OWL032 along the transmission line in 2020.

Plate 3.3-18. Ws05 MacCalla's willow - Beaked sedge swamp at OWL032 along the transmission line in 2022.

Plate 3.3-19. Ws07 Spruce - Common horsetail - Leafy moss swamp at OWL107 along the transmission line in 2020.

Plate 3.3-20. Ws07 Spruce - Common horsetail - Leafy moss swamp at OWL107 along the transmission line in 2022.

3.4 Floristic Quality Index

Each of the 2022 wetlands (excluding OW wetlands that are not suitable for monitoring using the FQI process) was assessed for species richness, distribution of coefficient of conservatism (CC) values, percentage of wetland indicator species, percentage of non-native species, and FQI score. The data for the 2020/21 wetlands are shown for reference.

3.4.1 Species Richness

Species richness was calculated for each wetland assessed in 2020/21 and 2022 individually (Figure 3.4 1) and then the data were combined, with average species richness calculated for each wetland type (Figure 3.4-2).

Species richness varied between individual wetlands and between monitoring years (Figure 3.4-1). In general, species richness appears to be higher in swamps than in fens, marshes, and bogs, although the difference may be small (Figure 3.4-2).

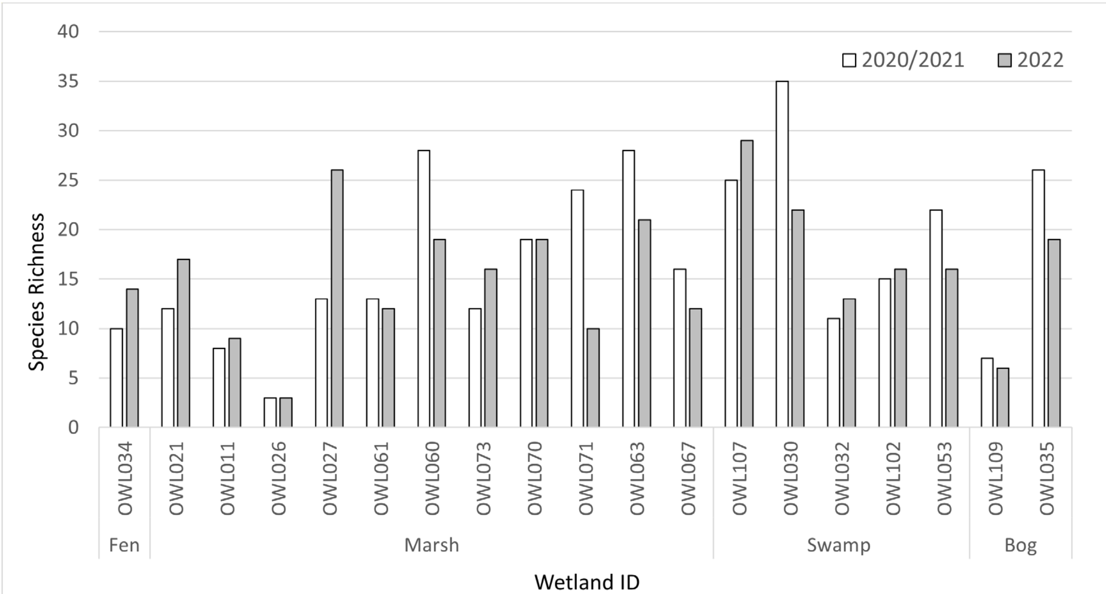


Figure 3.4-1. Individual Species Richness for Each Wetland Assessed in 2020/21 and 2022

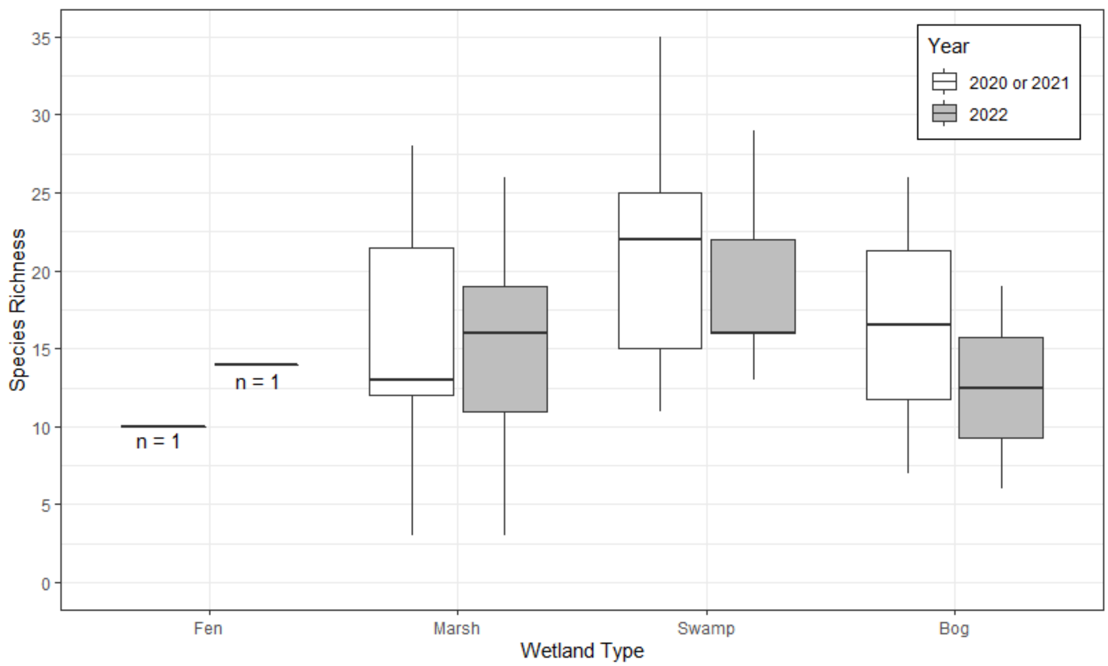


Figure 3.4-2. Comparison of Species Richness by Wetland (2020/21 and 2022)[2]

[2] For each boxplot, the horizontal line is the median, the box is the 25th-75th percentile, and the vertical whiskers indicate the range of the data. Points that are beyond the whisker are outliers.

3.4.2 Coefficient of Conservatism Values

The distribution of CC values assigned to the vegetation species found in each wetland type was plotted for 2020/21 and 2022 (Figures 3.4-3 to 3.4-6). The distribution of CC values within each wetland type was relatively similar between 2020/2021 and 2022. None of the wetlands contained species with CC values above seven. Out of all the wetland types, marshes had the highest frequency of vegetation species with a CC value of zero.

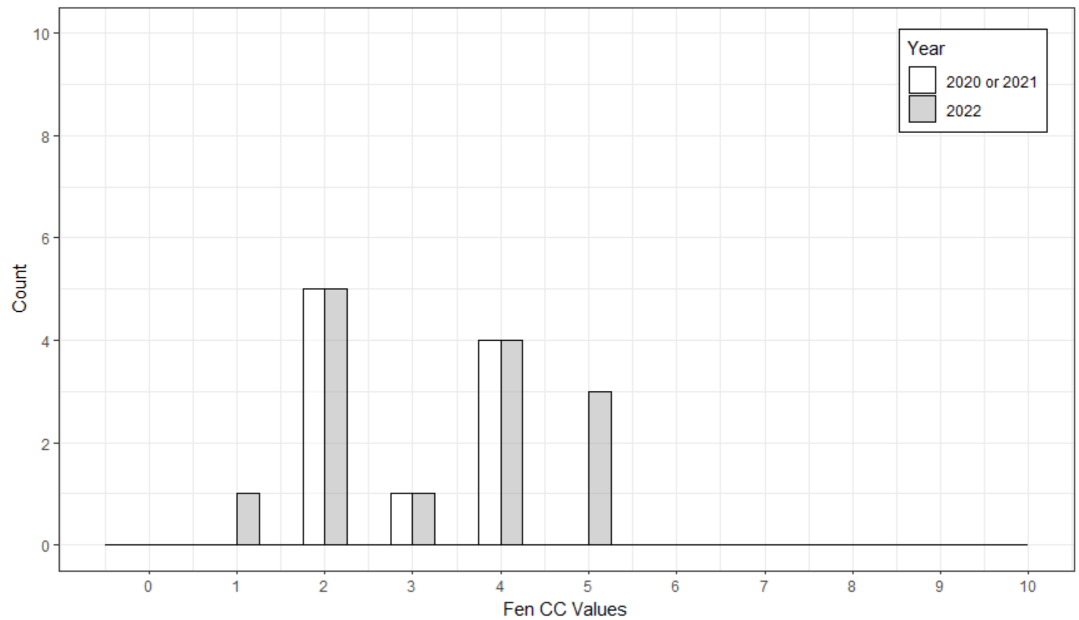


Figure 3.4-3. Coefficient of Conservatism Value Distribution for Fens Assessed in 2020/21 and 2022

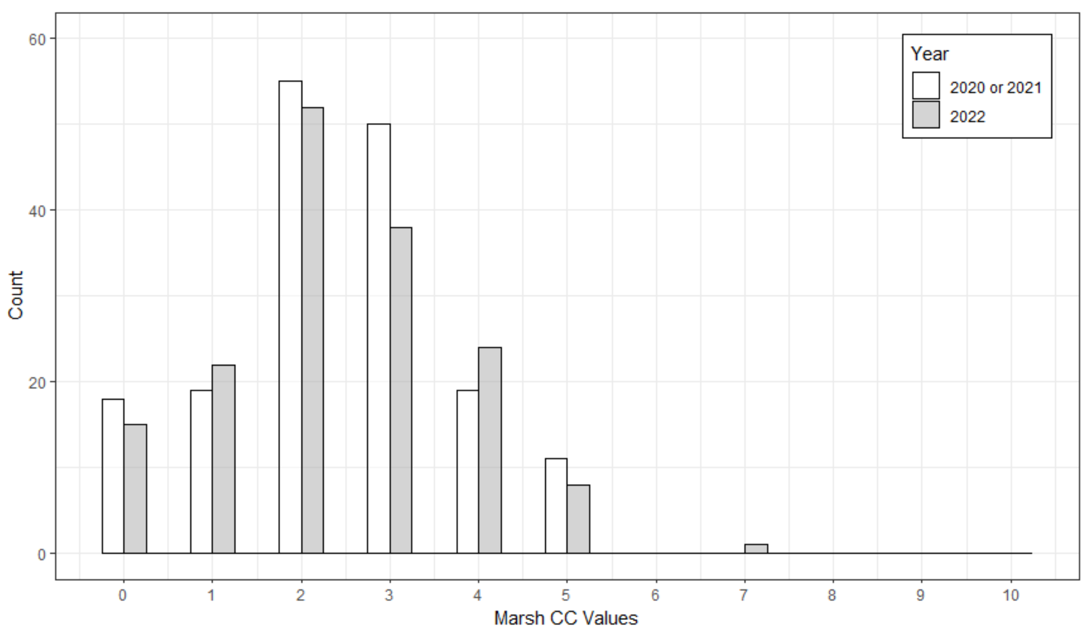


Figure 3.4-4. Coefficient of Conservatism Value Distribution for Marshes Assessed in 2020/21 and 2022

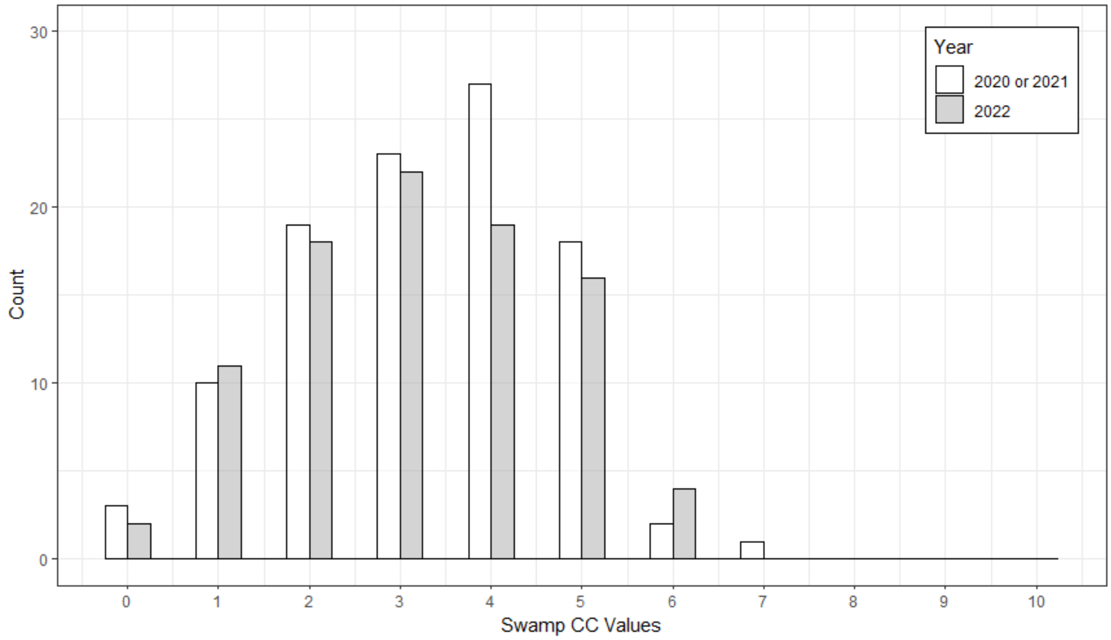


Figure 3.4-5. Coefficient of Conservatism Value Distribution for Swamps Assessed in 2020/21 and 2022

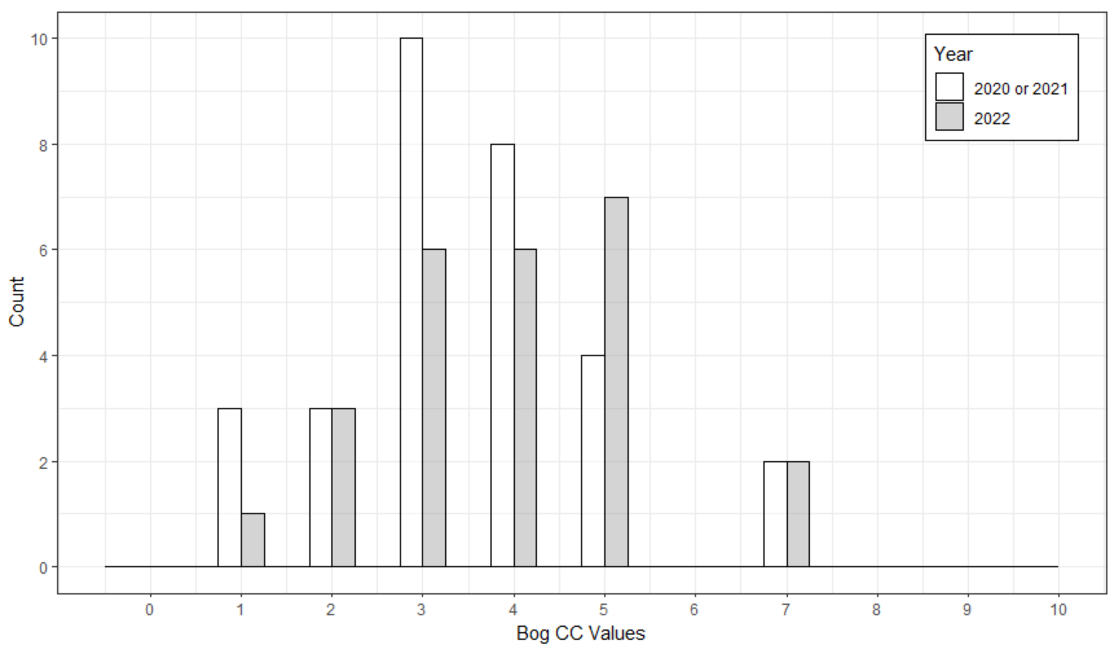


Figure 3.4-6. Coefficient of Conservatism Value Distribution for Bogs Assessed in 2020/21 and 2022

3.4.3 Wetland Indicator Species

The percentage of wetland indicator species of all species identified during the 2020/21 and 2022 assessments was calculated for each wetland individually (Figure 3.4-7) and then the data were combined and plotted by wetland type (Figure 3.4-8).

The percentage of wetland indicator species varied between individual wetlands and between monitoring years (Figure 3.4-7). All four wetland types had relatively high percentages of wetland indicators in both years (Figure 3.4-8). Swamps were the only wetland type that had a median percentage of wetland indicators at or below 75% for both years.

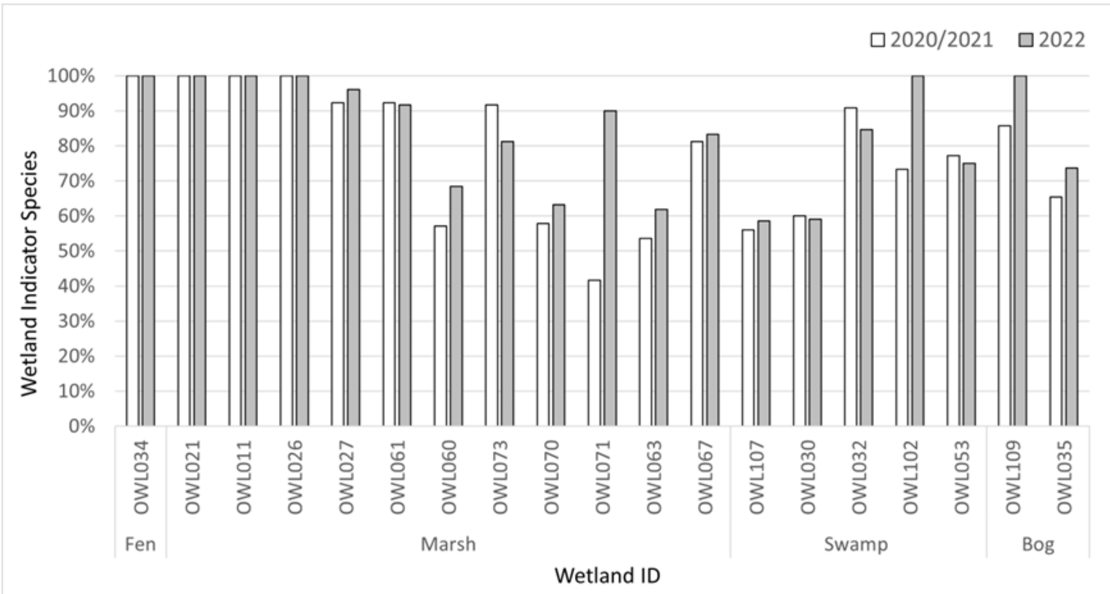


Figure 3.4-7. Percentage of Wetland Indicator Species Identified for Each Wetland Assessed in 2020/21 and 2022

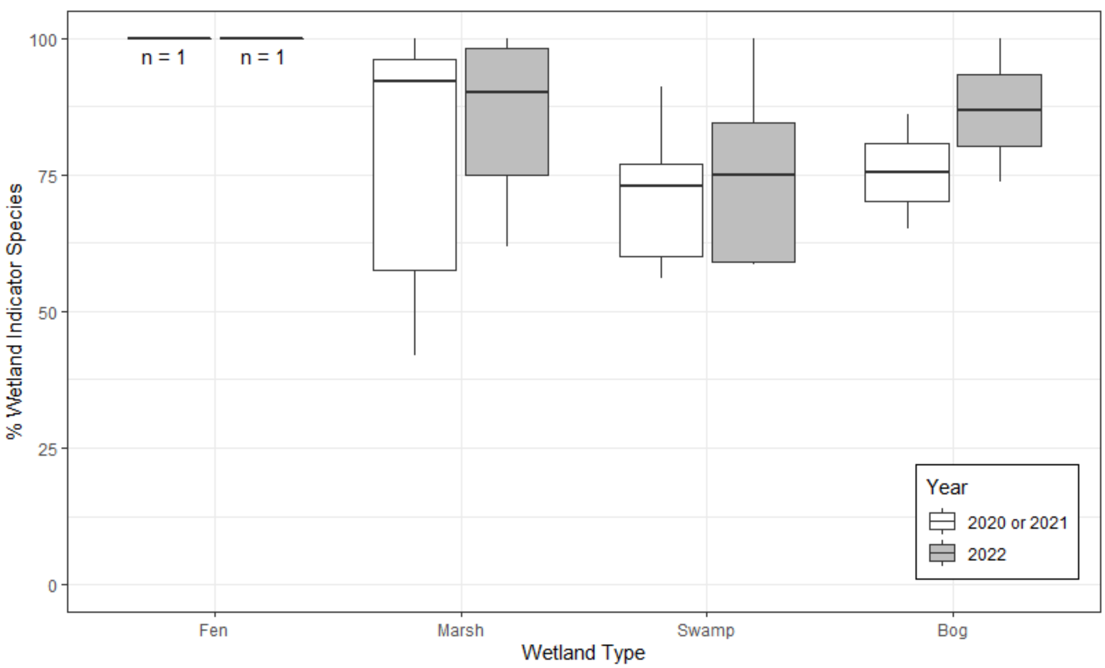


Figure 3.4-8. Comparison of Wetland Indicator Species by Wetland Type (2020/21 and 2022)

3.4.4 Non-Native Vegetation Species

The percentage of non-native vegetation species identified during the 2020/21 and 2022 assessments was calculated for each wetland individually (Figure 3.4-9) and then the data were combined and plotted by wetland type (Figure 3.4-10).

Non-native vegetation species were detected in eight of the 19 wetlands, including at six of the marshes (Figure 3.4-9). The median percentage of non-native vegetation species in fens, marshes, swamps, and bogs remained low (less than 5%) across both monitoring years (Figure 3.4-10).

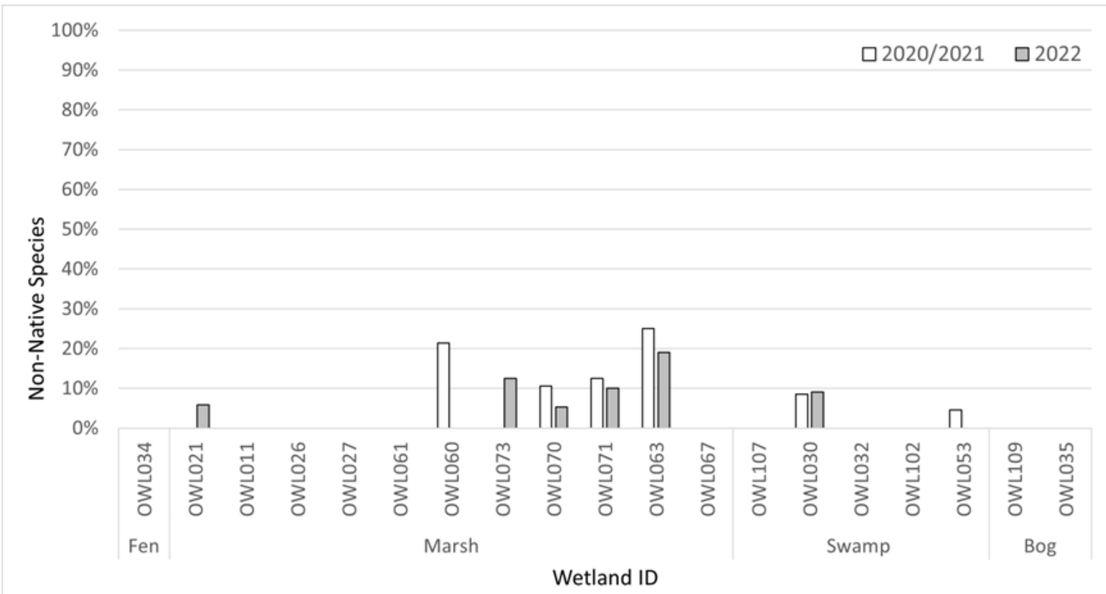


Figure 3.4-9. Percentage of Non-native Vegetation Species Identified for each Wetland (2020/21 and 2022)

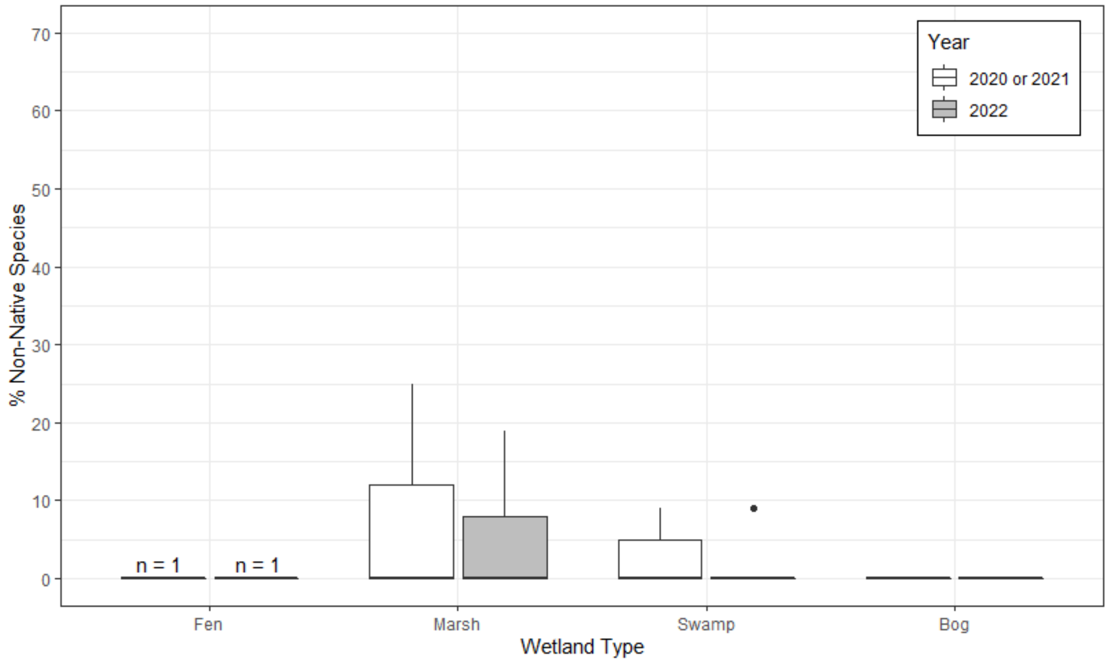


Figure 3.4-10. Comparison of Non-native Species by Wetland (2020/21 and 2022)

3.4.5 FQI Score

FQI scores were calculated for each wetland assessed in 2020/21 and 2022 individually (Figure 3.4-11) and then the data were combined and plotted by wetland type (Figure 3.4-12).

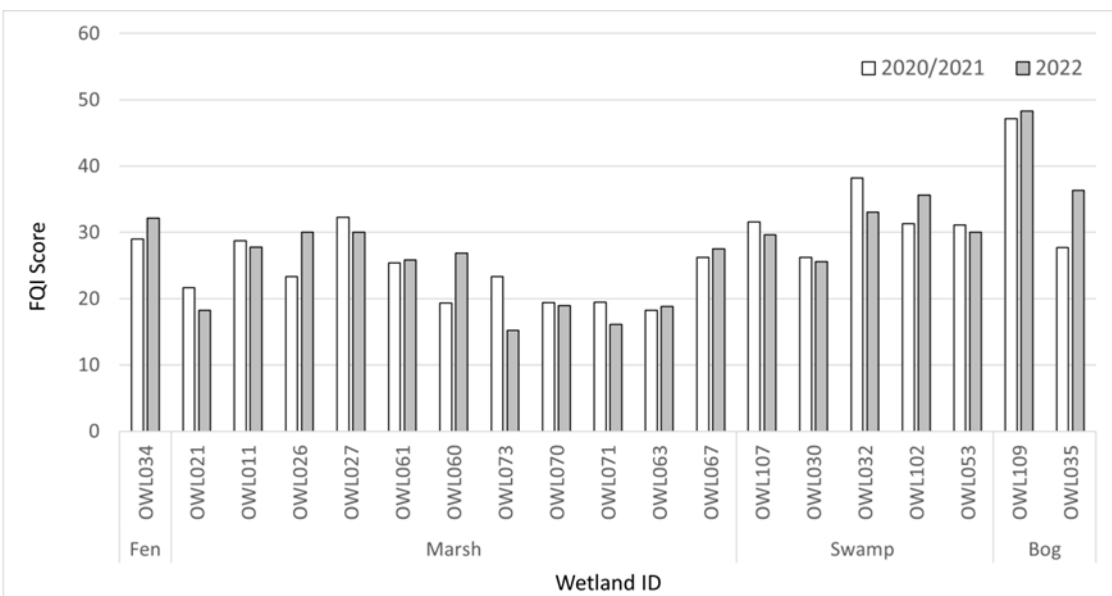


Figure 3.4-11. Individual FQI Scores for Each Wetland Assessed in 2020/21 and 2022

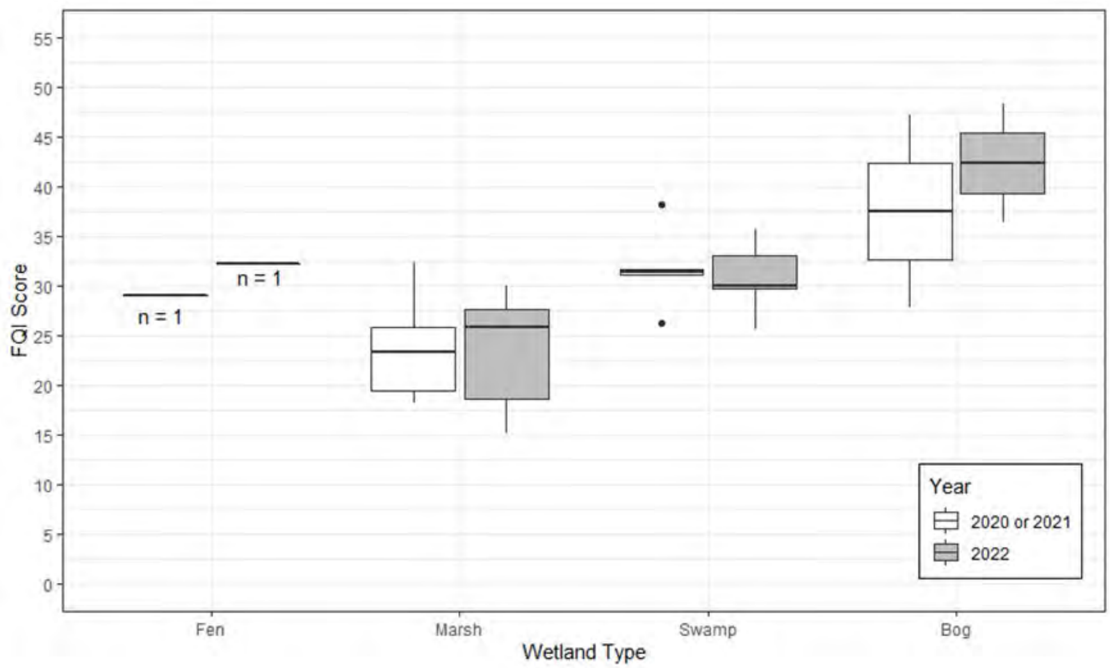


Figure 3.4-12. Comparison of FQI Scores by Wetland Type (2020/21 and 2022)

Individual FQI scores varied slightly between individual wetlands and between monitoring years (Figure 3.4-11). The median FQI scores are generally consistent between 2020/2021 and 2022 for all of the wetland types. Overall, bogs had the highest median FQI score, and marshes had the lowest median FQI score (Figure 3.4-12).

3.4.6 FQI Discussion

Due to the small sample size of wetlands monitored in 2022, and the sample size imbalance between wetland types (e.g., n=1 for fens and n=11 for marshes), patterns in FQI data cannot be identified with any confidence at the present time. Conclusions about patterns among monitoring years or wetland types will be made when the data from all monitoring years are pooled and undergo appropriate statistical analyses.

Overall, the results of the data analysis illustrated that the vegetation communities at the monitored wetlands were relatively consistent between 2020/2021 and 2022. Slight variations in species richness, distribution of CC values, percentage of wetland indicator species, and percentage of non-native vegetation species between the two monitoring years are expected for wetland vegetation communities. Variations could be due to a number of factors, including differing weather patterns, wetland water levels, anthropogenic or project-related impacts, survey timing, and placement of quadrat locations.

Non-native vegetation species were detected in eight of the 19 wetlands, including six of the marshes. Marshes are more susceptible to establishment of non-native plants because marsh wetlands have more bare ground available for weed establishment as compared to swamps, fens, and bogs. In addition, marshes typically have less canopy cover, creating sunny conditions which are favorable for many weedy, non-native species, as compared to shady environments.

Species richness is not always the best indicator of a healthy wetland, as richness can easily be influenced by establishment of non-native or weedy vegetation species. There are a number of naturally occurring wetland vegetation communities with characteristically lower species richness that would still be considered healthy, intact, late succession wetland vegetation communities (e.g., poor fens). To adjust for the nuances that come with vegetation species richness in wetlands, we compared the distribution of CC values assigned to the vegetation species identified within the wetland types (Figure 3.4-3 to 3.4-6). Based on the two years of data available, bogs, swamps and fens appear to have more species that don't tolerate disturbance and are found in advanced stages of succession (higher CC values) compared to marshes.

FQI was found to be the highest in bogs and lowest in marshes; these FQI scores are expected because bogs often contain a unique combination of plant species that are adapted to the acidic, nutrient-poor, water level stable conditions typical of bogs (e.g., a number of *Vaccinium* and *Drosera* species are often restricted to bogs; Mackenzie and Moran 2004). In addition, bog vegetation is often very slow-growing, intolerant of disturbances and can easily be outcompeted if conditions, such as water level, change. Marshes on the other hand, have a higher potential for non-native species, and often contain native species that are less specialized, more tolerant of disturbance and changing conditions, and are often found in other environments.

4. SUMMARY OF WETLAND SAMPLING: 2016–2022

A total of 128 wetlands within the PAZ have been assessed since the beginning of the Program in 2016 (Table 4-1). Starting in 2018, with the development of a standard methodology (NPS 2020), wetlands surveyed in 2016 and 2017 were re-sampled so that all data were collected in a consistent manner.

Table 4-1. Summary of Wetland Sampling (2016-2022)

General Location	Pre-NPS Methodology		Baseline and/or Construction Monitoring				
	2016	2017	2018	2019	2020	2021	2022
Downstream	-	-	-	5	-	5	-
Transmission Line	53	-	21	37	40	40	21
Reservoir	3	6	36	7	-	-	-
Total	**56**	**6**	**57**	**49**	**40**	**45**	**21**

Since 2018, all wetland sampling has been completed as per the *BC Hydro Site C Vegetation and Wildlife Wetland Monitoring Program: Baseline and Construction Phase Wetland Monitoring* (Appendix D of NPS 2020). The use of a current and standardized methodology allows for detailed classification of each wetland to the provincial Site Association level (Table 4-2). All wetlands assessed beyond 2021 will fall under the Construction Phase Monitoring portion of the project.

Table 4-2. Baseline and Construction Monitoring Wetlands Sampled from 2018 to 2022

Wetland Class	Site Association	Vegetation Community	No. Sampled				
			2018	2019	2020	2021	2022
Reservoir Footprint							
Bog	Wb06	Tamarack – Water sedge – Fen moss	1				
Fen	Wf00	Fen (unclassified)	1				
Swamp	Ws00	Swamp (unclassified)	4				
	Ws02	Mountain alder – Pink spirea – Sitka sedge		1			
	Ws05	MacCalla's willow – Beaked sedge	1				
	Ws15	SwSb – Labrador tea – Glow moss	1				
Marsh	Wm00	Marsh (unclassified)	1				
	Wm02	Swamp horsetail – Beaked sedge	1				
	Wm03	Awned sedge	2				
	Wm04	Common spike-rush	1				
	Wm05	Cattail	1				

Wetland Class	Site Association	Vegetation Community	No. Sampled				
			2018	2019	2020	2021	2022
	Wm06	Great bulrush	1				
Open Water	OW	Shallow Open Water (unclassified)	1				
Floodplain	Fl00	Low bench floodplain (unclassified)	8	1			
	Fl03	Pacific willow – Red-osier dogwood – Horsetail	1	1			
	Fl06	Sandbar willow	4	4			
	Fm00	Mid bench floodplain (unclassified)	2				
	Fm02	Cottonwood – Spruce – Red-osier dogwood	5				
		Reservoir Footprint Total	***36***	***7***	***0***	***0***	
Downstream							
Swamp	Ws02	Mountain alder – Pink spirea – Sitka sedge		1		1	
Floodplain	Fl00	Low bench floodplain (unclassified)		2		2	
	Fl06	Sandbar willow		2		2	
		Downstream Total		***5***		***5***	
Transmission Line							
Bog	Wb03	Black spruce – Lingonberry – Peat-moss	1	6	1	6	
	Wb05	Black spruce – Water sedge – Peat-moss	1		2		1
	Wb06	Tamarack – Water sedge – Fen moss	3	7	4	7	
	Wb08	Black spruce – Soft-leaved sedge – Peat-moss		7		7	
	Wb09	Black spruce – Common horsetail – Peat-moss			1		1
Fen	Wf01	Water sedge – Beaked sedge		3	1	3	1
	Wf02	Scrub birch – Water sedge	2	1	2	1	
Swamp	Ws00	Swamp (unclassified)	1		2		2
	Ws03	Bebb's willow – Bluejoint		1	2	1	
	Ws04	Drummond's willow – Beaked sedge	1				
	Ws05	MacCalla's willow – Beaked sedge			3		2
	Ws06	Sitka willow – Sitka sedge	1				
	Ws07	Spruce – Common horsetail – Leafy moss	1		2		1
	Ws14	Mountain Alder – Bebb's Willow – Bluejoint	2		2		
Marsh	Wm00	Marsh (unclassified)		1	1	1	
	Wm01	Beaked sedge – Water sedge	4	3	5	4	2
	Wm02	Swamp horsetail – Beaked sedge	1	1		1	
	Wm03	Awned sedge	1	4	8	5	8

Wetland Class	Site Association	Vegetation Community	No. Sampled 2018	2019	2020	2021	2022
	Wm05	Cattail	2		2		
	Wm15	Bluejoint – Beaked sedge		2		3	1
Open Water	OW	Shallow Open Water (unclassified)		1	2	1	2
		Transmission Line Total	***21***	***37***	***40***	***40***	***21***
		Grand Total	**57**	**49**	**40**	**45**	**21**

5. WETLAND SAMPLING PLAN: 2022–2027

As per *BC Hydro Site C Vegetation and Wildlife Wetland Monitoring Program: Baseline and Construction Phase Wetland Monitoring* (NPS 2020), wetlands are sampled two years after the initial baseline assessment, then every five years after that for up to 30 years of project operations, or when no additional changes are detected.

A summary of the total number of wetlands that have been sampled to date are presented in Table 5-1. This includes: 1) wetlands that have been re-assessed after the baseline visit; and 2) the expected number of wetlands to be sampled from 2025 to 2027. The first year that the five-year monitoring assessments will be completed for all wetlands in the study will be 2027.

Table 5-1. Summary of Wetlands Sampled from 2016 to 2021 and Planned Monitoring for 2021 to 2027

General Location	Pre-NPS Methodology		Baseline and/or Construction Monitoring			Construction Monitoring			Operation Monitoring			
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Downstream	-	-	-	5	-	5	-	-	-	-	5	-
Transmission Line	53	-	21	37	40	40	21	-	-	20	38	21
Reservoir	3	6	36	7	-	-	-	-	-	-	-	-
Total	**56**	**6**	**57**	**49**	**40**	**45**	**21**	**0**	**0**	**20**	**43**	**21**

The specific wetland sites that were sampled from 2016 to 2022, and those that will be sampled from 2023 to 2027, are presented in Table 5-2. Wetlands located within the reservoir area are not included in the construction and operation monitoring, as they will be inundated as the reservoir is filled. OWL110 was removed from the sampling plan as there is no safe access across a floating bog to the OW site.

Table 5-2. Wetlands Sampled from 2016 to 2022 and Planned Construction Monitoring for 2023 to 2027

General Location	Site	Pre-NPS Methodology				Baseline and/or Construction Monitoring				Operation Monitoring			
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Downstream	WL203				x		x					x	
	WL204				x		x					x	
	WL205				x		x					x	
	WL206				x		x					x	
	WL207				x		x					x	
Reservoir	WL001			x									
	WL002	x		x									
	WL003			x									
	WL004	x		x									

General Location	Site	Pre-NPS Methodology				Baseline and/or Construction Monitoring				Operation Monitoring			
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Reservoir (cont'd)	WL005			x									
	WL006	x		x									
	WL007			x									
	WL008			x									
	WL009			x									
	WL010			x									
	WL011			x									
	WL012			x									
	WL013			x									
	WL014			x									
	WL015			x									
	WL016			x									
	WL017			x									
	WL018			x									
	WL019			x									
	WL022			x									
	WL023			x									
	WL024			x									
	WL025			x									
	WL026			x									
	WL027			x									
	WL028			x									
	WL029			x									
	WL030			x									
	WL031			x									
	WL032			x									
	WL033			x									
	WL034			x									
	WL035			x									
	WL036			x									
	WL037			x									
	WL038			x									
	WL208				x								
	WL209				x								

General Location	Site	Pre-NPS Methodology				Baseline and/or Construction Monitoring				Operation Monitoring			
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Reservoir (cont'd)	WL210				x								
	WL211				x								
	WL212				x								
	WL213				x								
	WL214				x								
Transmission Line	BR2				x		x					x	
	MWL02	x			x		x					x	
	MWL08	x			x		x					x	
	MWL09	x			x		x					x	
	MWL10	x			x		x					x	
	MWL12	x			x		x					x	
	MWL13	x			x		x					x	
	MWL14	x			x		x					x	
	MWL18	x			x		x					x	
	MWL19	x			x		x					x	
	MWL33	x			x		x					x	
	MWL58	x			x		x					x	
	MWL59	x			x		x					x	
	MWL62	x			x		x					x	
	MWL69	x			x		x					x	
	MWL72	x			x		x					x	
	OWL001	x				x		x					x
	OWL011	x					x	x					x
	OWL021	x				x		x					x
	OWL026	x				x		x					x
	OWL027	x				x		x					x
	OWL030	x				x		x					x
	OWL032	x				x		x					x
	OWL034	x				x		x					x
	OWL035	x				x		x					x
	OWL053	x				x		x					x
	OWL060	x				x		x					x
	OWL061	x					x	x					x
	OWL063	x				x		x					x

General Location	Site	Pre-NPS Methodology				Baseline and/or Construction Monitoring				Operation Monitoring			
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Transmission Line (cont'd)	OWL067	x				x		x					x
	OWL070	x				x		x					x
	OWL071	x				x		x					x
	OWL073	x				x		x					x
	OWL102		x			x		x					x
	OWL103		x			x		x					x
	OWL107		x			x		x					x
	OWL109		x			x		x					x
	OWL110		x			x							
	PI1				x		x					x	
	PI2				x		x					x	
	PI4				x		x					x	
	PR				x		x					x	
	WL020	x		x		x					x		
	WL021	x		x		x					x		
	WL100			x		x					x		
	WL101	x		x		x					x		
	WL102	x		x		x					x		
	WL103	x		x		x					x		
	WL104	x		x		x	x					x	
	WL105	x		x		x					x		
	WL106	x		x		x					x		
	WL107			x		x					x		
	WL108	x		x		x					x		
	WL109			x		x					x		
	WL110			x		x					x		
	WL111			x		x					x		
	WL112			x		x					x		
	WL113			x		x					x		
	WL114			x		x					x		
	WL115	x		x		x					x		
	WL116	x		x		x					x		
	WL117		x	x		x					x		
	WL118	x		x		x					x		

General Location	Site	Pre-NPS Methodology				Baseline and/or Construction Monitoring				Operation Monitoring			
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Transmission Line (cont'd)	WL200				x		x					x	
	WL201				x		x					x	
	WL202	x			x		x					x	
	WL215	x			x		x					x	
	WL216				x		x					x	
	WL217				x		x					x	
	WL218	x			x		x					x	
	WL219	x			x		x					x	
	WL220	x			x		x					x	
	WL221	x			x		x					x	
	WL222				x		x					x	
	WL223				x		x					x	
	WL224	x			x		x					x	
	WL225	x			x		x					x	
	WL226				x		x					x	
	WL228	x			x		x					x	
	WL229				x		x					x	

REFERENCES

Alberta Sustainable Resource Development (ASRD). 2003. *Ecological Land Survey Site Description Manual* (2nd edition). Edmonton, AB.

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

B.C. Conservation Data Centre. 2020. BC Species and Ecosystems Explorer. B.C. Ministry of Environment, Victoria B.C. Available: http://a100.gov.bc.ca/pub/eswp.

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

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

BC Wildlife Federation. 2018. Floristic Quality Index for Eastern British Columbia, Canada – East of Cascade Mountains.

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

Civi Corp Pty Limited. 2021. Solocator [Mobile app]. Available at https://solocator.com.

Cretini, K.F., and Steyer, G.D. 2011. Floristic Quality Index: An Assessment Tool for Restoration Projects and Monitoring Sites in Coastal Louisiana. U.S. Department of the Interior and U.S. Geological Survey.

DeLong, C., A. Banner, W. H. MacKenzie, B. J. Rogers, and B. Kaytor. 2011. *A field guide to ecosystem identification for the Boreal White and Black Spruce Zone of British Columbia*. Land Management Handbook 65. BC Ministry of Forests.

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

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

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

Native Plant Solutions (NPS). 2020. BC *Hydro Site C Vegetation and Wildlife Wetland Monitoring Program: Baseline and Construction Phase Wetland Monitoring*. Prepared for BC Hydro: February 2020. 115pp.

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

United States Department of Agriculture (USDA). 2020. Natural Resource Conservation Service Plants Database. Available at: https://plants.sc.egov.usda.gov/java.

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

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

APPENDIX A. DEFINITION OF STRUCTURAL STAGES AND SUCCESSIONAL STATUS CODES

Structural stage codes and structural stage modifiers are used to describe the vegetation structure and appearance in each ecosystem unit. Structural stage codes describe the relative age of a given ecosystem (i.e., shrub-dominated vs. old-growth forest) while the modifiers are used to provide additional descriptions of structural stages (BC MOE and MOF 2010). Note that while the successional status has been included in the summary tables for each wetland class, it has been loosely applied as the codes used to describe successional status in British Columbia were developed for forested communities and are not directly applicable to non-forested wetlands.

Structural Stage

Structural Stage	Description
Post-disturbance stages or environmentally induced structural development	
1 Sparse/bryoid	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance less than 20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover less than 20%; total tree layer cover less than 10%.
1a Sparse	Less than 10% vegetation cover.
Stand initiation stages or environmentally induced structural development	
2 Herb	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover less than 10%, shrub layer cover less than or equal to 20% or less than 1/3 of total cover, herb-layer cover greater than 20%, or greater than or equal to 1/3 of total cover; time since disturbance less than 20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
2a Forb-dominated	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid-dominated	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
3 Shrub/Herb	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover less than 10%, shrub layer cover greater than 20% or greater than or equal to 1/3 of total cover.
3a Low shrub	Communities dominated by shrub layer vegetation less than 2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 20 years for normal forest succession.
3b Tall shrub	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
Stem exclusion stages	

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

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

Structural Stage Modifiers

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

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

Stand Composition Modifiers

Modifier	Description
C - coniferous	Greater than 3/4 of total tree layer cover is coniferous.
B - broadleaf	Greater than 3/4 of total tree layer cover is broadleaf.
M - mixed	Neither coniferous nor broadleaf account for greater than 3/4 of total tree layer cover.

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

Successional Status

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

Appendix 6. Pre-construction Rare Plant Surveys 2022 Annual Report

2022 Annual Report

Pre-construction Rare Plant Surveys

Site C Clean Energy Project

Prepared by:

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

Prepared for:

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

January 30, 2023

Contents

1. INTRODUCTION

1.1. Background

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

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

In addition, the Federal Decision Statement (FDS) 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 FDS conditions 16.1, 16.2, 16.3.3, 16.3.4, 16.3.6 and 16.3.7, BC Hydro is conducting preconstruction rare plant surveys in previously unsurveyed areas of the proposed transmission line, access roads, and other construction corridors. 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 pre-construction rare plant surveys are added to the Project's spatial environmental features database. These spatial data are 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, and the work has been proceeding every year since. This interim report documents the methods and results of the surveys completed from 2015 through the end of the 2022 field season.

1.2. Scope

The goals of the study are:

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

1.3. Study Area

Pre-construction rare plant surveys are being conducted in:

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

Pre-construction rare plant surveys were completed for some of these areas during the 2015 through 2021 field seasons. The 2022 work focussed on the remaining segments of Highway 29 realignment corridors on the north side of the Peace River, access roads on the south side of the Peace River, and on the Del Rio proposed aggregate extraction site.

2. Methods

2.1. Pre-field Review

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

For the purpose of the investigation, “rare plants” are defined as 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 2021); and
- species on the B.C. MOECCS' provincial Red or Blue lists (BCCDC 2022a).

Since 2005, BC Hydro has been conducting rare plant surveys in the Project's Regional Assessment Area (RAA)—as defined in the Site C Environmental Impact Statement (Hilton et al. 2013). As such, much is known about the rare flora of the area, and the pre-field review is based heavily on rare plant occurrence data collected over the last 17 years. Currently, 24 different rare plant taxa are reported to occur in the Project area. Consequently, these 17 vascular plants, four lichens, and three mosses form the basis of the target species list for the work, comprising the rare species with the highest likelihood of occurrence.

Since 2011 all rare plant data for the Project are managed in a master rare plant spatial database. This database contains occurrence information for all known rare plant sites in the RAA, as well as rare plant survey tracks, field notes, species information, and other collected data relevant to the rare plant work. Periodically, the master rare plant spatial database is queried to update the Project's spatial environmental features database (separately maintained by BC Hydro). This environmental features database is made available to Project engineers for use in mitigation planning.

In order to identify additional rare plant species that could potentially occur in the Project area, each year the dataset of all B.C. vascular plants, mosses, and lichens is downloaded from the MOECCS' Species and Ecosystem Explorer (BCCDC 2022a). Queries are run on the dataset to extract a list of the rare plant species that MOECCS associates with the Peace River Regional District and the Boreal Black and White Spruce Biogeoclimatic Zone. Each species on this list is further reviewed to determine its potential for occurrence within the areas targeted for survey.

In addition, the B.C. Conservation Data Centre's (BCCDC) occurrence dataset of all species and ecosystems at risk (BCCDC 2022b) is downloaded from the B.C. Data Catalogue and added to the master rare plant spatial database. The dataset is queried to investigate historic and verified extant rare plant occurrences within the Project area.

All the above information is compiled to produce a list of target rare plant species potentially occurring within the Project area. This target list includes the 24 taxa currently reported to occur in the Project area, as well as numerous other possible Peace Region species uncovered during the pre-field review of data and literature. The target list is used as a working guideline and can never be an exhaustive list of all potential rare plants for a given area. For this reason, the botanists consider all described plant taxa while conducting surveys.

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

To refine their search images for the target taxa, the surveyors study photographs, herbarium specimens, and species descriptions in various published references (Hitchcock et al. 1955; Flora of North America Editorial Committee 1993; Goward et al. 1994; McCune et al. 1995; Douglas et al. 1998; Goward 1999;

Brodo et al. 2001; Welsh 2001; Cronquist et al. 2013; Brodo 2016) and online databases (CNALH 2021; Klinkenberg 2022; NatureServe 2022). In addition, they review similar data for species that might be confused with the target taxa. Tables of summary identification characteristics are prepared for field use. The goals are to maximize detectability of the target species and to reduce surveyor bias during the field work.

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

2.2. Field Survey

The pre-construction surveys began in June of 2015 and have taken place every year since. Over the eight field seasons, 337 surveyor-days have been spent surveying a total transect distance of 1,910.5 km (Table 1 and Figure 1).

Table 1: Rare Plant Survey Effort

Year	Start Date	End Date	Surveyor-Days	Total Survey Km
2015	June 30	September 7	42	209.8
2016	June 20	August 23	41	191.8
2017	June 23	August 12	12	51.7
2018	June 13	August 29	56	409.3
2019	May 31	August 15	46	250.7
2020	June 4	October 9	56	322.3
2021	June 8	September 4	44	318.3
2022	June 6	August 23	40	156.6
Totals			**337**	**1,910.5**

Table notes:

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

For all eight years, the surveys were performed by two senior-level rare plant botanists, both of whom have been working with the rare flora of the Project area for the past 12 years. The surveyors primarily use a habitat-directed meander search protocol to cover the areas surveyed. This survey technique is based on floristic, intuitive-controlled meander search types outlined in various rare plant survey guidelines (Whiteaker et al. 1998; ANPC 2000; ANPC 2012; Penny & Klinkenberg 2012; MOECCS Ecosystems Branch 2018). The surveyors, working together or separately, walk the length of the linear corridors, zig-zagging back and forth from one edge of the proposed disturbance area to the other. For non-linear survey areas such as the Industrial 85th Avenue or Portage Mountain sites, the surveyors conduct meander transects to cover the entire area.

When using the habitat-directed meander search protocol:

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

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

For certain linear corridors that traverse habitat with a low potential for rare plant occurrence, the botanists drive slowly along the corridor in a Utility Terrain Vehicle (UTV) or truck, scanning both sides for rare plants and pockets of high-suitability rare plant habitat. This procedure is only conducted in corridors where the majority of habitat is low-probability, and at a speed of approximately five kilometres per hour. If high-potential rare plant habitat is encountered—such as wetlands or rock outcrops—the surveyors exit the vehicle and survey the habitat on foot. In 2015, 5.1% of the total 209.8 km traversed was surveyed from UTV and the rest was walked. In 2016 only 0.9% of the total 191.8 km survey distance was covered by UTV. In 2017, none of the transects were surveyed by UTV. In 2018, 14.6% of the total 409.3 km was covered by UTV or truck, and in 2019, 2.3% of the total 250.7 km was covered by UTV. Likewise in 2020, 2.3% of the total 322.3 transect kilometres were surveyed in this way. No corridors were surveyed by UTV in 2021. In 2022, only 0.5 km were surveyed by UTV or truck.

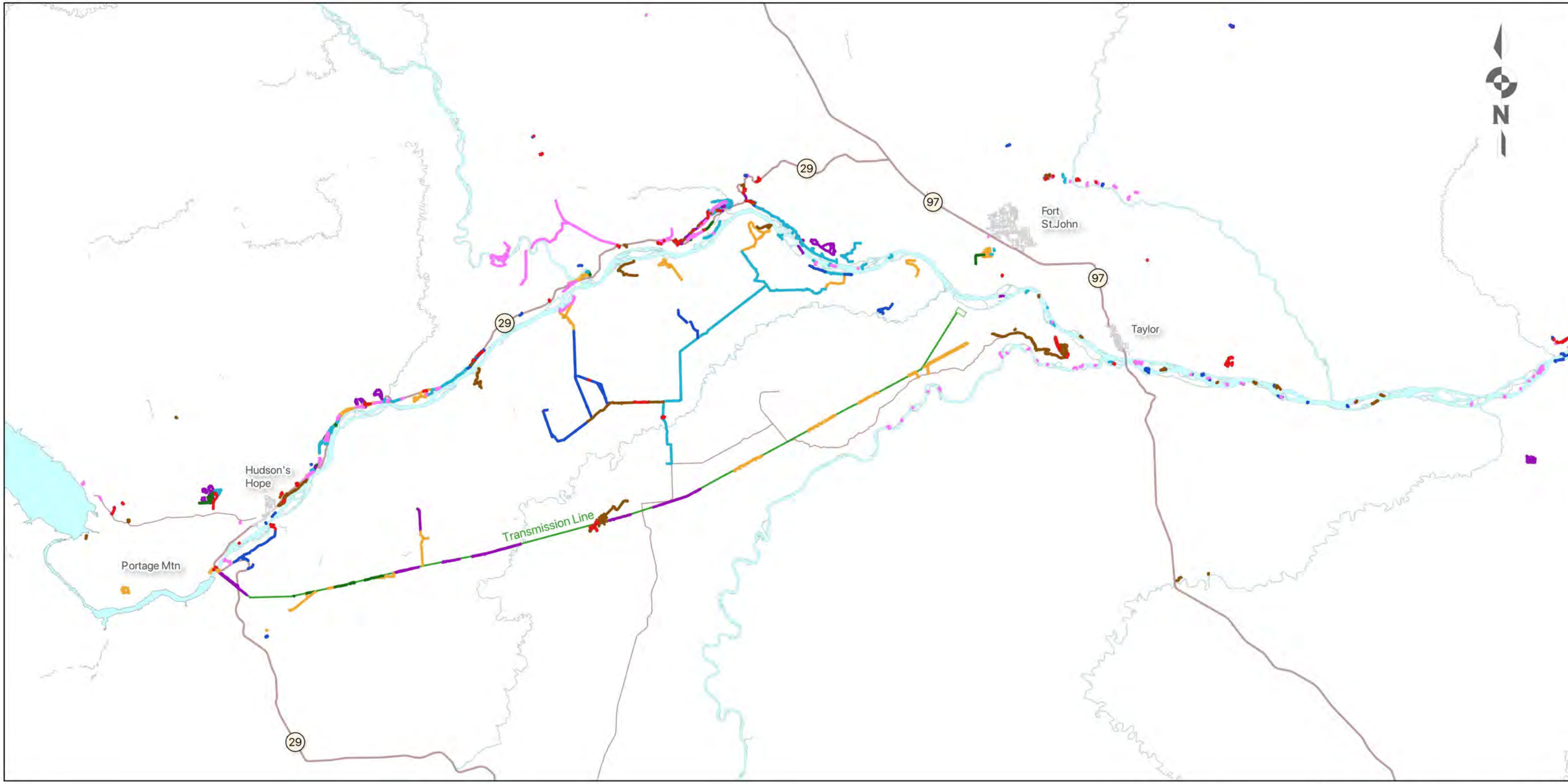
In 2016, surveys were conducted within the Rutledge and Wilder Creek mitigation parcels. These surveys were designed to provide a general overview of the rare plant populations present within the parcels, in order to inform mitigation planning. As such, these areas were surveyed at a lower intensity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

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

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

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

The botanists conducting the 2019 through 2022 preconstruction surveys were also working on the Site C Experimental Rare Plant Translocation program at the time, selecting and documenting potential recipient sites for translocation outplanting. When new rare plant sites were found during potential recipient site selection work, they were documented using the same methods as described above. All of the new rare plant sites found during the survey work for either program are reported here to provide a single document that contains all the new rare plant sites.



Map Notes:

1. Based on surveys completed through September 2022.
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.

Roads

- Highway
- Secondary
- Urban

Survey Transects

- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022

Map Scale 1:350000

0 10 20 30 km

SITE C CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING environmental consulting services

Figure 1
Rare Plant Survey Transects
2015 to 2022

Date	January 30, 2023	DWG NO	2022-12-11-001	Revision 1

2.3. Mitigation Planning and Implementation Assistance

In order to assist with mitigation efforts and determine Project effects to rare plant species, select known rare plant occurrences within the project activity zone are revisited during the course of the preconstruction survey work. The botanists note any impacts to these occurrences, predict upcoming threats, and look for mitigation opportunities to ameliorate adverse effects to the rare plants. This information is used to update the records in the Project rare plant database, assist with on-the-ground mitigation efforts, and provides decision makers with the information necessary to evaluate the threat statuses of the Project area rare plants.

In certain priority cases, where rare plant occurrences are situated in or near Project construction zones, the botanists work with BC Hydro planning teams and contractors to develop mitigation measures designed to reduce or eliminate impacts to the occurrences. This takes place on an as-needed basis in situations where a species is particularly difficult to identify in the field, or the layout of the occurrence is complex and difficult to map on the ground. The mitigation measures developed are focussed on avoidance or impact reduction, and include flagging occurrences in the field, coordinating with on-site construction personnel, and assisting rare plant salvage operations.

In addition, for one Red-listed species confirmed for the project area in 2018—*Selaginella rupestris* (rock selaginella)—a set of mitigation options was developed for all known occurrences in the RAA.

2.4. Analysis

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

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

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

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

- The master rare plant spatial database, which contains all rare plant data for the project, is a custom-built spatial database (PostgreSQL 13.8 spatially enabled with PostGIS 3.3). The database server software is regularly updated to the latest stable versions and all security patches are applied soon after issue.
- The tables in the database have been normalized to reduce data redundancy and improve integrity.
- Primary key constraints are enforced for all relational tables to improve database integrity and allow complex queries to be run.
- Fields are constrained at the database level to ensure type-consistency. Electronic input forms also constrain entered data to provide front-end validation and user guidance.
- Regular updates are pulled from the MOECCS' Ecosystem Explorer and are added to the master database to ensure that analyses are performed using the latest BCCDC rare plant statuses and nomenclature.
- The data fields *UTM northing*, *UTM easting*, *lat_long,* and *occurrence area* are calculated programmatically from the rare plant polygons, for accuracy of the derived fields. Point data are also derived programmatically from the rare plant polygons for locational consistency between the spatial fields.
- Multipolygons—a GIS feature class that allows one or more closed plane figures to be recorded for each occurrence—are used as the basic spatial descriptor for the rare plant occurrences recorded after 2008. This allows for more precise avoidance mitigation than would be possible using single polygons or points.
- Custom-built electronic forms are used by the botanists to enter rare plant data in the field while at the occurrence. Paper versions of the forms are also used in cases where there are difficulties with the electronic entry devices. In these cases, the paper forms are transcribed onto the electronic forms as soon as possible to allow for data validation.
- Every record is reviewed for typographical and transcription errors at the end of the field season.
- Associated species lists are reviewed by a second botanist to ensure identification accuracy.
- Rare plant polygons are reviewed on aerial imagery and ecosystem layers in the GIS to check boundary accuracy by the botanist(s) who recorded the occurrence.
- Voucher specimens are collected where appropriate and verified in the lab and herbarium, or are sent to species experts for further verification when taxonomic questions still exist.

3. Results

3.1. Pre-field Review

The 2022 pre-field review identified 103 rare plant taxa with potential for occurrence in the overall Project area (Appendix 1). The list comprises 38 vascular plant species, 48 bryophytes, and 17 lichens. As noted previously, this list was used for planning purposes and was not considered to be an exhaustive listing of all possible rare plant taxa in the project area. The surveyors considered all rare taxa during the surveys, whether they were on the target list or not.

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

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

In 2022, the status updates were published on July 21, after the field survey work was underway. Notably, *Oxytropis campestris* var. *davisii* (Davis' locoweed)—previously one of the principal target species for the rare plant program—was removed from the rare status lists. In addition, another species found in the Site C area—*Drymocallis arguta* (tall wood beauty)—was added to the BC Flora on the Blue list, indicating that the taxon was of conservation concern and therefore met the Project definition of a "rare plant" (BCCDC 2022a).

3.2. Field Survey

The 2015 field surveys found 34 new sites of 14 different rare plant species—11 vascular plants and three lichens. Some of these new sites were within one kilometre of other occurrences of the same species found in previous years, and so were considered to be extensions of these previously reported occurrences. Of the 14 rare species, five were on the MOECCS's Red list, with the remaining nine being on the Blue list. None of the taxa were listed on Schedule 1 of the Species at Risk Act, or were considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2021). Some of the rare taxa found in 2015 have since had their statuses revised and are no longer Red- or Blue-listed by MOECCS.

In 2016, 88 new sites of 13 different rare plant species were found—10 vascular plants and three lichens. As in 2015, some of the new sites were considered to be extensions of occurrences found in previous years. Of the 13 rare species found in 2016, five were on the B.C. Red list, while the remaining eight were on the Blue list. None of the 2016 taxa were listed on Schedule 1 of the Species at Risk Act, or were considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2021). As with the 2015 rare plant taxa, some of the 13 rare plant species found in 2016 are no longer Red- or Blue-listed by the MOECCS.

In 2017, three new sites of two different lichen species were found. One of the sites was considered to be an extension of a previously reported occurrence, and two were new occurrences. Both taxa found in 2017 were on the B.C. Blue list, however they have both since been removed. Neither was listed on Schedule 1 of the Species at Risk Act, or was considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2021).

For the 2018 field season, 46 rare plant sites were found. Several of these were extensions of previously known occurrences. Fourteen different rare plant taxa were found: four B.C. Red list, and 10 Blue list. None of the 14 were listed on Schedule 1 of the Species at Risk Act, or were considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2021). Several of the taxa documented in 2018 have since been removed from the B.C. Red/Blue lists.

In 2019, 21 occurrences of nine rare or formerly rare taxa were found or expanded. These 21 occurrences contained 47 separate patches. One of the taxa was on the B.C. Red list, six were on the Blue list, and two were on the Yellow list (*i.e.*, apparently secure) after being revised in July 2019 when the BCCDC status changes were published. None of the nine taxa were listed on Schedule 1 of the Species at Risk Act, or was considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2021).

During the 2020 field season, 22 rare plant occurrences (comprising 47 separate patches) were discovered or expanded. Nine rare plant species were documented: three Red-listed taxa and six Blue-listed taxa. None of the nine species 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 2021).

The 2021 field surveys discovered or expanded 19 occurrences (comprising 43 separate patches) of eight different rare vascular plant taxa: two B.C. Red-listed taxa, and six B.C. Blue-listed taxa. None of the eight species 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 2021).

In 2022, the field survey work documented 43 new, expanded, or reduced occurrences of nine different rare vascular plant taxa: two Red-listed species, and seven Blue-listed taxa (one of which was moved to the Yellow list when the BCCDC status update was published in July of 2022). The majority of these (25 occurrences) were newly documented tall wood beauty sites (the species that was Blue-listed by the BCCDC in the middle of the field season). As with previous years, none of the nine species 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 2021).

In total, 202 occurrences containing 437 patches of 30 currently or formerly listed rare plant taxa were discovered or expanded during the preconstruction surveys (Table 2 and Figure 2). Over the course of the eight survey years, the investigators recorded 700 vascular plant, bryophyte, and lichen taxa (Appendix 2).

Table 2: Rare plants found during the Site C Preconstruction surveys 2015 through 2022

Taxon	Common Name	Current BC List	Occurrences	Patches
Vascular Plants				
Artemisia herriotii	Herriot's sage	Yellow	7	24
Atriplex gardneri var. gardneri	Gardner's sagebrush	Red	2	3
Avenula hookeri	Spike-oat	Yellow	1	1
Calamagrostis montanensis	plains reedgrass	Yellow	5	14
Carex backii	Back's sedge	Yellow	4	11
Carex sprengelii	Sprengel's sedge	Blue	4	8
Carex torreyi	Torrey's sedge	Blue	7	12
Carex xerantica	dry-land sedge	Blue	14	31
Castilleja miniata var. fulva	tawny paintbrush	Yellow	1	1
Cirsium drummondii	Drummond's thistle	Yellow	4	13
Drymocallis arguta	tall wood beauty	Blue	25	56
Geum triflorum var. triflorum	old man's whiskers	Yellow	7	28
Juncus stygius var. americanus	bog rush	Yellow	1	1
Lomatium foeniculaceum var. foeniculaceum	fennel-leaved desert-parsley	Blue	2	2
Oxytropis campestris var. davisii	Davis' locoweed	Yellow	21	33
Pedicularis parviflora	small-flowered lousewort	Yellow	1	2
Penstemon gracilis	slender penstemon	Blue	13	38
Piptatheropsis canadensis	Canada ricegrass	Red	5	19
Polypodium sibiricum	Siberian polypody	Yellow	1	12
Potentilla pulcherrima	pretty cinquefoil	Yellow	4	9
Ranunculus rhomboideus	prairie buttercup	Blue	9	14
Salix petiolaris	meadow willow	Blue	1	1
Selaginella rupestris	rock selaginella	Red	7	13

Taxon	Common Name	Current BC List	Occurrences	Patches
Silene drummondii var. drummondii	Drummond's campion	Yellow	3	3
Sphenopholis intermedia	slender wedgegrass	Yellow	7	13
Symphyotrichum puniceum var. puniceum	purple-stemmed aster	Yellow	7	7
Lichens				
Physcia biziana	frosted rosette	Yellow	16	28
Physcia stellaris	immaculate rosette	Yellow	8	11
Ramalina sinensis	threadbare ribbon	Yellow	14	25
Usnea cavernosa	pitted beard	Yellow	1	4

Table notes:

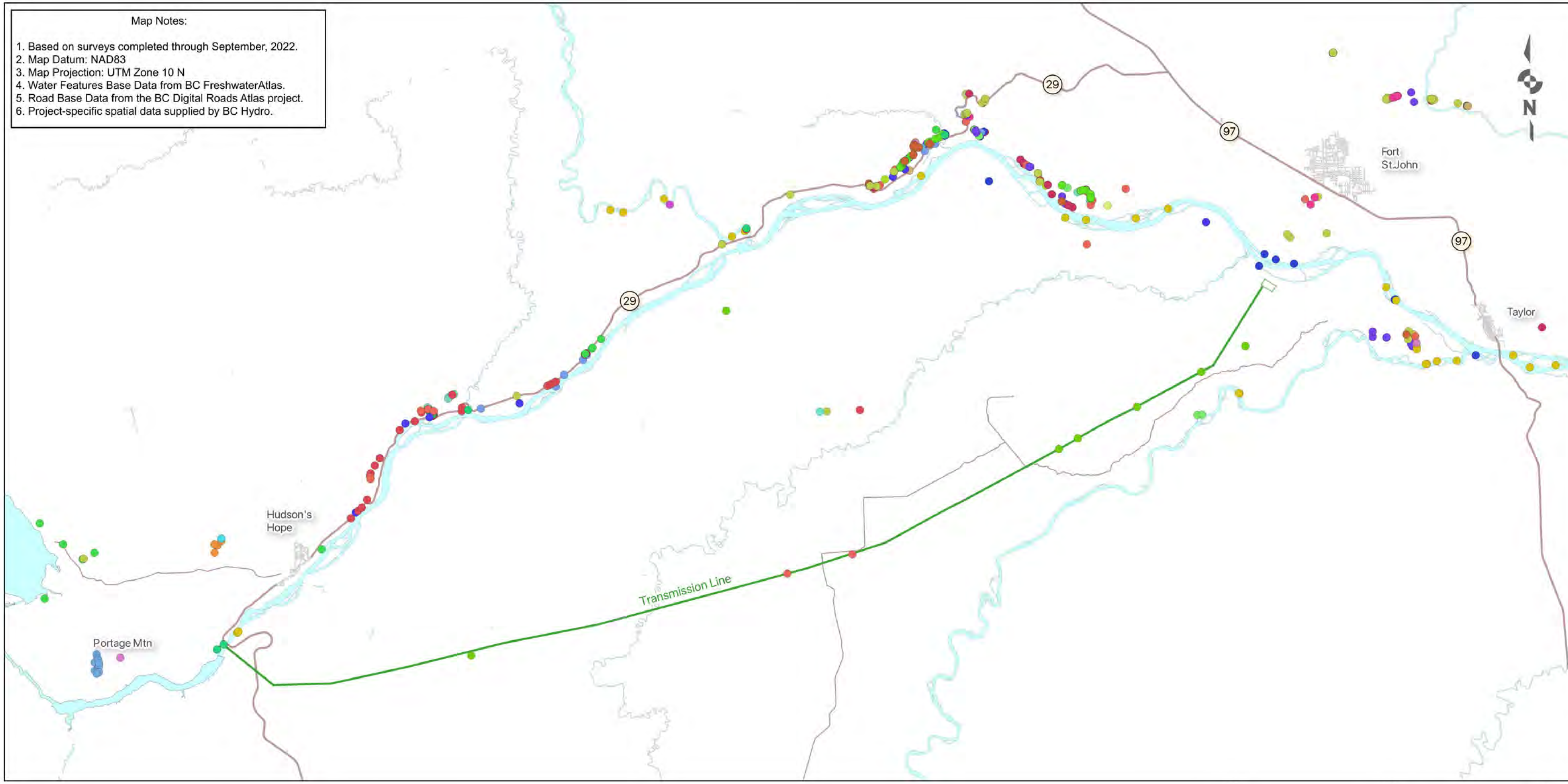
- *BC List (B.C. MOECCS): Red = Endangered, Threatened, or Extirpated; Blue = Special Concern; Yellow = Apparently Secure*
- *Occurrences: Includes newly discovered occurrences as well as occurrences expanded during the preconstruction surveys*

Many of the rare plant 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. Species descriptions for the eleven taxa that held rare status for all or part of the 2022 field season are presented in Appendix 3. Each section also contains an overview of any new sites documented in 2022, and up-to-date summary information on all reported occurrences for each of these taxa in the RAA.

In this report all of the rare plant taxa discussed in Appendix 3 were Red- or Blue-listed by the BCCDC for at least part of the 2022 survey season. For clarity, rare species found in previous years that have subsequently been removed from the Red or Blue lists are not included. Although not currently of conservation concern, the occurrence data for these taxa have been retained in the master rare plant spatial database for future reference if needed.

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

- Site C Project Environmental Impact Statement, Volume 2, Appendix R, Part 1 (Hilton et al. 2013);
- Report: Site C Clean Energy Project: Pre-disturbance Rare Plant Assessment #1: Rolling Work Plan 10 (Eagle Cap Consulting Ltd 2014);
- Report: Site C Clean Energy Project: Wildlife, Vegetation and Mapping Inventory for the Marl Fen Property (Simpson et al. 2014); and
- B.C. Ecosystem Explorer website (BCCDC 2022a).



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

Map Scale 1:250000

0 10 20 km

SITE C CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING environmental consulting services

Figure 2
Rare Plant Sites Found
in Project Vicinity (2015-2022)

Date	December 11, 2022	DWG NO	2022-12-11-0002	Revision 0

3.3. Mitigation Planning and Implementation

Twenty-four previously known rare plant occurrences were revisited during the 2022 survey work to verify continued survival, document potential threats, and develop potential mitigation strategies to ameliorate effects. The majority of these (18 of 24) were found to be still extant, three had been extirpated, and three others were partially extirpated.

To-date, eight priority rare plant occurrences have required specific mitigation assistance from the pre-construction rare plant survey team. In 2018, two occurrences of Red-listed species—*Piptatheropsis canadensis* (Canada ricegrass) and *Atriplex gardneri* var. *gardneri* (Gardner's sagebrush)—adjacent to access roads in the Wilder Creek area were flagged, mapped, and photographed to assist the road crews in avoiding these occurrences. The forestry contractor responsible for the area was contacted so that crews understood how the sites were flagged and the importance of avoiding them in the field. Monitoring surveys conducted in 2019 found that both sites had been substantially avoided during the road work and the viability of the occurrences had not been threatened by the activity. The Canada ricegrass occurrence had been completely avoided, and the Gardner's sagebrush occurrence had only a few individuals impacted, leaving the majority untouched.

In 2019, a priority rare plant site in the Farrell Creek East Highway 29 realignment clearing zone was identified that required additional mitigation assistance. The site contained two priority rare plant occurrences—*Selaginella rupestris* (rock selaginella) and *Penstemon gracilis* (slender penstemon)—that could be partially or completely extirpated by clearing activities. Due to access restrictions, propagule salvage operations could not occur at this site until BC Hydro acquired rights to the land. In cooperation with the BC Hydro off-dam environmental planning team, a mitigation plan was developed delaying clearing activities until 2021, allowing for propagule salvage after land acquisition. In 2021 the preconstruction botany team assisted the Experimental Rare Plant Translocation program team in salvaging some of the rock selaginella and slender penstemon individuals at this site, before the area was cleared for aggregate extraction. The site was revisited in 2022 to assess impacts, as the aggregate extraction work had apparently been completed and the equipment removed. The rock selaginella and slender penstemon occurrences at the site had been significantly reduced in extent and number of individuals, but both occurrences extend beyond the area of construction disturbance and may persist if further construction disturbance is avoided.

In 2020, preconstruction rare plant surveys discovered an occurrence of *Carex sprengelii* (Sprengel's sedge) in an area at Dry Creek that had been recently cleared. The overstory trees and shrubs had been cut and removed, and some ground disturbance had taken place. In the opening, four Sprengel's sedge plants were found, all of which were in late fruit. The remaining undispersed Sprengel's sedge achenes were collected and sent to NATS Nursery in Langley, B.C. to be incorporated into the Project's Experimental Rare Plant Translocation program. The four plants were left in place and will be monitored in future years. In 2021 the site was revisited and it was found that all four of the original plants were persisting. In addition, a fifth individual plant was found near one of the others. The site was revisited again in 2022 and all the plants were still surviving, however, the surrounding vegetation had become quite dense and was potentially negatively affecting the viability of the occurrence. It remains to be seen if the Sprengel's sedge plants at this site can persist through all the successional stages as the surrounding vegetation regrows.

Also in 2020, late season field work within the Cache Creek Highway Realignment construction corridor discovered another new occurrence of Canada ricegrass. Nine separate patches were found in and adjacent to the Leave to Construct (LTC) corridor. Several detailed options were developed to mitigate impacts to the patches. Because clearing in this area was scheduled for the Fall of 2020, the rare plant botanists returned to the site in early October to implement and facilitate mitigation measures for the occurrence.

One of the nine patches was in an area that had been cleared. Twelve Canada ricegrass plants were still present along the edges of the former patch—some stems were broken but the remaining base and root portions of the plants were intact. Several of the stem heads contained undispersed fruit and 27 seeds were collected. After microscope examination, nine of the seeds were found to be apparently viable, and these were sent to NATS Nursery for storage and propagation as part of the Project's Experimental Rare Plant Translocation program. The 12 plants were salvaged and directly replanted at two suitable recipient sites outside of the LTC zone. The replanting work was fully documented and these two plantings will be monitored in future years.

The remaining eight patches had not been affected by project activities. Two of these patches are well away from the LTC zone and are not expected to be affected by the Project. The other six are in areas of the LTC zone where construction activities may be able to avoid disturbing the patches. These six were clearly flagged and staked in the field to facilitate avoidance. Personnel from the construction firms were contacted so that they were aware of the rare plant sites and understood how the patches were flagged in the field. In addition, the botanists met with a representative from the Site C off-dam environmental team and visited each of the flagged patches. This occurrence will be monitored in subsequent years to determine the success of these measures and implement additional mitigation (such as salvage) if needed.

In 2021, this Canada ricegrass occurrence at Cache Creek was again revisited to determine its status. As expected, the patch that had been cleared in 2020 was extirpated under the newly built highway. The area adjacent to one other patch straddling the edge of the right-of-way (ROW) fence had been partially cleared by highway construction, although the portion outside of the ROW appeared to be unaffected. The remaining seven patches had not been directly impacted by highway construction.

The Canada ricegrass occurrence at Cache Creek was checked again during the 2022 field work. No construction effects were observed in seven of the nine original patches. In addition to the patch which was extirpated in 2020, the other affected patch straddling the ROW fence had been completely cleared within the ROW, but appeared to be unaffected on the other side of the fence outside the ROW. As well, a tenth small patch containing two plants was found further west within the ROW. It is not known if this tenth patch will persist given the high levels of ground and vegetation disturbance that take place within highway ROWs.

Another Canada ricegrass occurrence near the proposed Area E aggregate extraction site was staked and flagged in 2021 to facilitate contractor avoidance. This occurrence is located approximately 60 metres (m) outside of the extraction site boundary, and is not expected to be affected by construction activities. The occurrence was flagged as a precautionary measure to reduce the chance that unintentional indirect impacts would occur within its boundaries. This occurrence was revisited in early summer of 2022 after extraction activities had begun, and although it was too early in the season to locate individual Canada ricegrass plants, the occurrence appeared to be undisturbed by construction activities and the stakes and flagging were still in place.

Also in 2022, the *Ranunculus rhomboideus* (prairie buttercup) occurrence at Watson Slough was salvaged and transplanted to a site outside the project activity zone in anticipation of clearing activities scheduled for the winter of 2022/2023. Project botanists removed the majority of the occurrence (16 plants in nine clumps) and directly transplanted the individuals to a site near a wetland along Upper Cache Road. The transplant site will be monitored in the future to determine translocation success.

4. Discussion

4.1. Coverage

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

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

The logistics of performing rare plant surveys in the project area present certain challenges for coverage and timing. Several of the target rare plant species have extremely limited seasonal identification periods and can only be optimally found during a four-week window that may change slightly from year to year depending on the weather. In addition, access is often unsafe or impossible during substantial periods of the growing season due to severe weather events, flooding, road wash-outs, and impassable wetland conditions. These physical access limitations are particularly constraining on the plateau south of the Peace River, but can also be challenging on the north side of the river. Furthermore, landowner restrictions prevent surveyors' access to certain areas until BC Hydro is able to acquire access rights to the specific survey parcels (and often the roads that lead up to them).

All these factors—target species identification periods, favourable weather and road conditions, legally granted access permission—must coincide for a successful survey visit. Often, repeated attempts are necessary. In a limited number of cases, it was not possible to access certain planned construction corridors at the appropriate time of year prior to clearing. Over the eight years of pre-construction surveys, an estimated 1,803 hectares (ha) of corridor have been surveyed (including the mitigation areas). Of that total, the surveyors found approximately 84.8 ha (4.7% of the total) were cleared before they arrived. Nevertheless, these areas were surveyed using the standard methods described in Section 2.2 when rare plant habitat persisted following the clearing.

4.2. Seasonal Timing

Based on the observed phenology of the plants in the areas surveyed and data gathered during previous years' survey work, the seasonal timing of the surveys was sufficient to identify most of the target rare plants. The June and early July work typically focussed on sites north of the Peace River, where floodplain and grassland habitats make up the majority of the high-potential rare plant habitats present. Target species in these habitats often bloom early in the season, and then wither by later in the summer (although some notable exceptions have been observed, such as Canada ricegrass, which is not clearly identifiable until later in the season). The late summer and early fall surveys mainly focussed on areas south of the Peace River, where wetlands are the primary high-potential rare plant habitats. Many of these wetland-associated target rare plants bloom later in the season, and persist longer into the fall than those found in the upland areas.

4.3. Ongoing Work

The majority of the vegetation clearing related to Project construction has been completed, or is scheduled to take place over the winter of 2022/2023. There remain some small areas still to be surveyed for rare plants during the 2023 field season, but the majority of the expected survey work has been completed over the past eight field seasons. Changes to the Project construction footprint may necessitate additional rare plant survey work (as has occurred in each of the previous eight field seasons) but at this point no revisions are foreseen.

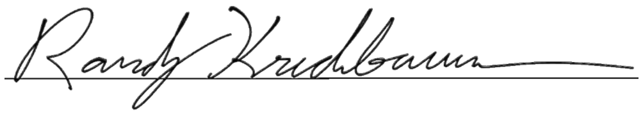
For the 2023 field season the following tasks are planned:

- continue to maintain and update the spatial database of rare plant occurrences in the vicinity of Project facilities;
- track and analyze new BCCDC data and listings as they are issued to determine the effect (if any) on Project area rare plant species;
- perform rare plant surveys in the remaining targeted areas of the Project construction footprint;
- perform rare plant surveys in new additions to the construction footprint (if any);

- monitor existing rare plant occurrences located near construction zones to determine impacts, and develop mitigation measures if needed;
- assist construction teams in implementing ongoing rare plant mitigation measures where needed;
- submit collected rare plant data to the B.C. Ministry of Environment and Climate Change Strategy and—for taxa of federal concern—to Environment and Climate Change Canada; and
- collect, prepare and submit voucher specimens from any new rare plant sites found during the 2023 field season.

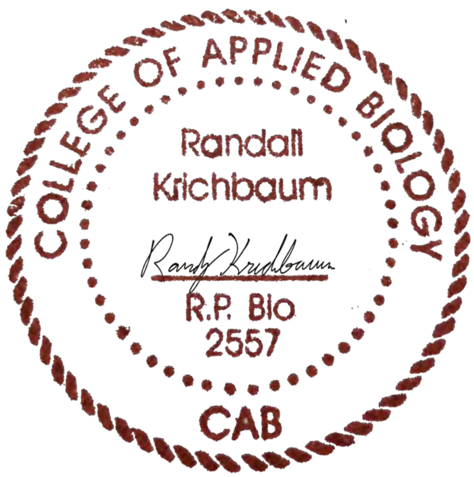
5. CLOSURE

Reviewed and approved:



Randy Krichbaum M.Sc., R.P. Bio., P. Biol.
Senior Ecologist
Eagle Cap Consulting Ltd.

<Original signed and sealed January 30, 2023 at Calgary, Alberta>



6. References

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

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

Argus GW. 2010. *Salix*. In: Flora of North America Editorial Committee, editor. Flora of North America North of Mexico. Vol. 7. New York, New York: Oxford University Press.

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

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

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

BC Conservation Data Centre (BCCDC). 2022a. BC Species and Ecosystems Explorer [Internet]. [accessed 2022 Nov 10]. http://a100.gov.bc.ca/pub/eswp

BC Conservation Data Centre (BCCDC). 2022b. Endangered species and ecosystems - non-sensitive occurrences (spatial data). Victoria, British Columbia, Canada: Government of British Columbia.

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

Beaty Biodiversity Museum. 2022. UBC Herbarium Vascular Plant Collection Database [Internet]. [accessed 2022 Dec 8]. https://databases.beatymuseum.ubc.ca/search.php?Database=vwsp

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

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

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

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2021. Species at Risk Public Registry [Internet]. [accessed 2022 Nov 10]. http://www.registrelep-sararegistry.gc.ca/sar/index/default_e.cfm

Consortium of North American Lichen Herbaria (CNALH). 2021. CNALH Data Portal [Internet]. [accessed 2020 Sep 22]. http://lichenportal.org/portal/index.php

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

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

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

Elisens WJ, Packer JG. 1980. A contribution to the taxonomy of the *Oxytropis campestris* complex in northwestern North America. Can J Bot. 58(16):1820–1831.

Ertter B, Elven R, Reveal JL, Murray DF. 2014. *Potentilla*. In: Flora of North America Editorial Committee, editor. Flora of North America North of Mexico. Vol. 9. New York, New York: Oxford University Press.

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

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

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

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

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

Gray A, Fernald ML. 1950. Gray's manual of botany: a handbook of the flowering plants and ferns of the central and northeastern United States and adjacent Canada. 8th ed. Portland, Oregon: Dioscorides Press.

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

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

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

Hitchcock CL, Cronquist A, Ownbey M, Thompson JW. 1961. Vascular plants of the Pacific Northwest: Part 3: Saxifragaceae to Ericaceae. Seattle, Washington: University of Washington Press.

Klinkenberg B. 2022. E-Flora BC: Electronic Atlas of the Plants of British Columbia [Internet]. [accessed 2022 Nov 10]. http://eflora.bc.ca

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

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

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

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

Moss EH, Packer JG. 1983. Flora of Alberta: a manual of flowering plants, conifers, ferns and fern allies found growing without cultivation in the province of Alberta, Canada. Toronto, Ontario: University of Toronto Press.

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

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

NatureServe. 2022. NatureServe Explorer: An online encyclopedia of life: Version 7.1 [Internet]. [accessed 2022 Oct 20]. http://explorer.natureserve.org/

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

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

Romaschenko K, Peterson PM, Soreng RJ, Futorna O, Susanna A. 2011. Phylogenetics of *Piptatherum* s.l. (Poaceae: Stipeae): Evidence for a new genus, *Piptatheropsis*, and resurrection of *Patis*. Taxon. 60(6):1703–1716.

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

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

Welsh SL. 1991. *Oxytropis* DC. - Names, basionyms, types, and synonyms - Flora North America Project. Great Basin Naturalist. 51(4):377–396.

Welsh SL. 2001. Revision of North American Species of *Oxytropis* de Candolle. Orem, Utah, USA: E.P.S. Inc.

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

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

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

7. APPENDICES

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

Scientific Name	Common Name	BC List	COSEWIC	SARA
VASCULAR PLANTS				
Acorus americanus	American sweet-flag	Blue		
Arctophila fulva	pendantgrass	Blue		
Artemisia alaskana	Alaskan sagebrush	Blue		
Atriplex gardneri var. gardneri	Gardner's sagebrush	Red		
Botrychium montanum	mountain moonwort	Blue		
Botrychium paradoxum	two-spiked moonwort	Blue		
Carex bicolor	two-coloured sedge	Blue		
Carex lapponica	Lapland sedge	Blue		
Carex sprengelii	Sprengel's sedge	Blue		
Carex torreyi	Torrey's sedge	Blue		
Carex xerantica	dry-land sedge	Blue		
Drosera linearis	slender-leaf sundew	Blue		
Drymocallis arguta	tall wood beauty	Blue		
Epilobium saximontanum	Rocky Mountain willowherb	Red		
Hesperostipa spartea	porcupinegrass	Blue		
Lomatium foeniculaceum var. foeniculaceum	fennel-leaved desert-parsley	Blue		
Nabalus racemosus	purple rattlesnake-root	Red		
Packera ogotorukensis	Ogotoruk Creek butterweed	Red		
Penstemon gormanii	Gorman's penstemon	Blue		
Penstemon gracilis	slender penstemon	Blue		
Piptatheropsis canadensis	Canada ricegrass	Red		
Polemonium boreale	northern Jacob's-ladder	Blue		
Polygala senega	Seneca-snakeroot	Red		
Polygonum ramosissimum ssp. prolificum	proliferous knotweed	Red		
Potentilla furcata	forked cinquefoil	Red		
Ranunculus cardiophyllus	heart-leaved buttercup	Red		

Scientific Name	Common Name	BC List	COSEWIC	SARA
Ranunculus rhomboideus	prairie buttercup	Blue		
Rosa arkansana	Arkansas rose	Blue		
Salix petiolaris	meadow willow	Blue		
Salix raupii	Raup's willow	Red		
Sarracenia purpurea ssp. purpurea	common pitcher-plant	Red		
Saussurea angustifolia var. angustifolia	northern sawwort	Red		
Selaginella rupestris	rock selaginella	Red		
Silene repens	pink campion	Blue		
Symphyotrichum falcatum var. commutatum	white prairie aster	Red		
Tephroseris palustris	marsh fleabane	Blue		
Thalictrum dasycarpum	purple meadowrue	Blue		
Utricularia ochroleuca	ochroleucous bladderwort	Blue		
LICHENS				
Anaptychia crinalis	electrified millepede	Red		
Anaptychia ulotrichoides	amputated millepede	Blue		
Cladonia parasitica	fence-rail pixie	Red		
Collema bachmanianum	Caesar's tarpaper	Blue		
Collema coniophilum	crumpled tarpaper	Red	T (2010)	1-T (2017)
Fulgensia desertorum	desert sulphur	Blue		
Fulgensia subbracteata	creeping sulphur	Blue		
Heterodermia speciosa	smiling centipede	Red		
Phaeophyscia adiastola	granulating shadow	Blue		
Phaeophyscia hispidula	whiskered shadow	Red		
Physcia dimidiata	exuberant rosette	Blue		
Physcia tribacia	beaded rosette	Red		
Physciella chloantha	downside shade	Blue		
Squamarina cartilaginea	pea-green dimple	Red		
Squamarina lentigera	snow-white dimple	Red		
Thyrea confusa	candied gummybear	Blue		
Xanthoparmelia camtschadalis	rockfrog	Red		

Scientific Name	Common Name	BC List	COSEWIC	SARA
BROPHYTES				
Acaulon muticum	[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 (2011)	1-T (2003)
Blindiadelphus subimmersus	[no common name]	Red		
Bryobrittonia longipes	[no common name]	Blue		
Cnestrum 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		
Drepanocladus turgescens	[no common name]	Blue		
Encalypta brevicolla	[no common name]	Blue		
Encalypta longicolla	[no common name]	Blue		
Encalypta mutica	[no common name]	Blue		
Encalypta spathulata	[no common name]	Blue		
Grimmia teretinervis	[no common name]	Red		
Haplodontium macrocarpum	Porsild's bryum	Red	T (2017)	1-T (2011)
Lescuraea saxicola	[no common name]	Blue		
Lewinskya elegans	[no common name]	Blue		
Meesia longiseta	[no common name]	Blue		
Myurella sibirica	[no common name]	Red		
Orthothecium strictum	[no common name]	Blue		
Philonotis yezoana	[no common name]	Blue		
Plagiobryum demissum	[no common name]	Red		
Platyhypnum alpestre	[no common name]	Blue		
Platyhypnum alpinum	[no common name]	Blue		
Pohlia bulbifera	[no common name]	Blue		
Schistidium boreale	[no common name]	Blue		
Schistidium confertum	[no common name]	Red		

Scientific Name	Common Name	BC List	COSEWIC	SARA
Schistidium pulchrum	[no common name]	Blue		
Schistidium robustum	[no common name]	Blue		
Schistidium trichodon	[no common name]	Blue		
Seligeria tristichoides	[no common name]	Blue		
Sphagnum balticum	[no common name]	Blue		
Sphagnum contortum	[no common name]	Blue		
Sphagnum wulfianum	[no common name]	Blue		
Splachnum vasculosum	[no common name]	Blue		
Stegonia latifolia var. latifolia	[no common name]	Blue		
Tayloria froelichiana	[no common name]	Blue		
Tayloria splachnoides	[no common name]	Red		
Tetraplodon urceolatus	[no common name]	Red		
Timmia norvegica var. norvegica	[no common name]	Blue		
Timmia sibirica	[no common name]	Red		
Tortella humilis	[no common name]	Red		
Warnstorfia pseudostraminea	[no common name]	Blue		
Weissia brachycarpa	[no common name]	Blue		

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*

7.2. Appendix 2: Plant and lichen species recorded during the 2015–2022 surveys

Vascular Plants

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

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

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

Halenia deflexa ssp. deflexa
Halerpestes cymbalaria
Hedysarum alpinum
Hedysarum boreale
Helictochloa hookeri
Heracleum maximum
Hesperostipa comata ssp. comata
Hesperostipa curtiseta
Heuchera richardsonii
Hieracium aurantiacum
Hieracium canadense
Hieracium umbellatum ssp. umbellatum
Hierochloë hirta ssp. arctica
Hippuris vulgaris
Hordeum jubatum ssp. jubatum
Hypopitys monotropa
Impatiens noli-tangere
Juncus alpinoarticulatus ssp. americanus
Juncus balticus ssp. ater
Juncus bufonius
Juncus dudleyi
Juncus nodosus
Juncus stygius ssp. americanus
Juncus vaseyi
Juniperus communis
Koeleria macrantha
Lactuca serriola
Lappula occidentalis var. occidentalis
Lappula squarrosa
Larix laricina
Lathyrus ochroleucus
Lemna minor
Lepidium densiflorum
Leucanthemum vulgare
Leymus innovatus ssp. innovatus
Limosella aquatica
Linaria genistifolia ssp. dalmatica
Linaria vulgaris
Linnaea borealis
Linum lewisii ssp. lewisii
Listera borealis
Listera cordata
Lithospermum incisum
Lomatium foeniculaceum var. foeniculaceum
Lonicera dioica var. glaucescens
Lonicera involucrata
Lotus corniculatus
Lycopodium annotinum
Lycopodium clavatum
Lycopodium dendroideum
Madia glomerata
Maianthemum canadense
Maianthemum racemosum ssp. amplexicaule
Maianthemum stellatum
Maianthemum trifolium
Matricaria discoidea
Medicago lupulina
Medicago sativa
Medicago sativa ssp. falcata
Melampyrum lineare var. lineare
Melica smithii
Melilotus albus
Melilotus officinalis
Mentha arvensis
Menyanthes trifoliata
Mertensia paniculata var. paniculata
Mitella nuda
Moehringia lateriflora
Monarda fistulosa var. menthaefolia
Moneses uniflora
Monotropa uniflora
Muhlenbergia glomerata
Mulgedium pulchellum
Myriophyllum sibiricum
Nassella viridula
Neslia paniculata
Nuphar sp.
Oplopanax horridus
Opuntia fragilis
Orobanche fasciculata
Orthilia secunda
Orthilia secunda var. secunda
Orthocarpus luteus
Oryzopsis asperifolia
Osmorhiza berteroi
Osmorhiza sp.
Oxybasis glauca
Oxytropis campestris var. davisii
Oxytropis deflexa
Oxytropis sericea var. speciosa
Oxytropis splendens
Packera paupercula
Packera plattensis
Packera streptanthifolia

Parnassia palustris
Pascopyrum smithii
Pedicularis groenlandica
Pedicularis labradorica
Pedicularis parviflora
Penstemon gracilis
Penstemon procerus var. procerus
Persicaria amphibia
Persicaria amphibia var. emersa
Persicaria amphibia var. stipulacea
Persicaria hydropiper
Persicaria lapathifolia
Persicaria sp.
Petasites frigidus var. palmatus
Petasites frigidus var. sagittatus
Phalaris arundinacea var. arundinacea
Phleum pratense ssp. pratense
Picea glauca
Picea mariana
Pinus contorta var. latifolia
Piptatheropsis canadensis
Piptatheropsis pungens
Plantago major
Platanthera aquilonis
Platanthera huronensis
Platanthera obtusata ssp. obtusata
Platanthera orbiculata
Platanthera sp.
Poa alpina ssp. alpina
Poa annua
Poa compressa
Poa glauca
Poa glauca ssp. glauca
Poa nemoralis ssp. interior
Poa palustris
Poa pratensis
Poa pratensis ssp. pratensis
Poa secunda
Polygonum achoreum
Polygonum aviculare
Polygonum douglasii
Polygonum fowleri
Polygonum ramosissimum
Polypodium sibiricum
Populus balsamifera
Populus tremuloides
Potamogeton alpinus
Potamogeton gramineus
Potamogeton pusillus ssp. tenuissimus
Potentilla anserina
Potentilla gracilis var. fastigiata
Potentilla hippiana
Potentilla norvegica
Potentilla pensylvanica
Potentilla pensylvanica var. pensylvanica
Potentilla pulcherrima
Prosartes trachycarpa
Prunus pensylvanica
Prunus virginiana ssp. melanocarpa
Prunus virginiana var. demissa
Pseudoroegneria spicata
Puccinellia distans
Puccinellia nuttalliana
Pulsatilla nuttalliana
Pyrola asarifolia
Pyrola chlorantha
Pyrola minor
Ranunculus acris
Ranunculus aquatilis var. aquatilis
Ranunculus aquatilis var. diffusus
Ranunculus cymbalaria
Ranunculus gmelinii
Ranunculus macounii
Ranunculus rhomboideus
Ranunculus sceleratus
Ranunculus sceleratus var. multifidus
Rhinanthus minor
Rhododendron groenlandicum
Ribes hudsonianum var. hudsonianum
Ribes lacustre
Ribes oxyacanthoides ssp. oxyacanthoides
Rorippa palustris
Rorippa palustris ssp. palustris
Rosa acicularis ssp. sayi
Rosa woodsii ssp. woodsii
Rubus arcticus ssp. acaulis
Rubus chamaemorus
Rubus idaeus ssp. strigosus
Rubus parviflorus var. parviflorus
Rubus pedatus
Rubus pubescens
Rumex britannica
Rumex crispus
Rumex fueginus

Rumex occidentalis
Rumex triangulivalvis
Salix arbusculoides
Salix bebbiana
Salix candida
Salix discolor
Salix drummondiana
Salix interior
Salix lasiandra var. lasiandra
Salix maccalliana
Salix myrtillifolia
Salix pedicellaris
Salix petiolaris
Salix planifolia
Salix prolixa
Salix pseudomonticola
Salix pseudomyrsinites
Salix pyrifolia
Salix scouleriana
Salix serissima
Salsola tragus
Sanicula marilandica
Saxifraga tricuspidata
Schedonorus arundinaceus
Schizachne purpurascens
Schoenoplectus tabernaemontani
Scirpus microcarpus
Scutellaria galericulata
Selaginella rupestris
Senecio eremophilus var. eremophilus
Senecio vulgaris
Shepherdia canadensis
Silene drummondii var. drummondii
Silene latifolia
Sisymbrium altissimum
Sisyrinchium montanum var. montanum
Sium suave
Solidago altissima ssp. gilvocanescens
Solidago bellidifolia
Solidago glutinosa
Solidago lepida var. lepida
Solidago lepida var. salebrosa
Solidago missouriensis
Solidago multiradiata
Solidago simplex var. simplex
Sonchus arvensis
Sonchus arvensis ssp. uliginosus
Sorbus scopulina var. scopulina
Sparganium emersum
Sparganium natans
Sparganium sp.
Sphenopholis intermedia
Spiraea betulifolia ssp. lucida
Spiraea lucida
Spiranthes romanzoffiana
Sporobolus cryptandrus
Stachys palustris ssp. pilosa
Stellaria borealis
Stellaria borealis ssp. borealis
Stellaria longifolia
Stellaria longipes var. longipes
Stellaria media
Stuckenia pectinata
Symphoricarpos albus
Symphoricarpos occidentalis
Symphyotrichum boreale
Symphyotrichum ciliolatum
Symphyotrichum ericoides var. pansum
Symphyotrichum laeve var. geyeri
Symphyotrichum lanceolatum var. hesperium
Symphyotrichum puniceum var. puniceum
Tanacetum vulgare
Taraxacum officinale
Thalictrum venulosum
Thinopyrum intermedium
Thlaspi arvense
Tofieldia pusilla
Tragopogon dubius
Triantha glutinosa
Trifolium hybridum
Trifolium pratense
Trifolium repens
Triglochin maritima
Triglochin palustris
Tripleurospermum inodorum
Triticum aestivum
Turritis glabra
Typha latifolia
Urtica dioica ssp. gracilis
Utricularia intermedia
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium myrtilloides
Vaccinium oxycoccos

Vaccinium vitis-idaea ssp. minus
Valeriana dioica ssp. sylvatica
Verbascum thapsus
Veronica americana
Veronica beccabunga ssp. americana
Veronica peregrina var. xalapensis
Veronica scutellata
Viburnum edule
Vicia americana
Viola adunca var. adunca
Viola canadensis var. rugulosa
Woodsia scopulina
Zizia aptera

Bryophytes

Abietinella abietina
Antitrichia curtipendula
Aulacomnium palustre
Barbula convoluta var. convoluta
Brachythecium salebrosum
Brachythecium sp.
Bryum argenteum
Ceratodon purpureus
Climacium dendroides
Dicranum polysetum
Dicranum undulatum
Didymodon fallax
Didymodon ferrugineus
Distichium capillaceum
Ditrichum flexicaule
Drepanocladus aduncus
Encalypta rhaptocarpa
Funaria hygrometrica
Hamatocaulis vernicosus
Hedwigia ciliata
Hylocomium splendens
Hymenostylium recurvirostre var. recurvirostre
Leptobryum pyriforme
Marchantia polymorpha
Marchantia quadrata
Mnium thomsonii
Orthotrichum anomalum
Orthotrichum obtusifolium
Orthotrichum speciosum
Philonotis fontana var. fontana
Plagiomnium cuspidatum
Plagiomnium ellipticum
Plagiomnium sp.
Pleurozium schreberi
Pohlia nutans
Polytrichum commune
Polytrichum juniperinum
Ptilium crista-castrensis
Pylaisiella polyantha
Sanionia uncinata
Sphagnum capillifolium
Sphagnum magellanicum
Sphagnum sp.
Syntrichia norvegica
Syntrichia ruralis
Tomentypnum nitens
Tortula mucronifolia

Lichens

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

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

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

7.3.1. Atriplex gardneri var. gardneri (Gardner's sagebrush)

Gardner's sagebrush (Figure 3), a small perennial sub-shrub with a woody base, is a member of the Chenopodiaceae (goosefoot family). Variety *gardneri* is found on fine-textured saline soils and dry grassy slopes in the Great Plains and Intermountain regions of central North America (Douglas et al. 1998; Welsh 2003). In B.C., Gardner's sagebrush is known only from the Peace River region (BCCDC 2022a). The taxon can be found as far east in Canada as southern Manitoba, and as far south as Utah and Colorado in the United States (Welsh 2003; NatureServe 2022).

Gardner's sagebrush has a rank of S2 (Imperilled) in B.C. and is on the province's Red list (BCCDC 2022a). The taxon has a global classification of G5TNR (*Atriplex gardneri* as a species is ranked globally Secure, but variety *gardneri* has not been given a global rank). Several other sub-national jurisdictions provide a rank for Gardner's sagebrush: Saskatchewan and Montana S5 (Secure), Alberta S4 (Apparently Secure), and Utah and Nebraska S1 (Critically Imperilled) (NatureServe 2022).

Figure 3: *Atriplex gardneri* var. *gardneri* (Gardner's sagebrush)

No new occurrences of Gardner's sagebrush were reported in the Site C Regional Assessment Area (RAA) in 2022.

There are a total of four known occurrences (in five patches) of Gardner's sagebrush in the RAA. Three of these occurrences (four patches) are situated north of the Peace River near the Alberta border, and, excluding the patch located in 2020, are older records without information on the number of individuals or areal coverage. The patch found in 2020 contained an estimated 50 male and female plants over an approximate area of 50 square metres (m^2). The fourth occurrence of Gardner's sagebrush, discovered in 2018 during Site C survey work, is some 60 km to the west near Wilder Creek. Here, an estimated 150 male plants were found scattered over an area of 618 m^2; no female plants were observed at this site.

All four of the Gardner's sagebrush occurrences are situated on open, dry, south-facing grassland slopes. The dominant associated species include native grasses such as various wildryes (*Elymus* spp.), junegrass (*Koeleria macrantha*), and green needlegrass (*Nassella viridula*), and native forbs such as prairie sagewort (*Artemisia frigida*) and asters (*Symphyotrichum* spp.).

7.3.2. Carex sprengelii (Sprengel's sedge)

Sprengel's sedge (Figure 4) is a perennial herb belonging to the Cyperaceae (sedge family); plants have tall stems with fibrous bases and bear achenes in drooping heads. The species forms loose clumps in a variety of dry to wet habitats, including openings, slopes, and alluvial woodlands, often on calcareous substrates (Douglas et al. 1998; Ball & Reznicek 2002). Sprengel's sedge was only known from three locations in B.C. prior to the Site C rare plant survey work: two near Williams Lake, and one in the Peace River region (BCCDC 2022a). The taxon ranges across North America as far east as New Brunswick, and as far south as Colorado, Missouri, and New Jersey. It is also reported from Alaska (Ball & Reznicek 2002; NatureServe 2022).

Figure 4: *Carex sprengelii* (Sprengel's sedge)

Sprengel's sedge has a rank of S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2022a). Globally, the taxon is classed G5 (Secure). Across much of North America the taxon is classed as Secure

(S5) or Apparently Secure (S4), but is considered rare on the western, southern, and eastern edges of its range: S3 (Vulnerable) in Québec, New Brunswick, Pennsylvania, Illinois, Montana and Wyoming; S2 (Imperilled) in Maine, Ohio, Missouri, and Colorado; S1 (Critically Imperilled) in Alaska, and SH (Possibly Extirpated) in Delaware (NatureServe 2022).

No new occurrences of Sprengel's sedge were reported in the Site C Regional Assessment Area in 2022, however one occurrence at Dry Creek was revisited. Prior to its discovery in 2020, the overstory of trees and shrubs had been removed from this site. At the 2022 revisit, it was observed that the regenerating woodland vegetation was quite lush, including around the individual Sprengel's sedge plants, and it is not known whether the dense growth will impact the continued survival of the rare sedges. All Sprengel's sedge plants at the site had flowered and produced achenes in the 2022 growing season, however.

In total, there are six known occurrences (in 11 patches) of Sprengel's sedge in the RAA. Four of these occurrences (eight patches)—found during survey work for the Site C project—are situated between Dry Creek and Wilder Creek, on flat to south-facing slopes north of the Peace River. An estimated 38 plants have been observed growing in a total approximate area of 17 m^2, in various shrub and woodland habitats. All of these sites are moist to mesic, and the Sprengel's sedge plants are generally found in relatively shaded microhabitats. Associated species are similar, including prairie saskatoon (*Amelanchier alnifolia*), prickly rose (*Rosa acicularis*), chokecherry (*Prunus virginiana*), aspen (*Populus tremuloides*), and native and weedy herbs such as smooth brome (*Bromus inermis*), northern bedstraw (*Galium boreale*), and American vetch (*Vicia americana*).

The remaining two sites of Sprengel's sedge in the RAA are derived from BCCDC records that lack certain population data. An occurrence of 20 plants in two patches was discovered between a hay field and a shrubby south-facing escarpment above the Pine River in 2016; areal extent, associated species, and other details of this occurrence were not documented. Additionally, a sixth occurrence of Sprengel's sedge, first observed in 2010, is reported from over 80 km southwest, in moist balsam poplar (*Populus balsamifera*) woods north of the Moberly River. No clear information is available on the number of individuals or areal coverage (BCCDC 2022a).

7.3.3. Carex torreyi (Torrey's sedge)

Torrey's sedge (Figure 5) is a soft-hairy perennial in the Cyperaceae (sedge family) found growing in montane meadows, shrublands, and moist woods (Douglas et al. 1998; Ball & Reznicek 2002). In B.C. the species is found only in the Peace River region (BCCDC 2022a). Globally, Torrey's sedge is distributed east across Canada to Ontario, and south in the U.S. as far as Colorado and Wisconsin (NatureServe 2022).

Figure 5: *Carex torreyi* (Torrey's sedge)

Torrey's sedge is ranked S3? (Vulnerable?) in B.C. and is on the province's Blue list (BCCDC 2022a). The species is ranked G4G5 (Apparently Secure or Secure) globally. Sub-national ranks vary—Torrey's sedge is classed as S4 (Apparently Secure) in Alberta and Saskatchewan, S3 (Vulnerable) in Manitoba and Montana, S2 (Imperilled) in Ontario and Wyoming, and S1 (Critically Imperilled) in Colorado and Wisconsin (NatureServe 2022).

One new occurrence of Torrey's sedge was documented in the study area in 2022. A single plant in fruit was discovered along a small trail in open shrub-grassland east of Taylor, BC.

There are a total of 12 occurrences (in 19 patches) of Torrey's sedge reported in the RAA. An estimated 532 plants have been observed growing in a total area of approximately 426 m^2. Ten of the occurrences are situated north of the Peace River; the 11th occurrence (not reconfirmed since the 1960 report) is located more than 45 km south, near Dawson Creek, B.C. All of the occurrences were found on mesic to xeric south-facing slopes in open shrub grassland complexes. Associated species are similar at the sites and include native shrubs such as prickly rose, prairie saskatoon, and snowberry (*Symphoricarpos* spp.); native and non-native graminoids such as smooth brome, bluegrasses (*Poa* spp.), and sedges (*Carex* spp.); and a diverse mix of native and weedy forbs.

7.3.4. Carex xerantica (dry-land sedge)

Dry-land sedge (Figure 6), a perennial herb with silvery-gold heads of the Cyperaceae (sedge family), is found in xeric steppe and montane habitats such as dry grasslands and hillsides, open forests, and rock outcrops (Douglas et al. 1998; Ball & Reznicek 2002). In B.C., dry-land sedge has been collected in the Peace River area as well as scattered locations in the central interior and central Rocky Mountains (BCCDC 2022a; Klinkenberg 2022). There is some disagreement on the taxon's global range. Douglas et al. (1998) note that dry-land sedge extends east from B.C. to Manitoba, and south to Minnesota and Nebraska; Ball & Reznicek (2002) show the species occurring as far east as Ontario and also in Wyoming; and Natureserve (2022) reports the sedge from as far north as Yukon and Alaska, and as far south as Arizona and New Mexico.

Figure 6: *Carex xerantica* (dry-land sedge)

Dry-land sedge is classed as S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2022a). Although globally the taxon is considered Secure (G5), most jurisdictions that provide a rank for the species indicate some degree of rarity: S1 (Critically Imperilled) in Alaska, Yukon and Wyoming; S2 (Imperilled) in Manitoba, Ontario, Nebraska, Colorado, and New Mexico; and S3 (Vulnerable) in Minnesota. Alberta and Saskatchewan rank the species S4 (Apparently Secure) (NatureServe 2022).

Six new patches of dry-land sedge were recorded in the study area in 2022: one newly-found occurrence and five occurrence extensions. The new occurrence was found along the base of a steep low-shrub grassland opening in aspen woodland near the Alberta border. An estimated 200 plants in flower were found growing in an area of approximately 148 m^2.

The remaining five new patches of dry-land sedge were determined to be extensions of previously-reported occurrences. At a site northeast of Fort St. John, BC, one new patch of approximately 20 plants in late fruit was documented in an area of about 50 m^2. This occurrence, first reported in 2005, now comprises four patches in total. A second occurrence extension, of three new patches, was found east of Taylor, BC, at a location first reported in 2016. In all, an estimated 35 new dry-land sedge plants were observed in flower and fruit in a total area of approximately 30 m^2.

The third new dry-land sedge patch consisted of a small extension to a very large occurrence, on a high-quality native grassland bench west of the confluence of the Peace and Pine Rivers (Area E). This site was first observed in 2012, when only a portion of the very large bench was surveyed; during the 2022 revisit, an additional 2 plants in bloom were found to the northwest of the known site. The full extent of the grassland bench remains unsurveyed. This occurrence has been greatly reduced by the development of a gravel pit and associated road and overburden pile.

In total, there are 21 known occurrences of dry-land sedge (in 51 patches) in the RAA. An estimated 14,243 plants have been observed growing in an approximate total area of 15.08 ha. Eighteen of the occurrences were found on south-facing slopes north of the Peace River from Bear Flat east to the Alberta border, and two occurrences were documented from a large bench and adjacent south-facing slopes on the south side of the Peace River at the Pine River. Dry-land sedge has also been collected on a slope above the Pouce Coupe River, over 25 km to the south.

The dry-land sedge sites are invariably located in xeric grassland habitat, generally in the vicinity of low shrub thickets. The dominant associated species include native shrubs such as prairie saskatoon, prickly rose, and snowberry; native dryland sedges such as hay sedge (*Carex siccata*); and native grasses such as junegrass, short-awned porcupinegrass (*Hesperostipa curtiseta*), spike-oat (*Helictochloa hookeri*), wildryes, and needlegrasses (*Achnatherum* spp. and *Nassella viridula*). A diverse mix of native and non-native forbs are also present at dry-land sedge occurrences.

7.3.5. Drymocallis arguta (tall wood beauty)

Tall wood beauty (syn. *Potentilla arguta)* (Figure 7) is a glandular hairy perennial in the Rosaceae (rose family). The species grows in a wide variety of open, mesic habitats across North America east of the Rocky Mountains (Ertter et al. 2014). The taxonomy of tall wood beauty was clarified by the 2014 Flora of North America treatment, but its presence in BC has not been well documented and the species was only added to the BC flora in July of 2022 (Ertter et al. 2014; BCCDC 2022a). Records and collections of tall wood beauty from BC require review to determine those that represent *D. convallaria* (white cinquefoil), a similar-looking plant that is common west of the continental divide (Ertter et al. 2014; Beaty Biodiversity Museum 2022; Klinkenberg 2022). The global range of tall wood beauty is reported as extending east across North America to New Brunswick, south as far as Virginia, Arkansas, Oklahoma, and perhaps Tennessee, and west as far as New Mexico and perhaps Idaho (Ertter et al. 2014; NatureServe 2022).

Figure 7: *Drymocallis arguta* (tall wood beauty)

Tall wood beauty has been given an initial classification of S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2022a). Globally the taxon is considered Secure (G5). Eighteen jurisdictions provide status ranks: Secure (S5) in Manitoba and New York; Apparently Secure (S4) in Alberta, Saskatchewan, Ontario, Québec, Montana, and Wyoming; Vulnerable (S3) in New Brunswick and Vermont; Imperilled (S2) in Connecticut and New Jersey; Critically Imperilled (S1) in Virginia, Ohio, Arkansas, and Oklahoma; Possibly Extirpated (SH) in Maryland; and Presumed Extirpated (SX) in West Virginia (NatureServe 2022).

Twenty-five occurrences of tall wood beauty were documented in the study area in 2022. In order to provide the BCCDC with as much information as possible, some of these occurrences are based on plants observed by the Project botanists during previous years' survey work (when possible, previously-observed locations were revisited in 2022). Since the Blue-list status of tall wood beauty was not announced by the BDCDC until late July, about half of the plants recorded during the 2022 survey work were in fruit, and the remainder were in leaf only, having apparently not flowered this season. A few plants were found in late bloom.

Twenty-three of the tall wood beauty occurrences are located north of the Peace River. The westernmost occurrence is located on the steep lower slopes of Bullhead Mountain, west of Hudson's Hope, BC. Approximately 75 plants were found in an estimated area of 320 m^2 in open low-shrub grassland.

Further east, between Farrell Creek and the Halfway River, three occurrences of tall wood beauty have been observed in open habitats north of Highway 29. Forty plants were counted in an approximate area of 1,012 m^2 in a narrow shrub-grassland opening between a fenceline and a regenerating aspen woodland. The two additional tall wood beauty sites along this section of Highway 29 have been impacted by construction work. An occurrence of eight plants on a grassland flat, noted in 2015, appears to have been partly or completely extirpated by disturbance related to a newly-constructed segment of the highway west of the mouth of the Halfway River. A much larger occurrence of tall wood beauty, first documented in 2021 approximately nine kilometres east of Farrell Creek on a steep grassland slope, has also been partially impacted, however, an estimated 50 plants are still extant over an area of about 416 m^2.

Between the Peace River Valley Viewpoint and Cache Hill above Bear Flat, BC, eight occurrences (in 17 patches) of tall wood beauty have been recorded, all in open habitats in the vicinity of Highway 29. The two largest occurrences contain an estimated 200 plants each, and the smallest consists of only two plants total. Areal coverage is similarly variable, ranging from approximately 2,632 m^2 for the largest down to less than one square metre for the smallest. Three of these eight occurrences have been partially impacted by disturbance related to construction of new segments of highway, while the remainder are in relatively undisturbed locations.

Another cluster of five tall wood beauty occurrences (in seven patches) is reported from open to partly-wooded slopes above the Peace River between the Wilder Creek area and Fort St. John, BC. These occurrences are mostly based on previous years' documentation, prior to rare-listing of the taxon, so population information is scant. Ten plants were noted at two occurrences west of Wilder Creek in 2016 and 2018, and three plants were recorded from two occurrences southwest of the town of Fort St. John in 2011 and 2012. A single plant was found at the fifth occurrence in 2022, south of Fort St. John. The tall wood beauty plants seen in the vicinity of Fort St. John occur in more-disturbed habitats than those observed west of Wilder Creek.

Four occurrences (in 16 patches) of tall wood beauty have been documented on open slopes above Montney Creek and the Beatton River, north of Fort St. John, BC. The largest occurrence contains an estimated 100 plants covering a total area of approximately 334 m^2, and the smallest consists of two plants observed in a one square metre area. Most of the plants were found in relatively undisturbed native shrub-grassland, although recreational trails are common in this area.

The largest tall wood beauty occurrence found to date comprises an estimated 1,000 plants in three patches on open shrub-grassland slopes east of Taylor, BC. The native habitat at this site is relatively intact; areal coverage is approximately 9,750 m^2.

The eastmost occurrence of tall wood beauty is based on documentation from 2019 of two plants in one square metre on an open grassland slope above the Peace River near the Alberta border.

Only two of the twenty-five tall wood beauty occurrences reported for 2022 are located south of the Peace River. The first occurrence appears to be an anomaly, as it consists of four plants in a three square metre area at the base of a road culvert in mixed forest on a large wetland plateau. It is possible that the rip-rap brought in to build the road and culvert contained tall wood beauty propagules. The second occurrence comprises ten plants documented in five patches over four separate survey years (2012, 2018, 2021, and 2022) on a native grassland bench west of the confluence of the Peace and Pine Rivers (Area E). Areal coverage is estimated to be 11 m^2 for the five patches. This area has been impacted by the recent construction of a gravel pit and associated access road and overburden pile.

In total, 25 tall wood beauty occurrences (in 56 patches) are known in the RAA. An estimated 1,886 plants have been documented growing in an approximate total area of 1.70 ha. The plants are usually found on open slopes, but occasionally occur on level ground. Tall wood beauty always grows in association with low to mid-height native shrubs, usually species such as prairie saskatoon, prickly rose, and snowberry. A diverse mix of native and non-native graminoids are also found at the sites: dominant taxa include bluegrasses, wildryes, needlegrasses, smooth brome, junegrass, short-awned porcupinegrass, and sedges. Associated forb species include northern bedstraw, asters, and woolly yarrow (*Achillea borealis*).

7.3.6. Lomatium foeniculaceum var. foeniculaceum (fennel-leaved desert-parsley)

Fennel-leaved desert-parsley (Figure 8), a low perennial herb with a long taproot, is a member of the Apiaceae (carrot family) (Douglas et al. 1998). The taxon is found on dry, open slopes across much of central North America (Hitchcock et al. 1961; NatureServe 2022). Fennel-leaved desert parsley var. *foeniculaceum* is restricted to the Peace River region in British Columbia (BCCDC 2022a), but its global range extends east as far as Manitoba and Missouri, and south into Texas (NatureServe 2022).

In B.C., fennel-leaved desert-parsley var. *foeniculaceum* carries a rank of S3 (Vulnerable) and is on the province's Blue list (BCCDC 2022a). The taxon's global classification is G5T5 (Secure for both the species and the variety), however, of the seven other jurisdictions that provide a rank for this variety, five indicate some degree of rarity: S2 (Imperilled) in Colorado, Kansas, and Missouri, and S3 (Vulnerable) in Alberta and Manitoba. Wyoming and Saskatchewan class fennel-leaved desert-parsley var. *foeniculaceum* as S4 (Apparently Secure) and S5 (Secure), respectively (NatureServe 2022).

One new occurrence of fennel-leaved desert-parsley was discovered in the study area in 2022. An estimated 30 individuals were found growing over an area of approximately 75 m^2 on an open grassland slope east of Taylor, BC. About half of the plants were in flower and early fruit, and the remainder were vegetative. Associated species included low shrubs such as prairie saskatoon and snowberry, and herbs such as thick-spike wildrye (*Elymus lanceolatus* ssp. *lanceolatus*), short-awned porcupinegrass, green needlegrass, and pale comandra (*Comandra umbellata* ssp. *pallida)*.

Figure 8: ***Lomatium foeniculaceum var. foeniculaceum (fennel-leaved desert-parsley)***

A total of seven occurrences (in 12 patches) of fennel-leaved desert-parsley are known from the RAA. In addition to the new occurrence described above, there are two dating from 1981, near the Peace River downstream of the Beatton River, three from Site C survey work in 2017, of which two are above the Beatton River and one is near Cache Creek, and one from Site C work in 2021, just east of Bear Flat, BC. An estimated 980 plants have been documented in an approximate total area of 8,626 m^2. All fennel-leaved desert-parsley sites occur on dry, south-facing grassland slopes in plant associations similar to the one described for the 2022 site.

7.3.7. Oxytropis campestris var. davisii (Davis' locoweed)

Davis' locoweed (Figure 9) is a small perennial in the Fabaceae (pea family) that grows on stream gravels and in mesic to dry meadows and forest openings in the montane zone (Elisens & Packer 1980; Welsh 1991; Douglas et al. 1998). Variety *davisii* is found in northeast B.C. where it can be locally abundant, and is also reported from Alberta (Welsh 2001; BCCDC 2022a; NatureServe 2022). As of June 2022, Davis' locoweed was classed S3? (Vulnerable?) by the BCCDC, and was on the provincial Blue list, however the rare status was removed in late July when the taxon was reassigned to the Yellow list (BCCDC 2022a). Globally, the variety is ranked as Vulnerable (T3), due to its limited range. Alberta lists Davis' locoweed as S2? (Imperilled?) (NatureServe 2022).

Figure 9: *Oxytropis campestris* var. *davisii* (Davis' locoweed)

One new occurrence of Davis' locoweed was documented in the study area in 2022. Twenty-two plants were found in a three square metre area on open roadside gravel in an abandoned section of an active gravel pit west of the confluence of the Peace and Pine Rivers. Associated species included balsam poplar, the non-native herbs smooth brome, Kentucky bluegrass (*Poa pratensis*), and chick-pea milk-vetch (*Astragalus cicer*), and native forbs such as alpine milk-vetch (*Astragalus alpinus)* and pretty oxytrope (*Oxytropis sericea).*

There are a total of 28 occurrences of Davis' locoweed (in 40 patches) reported in the RAA. An estimated 70,994 plants have been recorded in an approximate total area of 13.5 ha. Nineteen of the occurrences have been documented from along the Peace River, and many of these sites contain hundreds or thousands of individuals and cover relatively large areas of ground. Four occurrences have been observed along the Halfway River, and four on the Pine River near its confluence with the Peace River. There is also one historical record of Davis' locoweed on the Pine River at Highway 97, over 50 km to the south (not reconfirmed since the 1954 report).

Except for the 2022 occurrence and the historical record on the Pine River, all Davis' locoweed occurrences in the RAA have been mapped within 400 m of current river shorelines, on non-active cobble bars, floodplains or river benches. Habitat at the majority of sites is similar, consisting of open, often bare cobble-silt substrates and young to medium-aged balsam poplar. Other associated species include a relatively sparse cover of native and weedy herbs such as chick-pea milk-vetch, yellow mountain-avens (*Dryas drummondii*) and sweet-clover (*Melilotus* spp.) as well as quackgrass, slender wheatgrass, Canada wildrye (*Elymus* spp.) and other species of locoweeds. The notable exceptions to this early seral habitat are one occurrence of Davis' locoweed on a forested bedrock shoreline, and two patches in mature floodplain forest.

7.3.8. Penstemon gracilis (slender penstemon)

Slender penstemon (Figure 10) is a perennial herb of the Plantaginaceae (plantain family)—formerly of the Scrophulariaceae (figwort family)—that inhabits mesic to dry plains and grasslands (Hitchcock et al. 1959; Douglas et al. 1998; Freeman & Rabeler 2016). The species is commonly found throughout much of central North America, but in B.C. is restricted to the Peace River area (Hitchcock et al. 1959; BCCDC 2022a; NatureServe 2022).

Figure 10: *Penstemon gracilis* (slender penstemon)

Slender penstemon is ranked S3 (Vulnerable) in B.C., and is on the province's Blue list (BCCDC 2022a). The species' global status is G5 (Secure) (NatureServe 2022). Of the remaining 17 jurisdictions where it is known to occur, only four rank slender penstemon with any degree of rarity—Manitoba and Wyoming as S3 (Vulnerable), and Iowa and Michigan as S1 (Critically Imperilled) (NatureServe 2022).

Nine new sites of slender penstemon were discovered in the study area in 2022. A small occurrence was recorded on a southwest-facing slope east of Taylor, BC, in a grassland and woodland mosaic. Here, 18 slender penstemon plants in bud were found growing in an area of approximately 20 m^2.

The remaining eight new sites of slender penstemon were determined to be extensions of previously-reported occurrences. A large patch of an estimated 50 plants in bud was discovered near the Alberta border, at an occurrence first reported in 2020. The new patch had an approximate areal coverage of 660 m^2. East of Taylor, BC, at an occurrence first located in 2016, five new patches of slender penstemon were documented on relatively intact native shrub-grassland slopes. During the 2022 revisits, an estimated 50 plants in bud or flower were mapped in five patches with a total areal coverage of approximately 2.5 ha. The full extent of the occurrence remains undetermined.

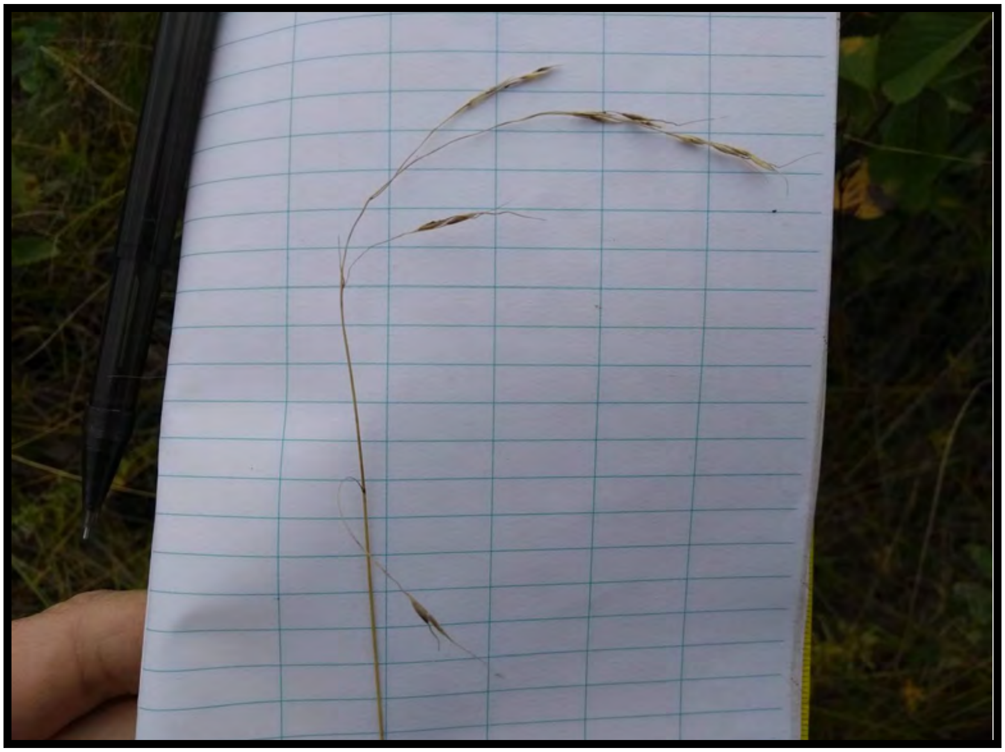
The seventh new patch of slender penstemon consists of two plants in fruit at an occurrence first reported in 2021 east of Bear Flat, BC. The plants were growing on a shrub-grassland slope 20 m southwest of the original patch. The final new patch for 2022 is an adjustment to a large patch first mapped in 2018 on a steep, relatively intact shrub-grassland slope above Highway 29 east of Farrell Creek. While recent disturbance related to aggregate extraction has removed the eastern three-quarters of this patch (containing hundreds of slender penstemon plants), an estimated 25 additional plants in fruit were documented at the 2022 revisit, with the result that the western edge of the patch was extended approximately 30 m.

In total, there are 28 occurrences of slender penstemon (in 59 patches) reported in the RAA. All of the occurrences are situated north of the Peace River, from the Farrell Creek area east to the Alberta border. An estimated 3,855 plants have been documented in an approximate total area of 6.47 ha. All of the occurrences were found on south-facing slopes in xeric grassland habitat, often in the vicinity of low shrub thickets. Dominant associated species include the native shrubs prairie saskatoon, kinnikinnick, and common snowberry (*Symphoricarpos albus*), native graminoids such as junegrass, wildryes, and dryland sedges, and a diverse mix of native and non-native forbs.

7.3.9. Piptatheropsis canadensis (Canada ricegrass)

Canada ricegrass (Figure 11) is a delicate perennial bunchgrass of the Poaceae (grass family). The species grows in grasslands and open woods; additionally, in eastern North America, the taxon is specifically reported from dry, sparsely-vegetated soils which are usually sandy or rocky, as well as moist peaty barrens. Canada ricegrass ranges from Alberta east across Canada to Newfoundland, and south into the U.S. Northeast and Great Lakes regions (Gray & Fernald 1950; Moss & Packer 1983; Lapin 2004; Barkworth 2007; BCCDC 2022a). Prior to the 2018 Site C rare plant survey work, no verified extant occurrences of Canada ricegrass were known from B.C. (BCCDC 2022a). Of note: the genus *Piptatheropsis* was only recently described (Romaschenko et al. 2011), therefore Canada ricegrass is still referred to by the name *Piptatherum canadense* in some important literature (Lapin 2004; Barkworth 2007; NatureServe 2022).

Figure 11: *Piptatheropsis canadensis* (Canada ricegrass)



Canada ricegrass is ranked S1 (Critically Imperilled) in B.C., and is on the province's Red list (BCCDC 2022a). The taxon's global classification is G4G5 (Apparently Secure or Secure) (NatureServe 2022). However, although Canada ricegrass is widely distributed across North America, the species has few reported occurrences and most of these are small (frequently less than 100 individuals at a site) (Lapin 2004). Accordingly, Canada ricegrass is generally classed as rare sub-nationally: SH (Possibly Extirpated) in Prince Edward Island; S1 (Critically Imperilled) in Manitoba, Wisconsin, West Virginia, and New Hampshire; S2 (Imperilled) in Alberta, New Brunswick, Newfoundland, Minnesota, Michigan, New York, and Maine; S3 (Vulnerable) in Saskatchewan and Nova Scotia; and S4 (Apparently Secure) in Ontario and Québec (NatureServe 2022).

Two new sites of Canada ricegrass were documented in the study area in 2022, both determined to be extensions to previously-reported occurrences. One new patch consisted of two fruiting plants along a newly-constructed segment of Highway 29, west of Bear Flat, BC. This occurrence was first discovered in 2020, in multiple locations of remnant native shrub-grassland on a bench north of Highway 29. The second new site of Canada ricegrass was a patch of an estimated 75 plants found in fruit on a gentle shrub-grassland slope north of Fort St. John, BC. Areal coverage of the new patch is approximately 460 m^2. This occurrence was also first documented in 2020.

There are a total of five known occurrences of Canada ricegrass (in 19 patches) in the RAA, all found during Site C survey work. The occurrences are located from the Cache Creek area east to the Pine and Beatton Rivers. An estimated total of 321 plants have been documented in an approximate total area of 1,221 m^2. All of the Canada ricegrass sites occur on level to gently sloped, open, good quality native shrub-grassland or remnants of such, usually in close proximity to aspen woodlands. Soils at the sites can be moist to dry. The Canada ricegrass plants grow scattered in dense vegetation consisting of a diverse assemblage of low shrubs and herbs. Dominant associated species are native plants and include the shrubs prairie saskatoon, prickly rose, and chokecherry; graminoids such as spreading needlegrass (*Achnatherum richardsonii*), slender wheatgrass (*Elymus trachycaulus* ssp. *subsecundus*), false melic (*Schizachne purpurascens*), and hay sedge; and forbs such as northern bedstraw and anemones (*Anemone* spp.). A few non-native species are also present at the sites, particularly Kentucky bluegrass.

7.3.10. Ranunculus rhomboideus (prairie buttercup)

Prairie buttercup (Figure 12) is a soft-hairy perennial of the Ranunculaceae (buttercup family). The species grows in grasslands, prairies, open woods and thickets across north-central North America (Whittemore & Parfitt 1997; Douglas et al. 1998). In B.C., prairie buttercup is only known from the Peace River region (BCCDC 2022a). The taxon's range extends southeast through the Canadian prairie provinces and the northern U.S. Great Plains into Nebraska, Iowa, Illinois, and southern Ontario (Whittemore & Parfitt 1997; NatureServe 2022).

Figure 12: *Ranunculus rhomboideus* (prairie buttercup)

Prairie buttercup has a ranking of S2S3 (Imperilled and Vulnerable) in B.C., and is on the province's Blue list (BCCDC 2022a). Globally, the taxon is ranked G5 (Secure). Only sporadic sub-national ranks are provided for prairie buttercup: Alberta, Saskatchewan, Manitoba, and Ontario class the species as S4

(Apparently Secure); Iowa as S3 (Vulnerable); Illinois and Michigan as S2 (Imperilled); Nebraska as S1 (Critically Imperilled); and Québec as SX (Presumed Extirpated) (NatureServe 2022).

One new occurrence of prairie buttercup was documented in the study area in 2022. Two plants in fruit were found along a small trail in open shrub-grassland east of Taylor, BC.

In total, 12 occurrences of prairie buttercup (in seventeen patches) have been reported in the RAA. Nine of the occurrences (fourteen patches)—discovered during the Site C rare plant survey work—are situated north of the Peace River from the Cache Creek area east to the Beatton River, and contain an estimated 210 plants in an approximate total area of 419 m^2. One other plant, observed west of the confluence of the Peace and Pine Rivers in 2018, was also found during Site C-related work. The remaining occurrences are historical records not recently verified and with no information available on precise location, number of individuals or areal coverage. The habitat for prairie buttercup is somewhat variable: soils can range from moist to dry, shrub cover can be dense to sparse, and occurrence microsite can be flat to sloped. Dominant associated species include a wide variety of native forbs such as northern bedstraw and American vetch as well as weedy grasses such as smooth brome and Kentucky bluegrass. Native shrub species are also present, the most commonly reported being rose (*Rosa* spp.) and prairie saskatoon.

7.3.11. Salix petiolaris (meadow willow)

Meadow willow (Fig 13), a shrub or small tree of the Salicaceae (willow family), has long, slender leaves and is found in moist to wet habitats across north-central North America (Douglas et al. 1998; Argus 2010). In B.C., the species has only been collected in the northeast part of the province (BCCDC 2022a; Klinkenberg 2022). Meadow willow extends north to Northwest Territories, east across Canada to Nova Scotia, and south in the United States as far as New Jersey, Missouri, and Colorado (NatureServe 2022).

Meadow willow is ranked S3 (Vulnerable) in B.C. and is on the Blue list for the province (BCCDC 2022a); the species is classed as G5 (Secure) globally. Across much of North America the taxon is classed as Secure (S5) or Apparently Secure (S4), but is considered rare on the southern edge of its range: S1 (Critically Imperilled) in Missouri; S2 (Imperilled) in Ohio and Colorado, and S3 (Vulnerable) in Prince Edward Island and Illinois (NatureServe 2022).

One new patch of meadow willow was documented in the study area in 2022, an extension of an occurrence first discovered in 2021 on the southern edge of a large wetland on the plateau between the Peace and Moberly Rivers. Twenty additional vegetative shrubs were mapped, increasing both the total number of meadow willow plants to 22, and the areal coverage to approximately 160 m^2. The plants were growing in partial shade in a thicket of diverse tree and shrub species along a weedy road edge. Associated species included *Salix discolor* (pussy willow), *Salix lasiandra* var. *lasiandra* (Pacific willow), *Salix bebbiana* (Bebb's willow), balsam poplar, western snowberry, and prickly rose.

Figure 13: *Salix petiolaris* (meadow willow)

Including the site described above, there are a total of six reported occurrences of meadow willow in the RAA, five of which have not been recently field verified. Four records date from 1967 to 1976 and provide little or no information besides a collection point: two are from east of Fort St. John, B.C., and two are located to the south near Dawson Creek, B.C. The fifth occurrence was reported in 2008 from along a forest road south of Hudson's Hope, B.C., but subsequent attempts to relocate this site have not been successful and it is presumed that either the location data or the identification are incorrect. The record states that 250–1,000 individuals were observed over an area of 1,500 m^2 along the edge of a logging road in mixed upland forest.

7.3.12. Selaginella rupestris (rock selaginella)

Rock selaginella (Figure 14) is a small, mat-forming evergreen perennial in the Selaginellaceae (spike-moss family). The taxon is found in a variety of open, dry, rocky or gravelly habitats in eastern and central North America (Valdespino 1993; Douglas et al. 1998). In B.C., rock selaginella is known only from the Peace River region (BCCDC 2022a; Klinkenberg 2022). The taxon ranges east across Canada to Nova Scotia and southeast in the U.S. to southern Georgia (Valdespino 1993; NatureServe 2022).

Figure 14: *Selaginella rupestris* (rock selaginella)

Rock selaginella is ranked S2 (Imperilled) in B.C., and is on the Red list for the province (BCCDC 2022a). The taxon is classed as G5 (Secure) globally, but sub-national rankings vary. Of the jurisdictions providing a rank, rock selaginella is listed as S5 (Secure) in Ontario, Québec, Arkansas, Georgia, and Virginia; as S4 (Apparently Secure) in Saskatchewan, Manitoba, and New York; as S3 (Vulnerable) in Alberta, Illinois, North Carolina, West Virginia, Vermont, and Massachusetts; as S2 (Imperilled) in Iowa, Alabama, and New Jersey; as S1 (Critically Imperilled) in New Brunswick, Nova Scotia, Ohio, Indiana, North Dakota, and Wyoming; and SX (Presumed Extirpated) in Delaware (NatureServe 2022).

Two new patches of rock selaginella were documented in the study area in 2022; these were determined to be extensions of a previously-reported occurrence. An estimated 250–1,000 plants over an approximate area of 1,520 m^2 were observed about 750 m west of the main patch first discovered in 2012. The occurrence is located on steep shrub-grassland hillsides on the lower slopes of Bullhead Mountain, west of Hudson’s Hope, BC.

In total, there are ten known occurrences of rock selaginella (in 16 patches) in the RAA. Nine of the occurrences—discovered or resurveyed as part of the Site C rare plant work—are located north of the Peace River, from Williston Reservoir east to the Alberta border, and contain an estimated 3,530 individuals in an approximate total area of 7,466 m^2.

The tenth occurrence of rock selaginella in the RAA, reported for 2020 but not part of the Site C work, consists of a collection from over 45 km south of the Peace River. A few clumps were found on a dry grassland hillcrest north of Highway 97, 16 km southwest of Chetwynd, B.C.; areal extent, associated species, and other details were not documented.

The rock selaginella sites are dry and usually rocky; most of the occurrences are in open shrub-grassland habitat on south-facing hillsides or hillcrests, and slopes are often quite steep. Dominant associated species include the shrubs prairie saskatoon, kinnikinnick, and common juniper (*Juniperus communis*); graminoids such as junegrass, thickspike wildrye, and various dryland sedge species; and forbs such as prairie sagewort, northern bedstraw, and woolly yarrow. The exceptions are two occurrences found in open forest near the east end of Williston Reservoir, where the rock selaginella was growing with mosses on rock in shaded, dry microsites.

Appendix 7. Portage Mountain Bat Studies 2022 Annual Report

Site C Wildlife Monitoring – Portage Mountain Bat Studies: 2022 Annual Report

Photo Credit: Ausenco

Photo Credit: F. Martinez-Nunez

Prepared for:

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

Project No. 989619-10

Prepared by:

Ausenco
18th Floor, 4515 Central Boulevard
Burnaby, BC V5H 0C6
T: 604.669.0424
F: 604.669.0430
ausenco.com

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Executive Summary

BC Hydro's quarry on Portage Mountain, developed and operated between 2019 and 2021, supplied blast rock and fill materials for the Site C Clean Energy Project. The quarry is close to rock crevice habitat that is highly suitable for bats and is used by federally designated at-risk bat species. The Portage Mountain quarry operated under spatial and temporal constraints intended to minimize impacts on bats and bat habitat. Starting in 2016, BC Hydro undertook bat monitoring as part of its bat mitigation and monitoring plan, with the objective of collecting data to identify and characterize impacts to bats and bat habitat due to quarry construction and assess the effectiveness of mitigation. Annual reports of monitoring results have been produced since 2016 and a comprehensive report was produced in early 2022 that synthesized all available monitoring data to late 2021.

This 2022 annual report summarizes the methods and results of 2021 to 2022 monitoring at Portage Mountain. It also summarizes methods and results to date of bat acoustic data collection undertaken by the province at five sentinel sites in northwestern British Columbia that will be used to provide comparative data on bat activity to be used in future comprehensive monitoring reports.

Bats were monitored at Portage Mountain year-round between late 2021 and late 2022 using emergence counts and remote acoustic detectors. Emergence counts were used to monitor roost site use, including two suspected maternity roosts. Remote acoustic detectors provided continuous, long-term monitoring of bat activity at Portage Mountain.

Bats were observed emerging at two of the three potential maternity roosts monitored in 2022. The number of bats counted at one of the two roosts represents an increase in the number of bats counted at that roost compared to the previous three years. One Portage Mountain acoustic detector had power supply issues in 2022, resulting in data gaps for this unit, but no data gaps occurred for the other detectors. Bats in the *Myotis* genus were the species group most commonly recorded at Portage Mountain during the 2021 to 2022 field season. Based on the acoustic detections of *Myotis* and big brown bat files during winter 2021/2022, bats continue to hibernate at Portage Mountain.

The five sentinel site detectors were active beginning in spring (March to April) 2022 for sampling periods ranging from 11 to 181 days. Big brown bat was assigned to the largest number of bat call files at the sentinel sites. Eastern red bat, silver-haired bat, hoary bat, little brown myotis, long-eared myotis, northern myotis and long-legged myotis were also confirmed. A brief assessment of the compatibility of the Portage Mountain and sentinel site datasets was completed. A comparison of broad trends in bat activity between sentinel sites and Portage Mountain is planned for the 2024 report.

This work was performed in accordance with Purchase Order 4130005798 under Master Service Agreement 95055 between Ausenco Sustainability Inc., a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and BC Hydro (Client), dated March 31, 2022. This report has been prepared by Ausenco, based on fieldwork conducted by Ausenco, for sole benefit and use by BC Hydro. In performing this work, Ausenco has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work

and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the report was produced. The conclusions and recommendations contained in this report are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

This Executive Summary is not intended to be a stand-alone document, but a summary of findings as described in the following Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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List of Acronyms and Abbreviations

Acronym / Abbreviation	Definition
BC	British Columbia
BMP	Best Management Practice(s)
BWBSmw	Boreal White and Black Spruce moist, warm subzone
WBWSwk1	Boreal White and Black Spruce wet, cool Murray subzone variant
NA	Not applicable
quarry	Portage Mountain Quarry
Project	Site C Clean Energy Project
study area	Portage Mountain Quarry and adjacent cliffs
SARA	*Species at Risk Act*
NABat	North American Bat Monitoring Program

List of Symbols and Units of Measure

Symbol / Unit of Measure	Definition
%	per cent
km	kilometre
m	metre
n	number

1.0 Introduction

Portage Mountain, approximately 15 kilometres (km) west of Hudson's Hope in northwestern BC (**Figure 2-1**), is the site of a quarry developed to supply aggregate for the construction of the Site C Clean Energy Project in the Peace River valley. The Portage Mountain Quarry provided riprap material used for constructing the Highway 29 realignment and protecting the shoreline along the Peace River near Hudson's Hope during the eventual filling of the reservoir. The quarry ceased operation in 2021.

Baseline studies for the Site C Clean Energy Project (Andrusiak 2014; Simpson et al. 2013), as well as subsequent surveys (Sarell and Alcock 2017), identified cliff faces at Portage Mountain as hibernation and roosting habitat for bats, including two at-risk bat species: little brown myotis (*Myotis lucifugus*) and northern myotis (*Myotis septentrionalis*), listed as endangered on Schedule 1 of the federal *Species at Risk Act* (SARA). Little brown myotis is also provincially Blue-listed (Special Concern). Disturbance of bats during winter may cause them to arouse from hibernation and repeated arousals in response to disturbance are considered detrimental to their survival (Boyles 2017; Sheffield et al. 1992; Thomas 1995).

The potential effects of development and operation of the Portage Mountain Quarry (**Figure 2-1**) on nearby bats were assessed in the Site C Environmental Impact Statement (BC Hydro 2013) and monitoring and mitigation for bats is required by the provincial Environmental Assessment Certificate, the Federal Decision Statement, and Schedule A of the Project's conditional water licences. BC Hydro implemented mitigation actions (BC Hydro 2020) during the quarry's development and operation to minimize the potential for impacts on bats, including the following:

- spatial setback of quarry activities from roost sites; and
- temporal restrictions on high-intensity noise or vibration (i.e., blasting) from 15 September to 15 May to avoid disturbing bats during winter hibernation.

The objective of monitoring bat activity at Portage Mountain is to collect data to help identify and characterize any impacts to bats and bat habitat due to the construction and operation of Portage Mountain Quarry, as described in the *Bat Mitigation and Monitoring Plan* (BC Hydro 2020), which allows the efficacy of mitigation and previous predictions of impacts to be tested. Bat activity monitoring at Portage Mountain over the years has used the following general approaches:

- monitoring of noise and vibration from construction activities, including blasting, to assess whether the disturbance is within best management practices (BMP) guidelines (MOE 2016c) and evaluate whether there are significant relationships with bat activity patterns.
- emergence counts (**Section 4.2.1**) at identified maternity roosts (9427G and 6287F; **Figure 2-1**).
- additional emergence counts at roosts not yet determined to be occupied by maternity colonies (**Section 4.2.1**).
- roost monitoring using remote logger devices (**Section 4.3.2**) to sample activity, temperature, and humidity at the identified maternity roosts.
- long-term, year-round passive acoustic monitoring (**Section 4.3**) using remote bat detectors at the north and south cliffs and near the quarry. Data from acoustic monitoring provide ongoing documentation of bat species presence and activity to assess seasonal and year to year changes in bat activity and potential effects of quarry operation on bat activity and species presence.

Using funds provided by BC Hydro, the province began bat acoustic monitoring at five sentinel sites (i.e., control sites) in northeastern BC in fall 2020. The sentinel sites provide comparative data that can be used to assess trends in activity of bats at Portage Mountain. No in-depth comparisons of the sentinel data and the Portage Mountain data are presented in this report; that comparison is planned for the 2023 report when more sentinel monitoring data are available, pending additional discussions with BC Hydro. This report summarizes the results of bat monitoring at Portage Mountain from late fall 2021 to late fall 2022 undertaken to meet the objectives of the *Bat Mitigation and Monitoring Plan* (BC Hydro 2020) and the methods and results of the sentinel site monitoring from its start in 2021 until fall 2022.

2.0 Study Areas

The study areas consist of the Portage Mountain study area, in which bat activity has been monitored continuously since 2017, and the sentinel sites, at which bat activity has been monitored since 2021.

2.1 Portage Mountain Study Area

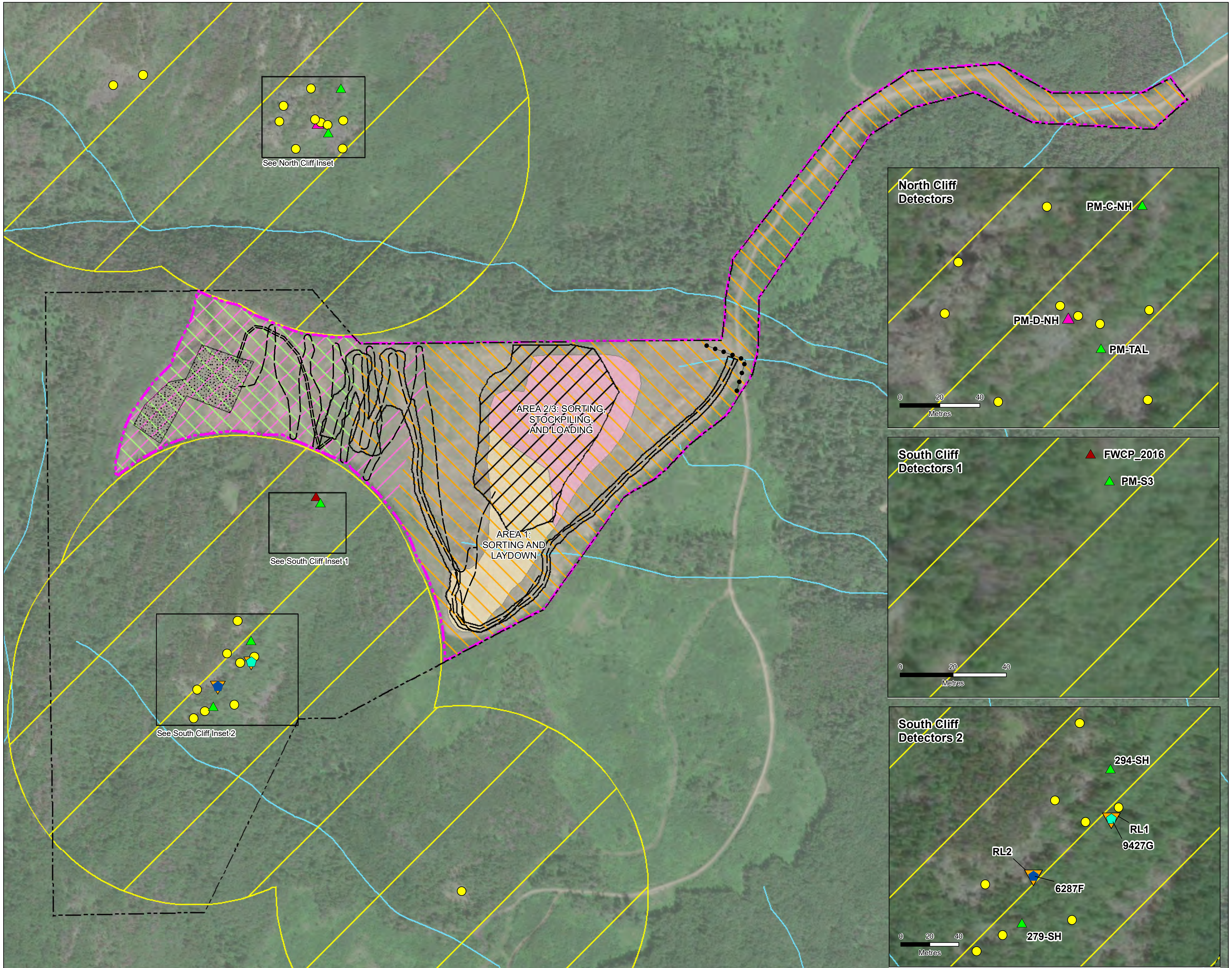
The Portage Mountain study area has been described in Hemmera (2020) and is briefly summarized here. The bat monitoring study area (**Figure 2-1**) includes the quarry (BC Hydro 2020) and the adjacent cliffs to the north and south within approximately 750 metres (m) of the quarry. This study area has the following characteristics indicative of potential bat hibernacula (MOE 2016a, 2016b; Nagorsen et al. 1993):

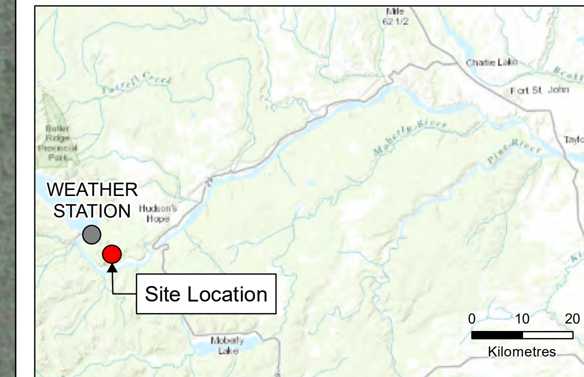
- large and exposed (i.e., sparsely vegetated) rock features that gain and maintain solar insolation and have numerous crevices; and
- deep crevices and caves (including mine adits) that provide cool and stable temperatures and high humidity for hibernating bats.

The Portage Mountain cliffs are located within the Boreal White and Black Spruce moist, warm (BWBSmw) biogeoclimatic subzone variant, in forest dominated by hybrid white spruce (*Picea engelmannii* x *glauca*) and trembling aspen (*Populus tremuloides*). The two main areas of cliff (north and south) are separated by an unnamed creek gully that drains into Dinosaur Reservoir (**Photo 2-1**). A stand of mature balsam poplar (*Populus balsamifera*) is present within the gully. Development of the Portage Mountain quarry, located on the south side of the creek gully, began in 2017 with clearing and access road construction. Production blasting and extraction of quarry rock began in the summer of 2019 and ceased in 2021. Further details of quarry activities are provided in **Section 3.2**. The quarry is accessed by a forestry road (400 Road) and is located at an average elevation of 1,020 m.

Site C Clean Energy Project
Wildlife Mitigation and Monitoring Services

Study Area and Bat Detector Locations for Portage Mountain Bat Monitoring





Legend

- Permanent Bat Detector
- Bat Detector (Historic)
- Short-Term Bat Detector
- Confirmed Maternity Roost
- Potential Hibernacula
- Potential Maternity Roost
- Roost Logger
- Weather Station
- Security Fencing
- In Quarry Access Road
- Quarry Haul Road
- Stockpile Road
- Site Boundary
- Potential Hibernacula - 300m Buffer
- Portage Mountain LOO
- Stripping/Overburden Stockpile Area
- Quarry Road
- Stockpile & Sort Area
- Quarry Development Area
- Grubbing Area by BC Hydro
- Clearing Area by BC Hydro
- Area 1: Sorting and Laydown
- Area 2/3: Sorting, Stockpiling, and Loading

Notes

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

Sources

- Base Data: BC Hydro, 2017
- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

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Metres

NAD 1983 UTM Zone 10N

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989619-10	Production Date: Feb 10, 2022	Figure 2.1

Hemmera An Ausenco Company

BC hydro

Photo 2-1 Portage Mountain Quarry, Gully and North Cliffs

2.2 Sentinel Sites

The sentinel sites (**Figure 2-2**) are five locations at which bats were monitored in northwestern BC, summarized in **Table 2-1**. The Rainbow Rocks (Williston Lake) site (**Photo 2-2**) is located northwest of Portage Mountain. Two sites, Bear Flats (**Photo 2-3**) and Tea Creek (**Photo 2-4**), are located along the Peace River valley northeast of Portage Mountain. The Hasler Bluffs (**Photo 2-5**) and Bergeron Cliffs (**Photo 2-6**) sites are located to the south of Portage Mountain. All but one of the sentinel sites are in the BWBSmw; the Bergeron Cliffs site is located in the Boreal White and Black Spruce wet cool Murray (BWBSmk1) variant.

Table 2-1 Bat Monitoring Sentinel Sites

Sentinel Site	Approximate Distance from Portage Mountain Quarry (km)	Biogeoclimatic Subzone Variant	Approximate Elevation (m)
Rainbow Rocks (Williston Lake)	26	BWBSmw	840
Bear Flats	67	BWBSmw	760
Tea Creek	76	BWBSmw	700
Hasler Bluffs	43	BWBSmw	660
Bergeron Cliffs	113	BWBSwk1	1,100

Site C Clean Energy Project
Wildlife Mitigation and Monitoring Services

Figure 2-2 Bat Detector Locations - Sentinel Sites

Legend
- Portage Mountain Quarry
- Sentinel Site
- Weather Station
- Site C Dam Site
- Geographic Location
- Highway
- Provincial Boundary

Notes
1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources
- Contains information licensed under the Open Government Licence - Province of British Columbia
- Base Data: BC Hydro, 2017
- Aerial Image: World Topo Base

N
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989619-10	Production Date: Mar 15, 2023	Figure 2.2

Ausenco BC hydro

Path: S:\Geomatics\Projects\989619\10_portage_mtn_bats\mxd\Fig2_2_989619_10_PortageMtnBats_SentinelSites_230315.mxd

Photo 2-2 Rainbow Rocks Monitoring Location, April 2020

Photo 2-3 Bear Flats Monitoring Location, April 2020

Photo 2-4 Tea Creek Monitoring Location, April 2020

Photo credit: B. Paterson

Photo 2-5 Hasler Bluffs Monitoring Location

Photo credit: B. Paterson

Photo 2-6 Bergeron Cliffs Monitoring Location

3.0 Background

Bat baseline studies were conducted from 2012 to 2014 at Portage Mountain to support the development of the Environmental Impact Statement for the Site C Clean Energy Project. Those studies determined that some rock features in the vicinity of the proposed quarry area were highly suitable for hibernating bats (Andrusiak 2014). Two at-risk bat species are known to be present at Portage Mountain and are very likely hibernating based on the dates of detections: little brown myotis and northern myotis. Both species are listed as endangered on Schedule 1 of the SARA and both have been confirmed to use rock crevices for hibernation (COSEWIC 2013; White et al. 2020). Based on previous surveys and the characteristics of the habitat, rock crevices used by little brown myotis and northern myotis for hibernation at Portage Mountain meet the criteria for critical habitat under the SARA (COSEWIC 2013). Six other bat species have been recorded at Portage Mountain, at least four of which are likely hibernating and all of which could be using maternity roosts (trees and rock crevices) in the vicinity of Portage Mountain (**Table 3-1**). Based on known bat distributions (Lausen et al. 2022), a similar suite of species is expected to be present at the sentinel sites.

Table 3-1 Bat Species* Previously Recorded at Portage Mountain**

English Name	Scientific Name	BC Status	SARA Schedule 1 Status	Winter Behaviour
Long-eared myotis	*Myotis evotis*	Yellow	None	Hibernate
Little brown myotis	*Myotis lucifugus*	Blue	Schedule 1 Endangered	Hibernate
Northern myotis	*Myotis septentrionalis*	Blue	Schedule 1 Endangered	Hibernate
Long-legged myotis	*Myotis volans*	Yellow	None	Hibernate
Silver-haired bat	*Lasionycteris noctivagans*	Yellow	None	Hibernate or Migrate
Eastern red bat	*Lasiurus borealis*	Unknown	None	Migrate
Hoary bat	*Lasiurus cinereus*	Yellow	None	Migrate
Big brown bat	*Eptesicus fuscus*	Yellow	None	Hibernate

Notes: *English and scientific names are those used by the BC Conservation Data Centre (BC CDC 2022)
**(Andrusiak 2014; Hemmera 2018, 2020; Sarell and Alcock 2017)

The bat studies conducted since 2014 (Andrusiak 2014; Hemmera 2018, 2020; Sarell and Alcock 2017) used a combination of passive acoustic surveys and emergence surveys to build an understanding of bat activity and habitat use, and provide strong evidence that bats are using Portage Mountain rock crevices for the following:

- hibernacula in the winter (typically both sexes, likely in small groups).
- maternity roosts in the summer where breeding females congregate to gestate, give birth, and raise young.
- day roosts, in the spring, summer, and fall, used by single individuals or small groups of males or of non-reproductive females.

BC Hydro prepared a bat monitoring plan in 2017, which was updated in 2020 (BC Hydro 2020) with input from the Site C Clean Energy Project's Vegetation and Wildlife Technical Committee.

The ongoing bat monitoring program at Portage Mountain (**Table 3-2**) consists of:

- year-round acoustic monitoring
- emergence counts at maternity roosts during the summer
- monitoring of noise and vibration produced by quarry operation.

Monitoring studies (Hemmera 2018, 2020) were designed to determine the efficacy of mitigation implemented during construction and operation of the Portage Mountain quarry to reduce the disturbance or displacement of bats that use rock crevices as maternity roosts and/or hibernacula (**Figure 2-1**; **Table 3-2**). **A comprehensive report (Hemmera 2022) was prepared in early 2002 that summarized all bat data collected at Portage Mountain between August 21, 2017 and November 3, 2021.** The province began bat acoustic monitoring at five sentinel sites in 2021 (**Table 3-2).**

Table 3-2 Bat Monitoring Program Components Conducted at Portage Mountain and Sentinel Sites

Monitoring Activity	2017	2018	2019	2020	2021	2022
Portage Mountain						
Passive Acoustic Bat Activity	X	X	X	X	X	X
Maternity Roost Emergence Counts and Roost Inspection	X	X	X	X	X	X
Noise and Vibration	–	X	X	X	X	-
Sentinel Sites						
Passive Acoustic Bat Activity	–	–	–	–	X	X

Note: X = surveys were conducted, – = surveys were not conducted.

3.1 Known and Suspected Hibernacula and Maternity Roosts

Early studies identified sections of the Portage Mountain cliffs adjacent to the quarry as potential hibernacula (Andrusiak 2014; Sarell and Alcock 2017). Hemmera (Hemmera 2018, 2019, 2020) conducted passive acoustic monitoring over multiple years and identified peaks of bat activity during the mating period in the fall (swarming), some winter bat activity, and activity in the spring when bats start emerging from hibernation, supporting the conclusion that bats were hibernating at the cliff features at Portage Mountain.

Early studies also identified use of the cliffs as day roosts (Hemmera 2018, 2020). Emergence counts conducted in 2017 through 2021 (**Table 3-3**) identified potential maternity roosts (6287F, 9247G) in the cliffs south of the quarry (**Figure 2-1**) based on multiple individuals observed exiting the cliffs during emergence counts. Other counts identified areas of the cliff where smaller numbers of bats were observed emerging. However, finding specific roost crevices in the cliffs is difficult due to the presence of multiple crevices in close proximity, the height above ground of many crevices, and the steep and hazardous terrain that prevents surveyors from closely approaching crevices. Bats may also roost in the trees on Portage Mountain.

Table 3-3 Emergence Counts Previously Conducted at Portage Mountain

Year	Dates of Emergence Counts
2017	• July 31 to August 10
2018	• June 17 to June 20 • June 30 to August 03
2019	• June 09 to June 13 • June 19 • July 22 to July 25
2020	• June 22 to June 28 • July 14 to July 20
2021	• June 14 to June 20 • July 13 to July 20

3.2 Quarry Construction and Operation Activities and Bat Mitigation

Quarry construction and operation activities within the quarry boundaries (**Figure 2-1**) between 2019 and 2022 included the following:

- developing and upgrading road access;
- clearing vegetation in the quarry area;
- blasting, excavating, and transporting material; and,
- rock sorting (in the lower area close to 400 Road).

Construction activities for road access, vegetation clearing, and the haul road began in 2016 and were completed in fall 2019 (**Table 3-4**). In 2020, riprap loading and sorting and tree clearing continued, and nighttime activities took place from July 1 to October 9. Production blasting occurred during 2020 and 2021, ceasing in mid-August 2021. Additional processing and loading continued into June 2022, and maintenance and cleanup activity has occurred periodically at the quarry since then.

Table 3-4 Quarry Construction and Operation Activities 2017- 2022

Dates	Location *	Activity
2016	Access road and quarry site	Clearing and access road construction
August 10 to August 14, 2018	Future quarry site	Test blasting
June 6 to September 15, 2019	Quarry and along 400 Road	Tree clearing
June 6 to August 20, 2019	Quarry	Blasting for haul road construction
August 21 to September 15, 2019	Pit	Production blasting
May 16 to September 14, 2020	Pit	Production blasting
May 16 to early November, 2020	Quarry, Stockpile and Sorting Area (Area 1) to Offsite Rip Rap Stockpile Area (Area 4)	Tree clearing
May 16 to early November 2020	Area 1 to Area 4	Riprap loading and sorting

Dates	Location *	Activity
July 1 to August 18, 2020	Area 1 to Area 4	Nighttime hauling
July 22 to August 18, 2020	Pit to Area 1	Nighttime hauling with vehicle lights only
July 22 to August 18, 2020	Pit	Nighttime excavation at the pit
August 9, 2020	Area 1	Installation of lights for safety at nighttime
August 28 to October 9, 2020	Area 1 to Area 4	Nighttime hauling
May 16 to August 17, 2021	Pit	Production blasting
March to April, 2021	Area 5	Clearing, grubbing, stripping and hauling
May to August, 2021	Area 1 to Area 4	Nighttime hauling in areas 1 and 4
September to December, 2021	Area 1	Processing material
March to June, 2022	Area 2 and 3	Load remaining material for berm construction
June 2022	All	Construct water bars and site cleanup
October 2022	all	Additional cleanup, dig out settling ponds, water bar maintenance

Note: *See **Figure 2-1**.

4.0 Methods

Methods implemented at Portage Mountain from 2017 through 2022 were developed in consultation with the Vegetation and Wildlife Technical Committee and local biologists (Hemmera 2018). Methods are based on standard techniques used for bat studies (Bachen et al. 2020; BC Ministry of Environment 2016b), with minor variations to account for the specific habitats, terrain, and access challenges at the monitoring sites.

4.1 Weather and Sunset Data

BC Hydro provided hourly weather data from their weather station at the Portage Mountain quarry (**Figure 2-1**).

4.2 Portage Mountain Roost Emergence Counts, Roost Inspections, and Maternity Roost Monitoring

Bats consistently emerge from maternity roosts at dusk for feeding, which provides opportunities for roost identification and enumeration of bats via emergence counts. Roosts used by pregnant and nursing female bats have more regular patterns of emergence than roosts used by male or non-reproductive individuals (Barclay 1989; MOE 2016b). The objectives of the emergence surveys were to identify maternity roosts, to assess potential changes in use of the cliffs as maternity roosts, and to examine the relationship between any changes in maternity roost use and quarry activity.

Two methods were used to collect emergence data at identified and suspected maternity roosts and non-maternity roosts:

- emergence counts and roost inspections; and
- continual roost monitoring with remote roost loggers placed near the roost entrances to record bat calls.

4.2.1 Portage Mountain Roost Emergence Counts and Roost Inspections

Roost emergence counts were conducted in 2022 at Portage Mountain following methods described in Loeb et al. (2015) and Vonhof (2006). The methods have been previously described in Hemmera (2019). Information on site selection criteria was provided in the 2017 to 2019 bat monitoring report (Hemmera 2020). Physical inspections for roosting bats or bat sign such as guano were conducted where potential features could be safely accessed by surveyors.

Visual emergence counts were completed twice yearly during the maternity period: once ('early period') during pre-volancy (i.e., when pups are not able to fly) between June 1 and June 21, and once ('late period') during post-volancy (i.e., when pups can fly) from July to early August. Emergence counts were conducted from 30 minutes before dusk until approximately one hour after dusk, when visibility became a limiting factor, or until bats started to return to the roost. Each site on the north and south cliffs was surveyed on two consecutive nights both pre- and post-volancy (four surveys total). Surveyors were equipped with handheld acoustic detectors (Echometer Touch) that recorded bat vocalizations in the vicinity of the surveys. Sites where no bats were observed were not resurveyed in subsequent years.

4.2.1.1 Data Analysis

The numbers of bats observed exiting the cliff at each roost emergence count location on each date were summed. Observations of bats foraging or flying by the observer were not included in the total unless the surveyor had observed the bats emerging from the cliff.

Acoustic data recorded by the Echometer Touch hand-held units during emergence counts were analysed using the same process used for all the other acoustic data analyses in this project (**Section 4.3**). Acoustic data were correlated with the visual observations made by the surveyors based on the location and time of the observations and hand-held unit recordings, as well as the surveyors' comments.

The bat mitigation and monitoring plan (BC Hydro 2020) and previous monitoring reports for Portage Mountain (Hemmera 2020) use a threshold of 10 bats emerging at a given site to define a 'maternity roost', although some of the provincial BMP definitions for a 'significant' roost (**Section 3.1**) specify fewer individuals than the threshold of 10 bats used for this project. Hemmera/Ausenco is not aware of any literature that provides a minimum number of bats that constitute a maternity roost. To maintain consistency through multiple years of data analysis, the 10-bat threshold was used; however, roosts where three to nine individuals were counted were also reported.

The following criteria were used to determine likely maternity roost occupancy:

- at least 10 bats emerging from a single feature during at least one emergence count during the maternity period (assumed to occur from mid-May to mid-August [Paterson, B., pers. comm., July 2019]).
- emergence timing at or near sunset (indicative of lactating females with dependent pups).
- observations of bats returning to the roost (i.e., to feed dependent pups) during the emergence survey.
- a marked increase in count numbers occurring at a single site over the pre-volant to volant period for young-of-year bats, in consideration of other influencing factors such as weather.

Daily emergence at or near sunset may indicate lactating female bats. Lactating bats leave their roosts at or near sunset because the energetic burdens of pregnancy and nursing require them to start foraging early to maximize foraging duration (Henry et al. 2002; Lemen et al. 2016). The daily emergence times of males and non-breeding females are more flexible because they have lower energy demands than lactating females and can use daily torpor to further decrease their metabolic requirements (Kurta et al. 1989; reviewed in Sedgeley 2001). Lactating females must also return to the roost during the night to nurse dependent pups.

The presence of juveniles also provides strong evidence of a maternity roost, at least up to the late summer period. The presence of juveniles in the roost can be inferred by a sudden increase in the number of bats counted during emergence counts late in the summer, when young-of-the-year can fly, compared to the number of bats counted during emergence surveys early in the summer.

4.2.1.2 Assumptions and Data Limitations

The assumptions used in collection and analysis of the emergence count data include the following:

- observers can accurately distinguish between a bat emerging from the cliff and a bat foraging along the cliff.
- vocalizations recorded on the observer's handheld detector at the same time as a visual observation of an emerging bat are those of the bat observed.

The accuracy of emergence counts was limited by physical and weather conditions at the sites monitored. Surveyors had to choose vantage points that were safe for them to access, which often meant that they could not get the best view of emerging bats. Some bats emerged from crevices high on the cliffs and it was difficult for observers at the bottom of the cliffs to see them. Rain and fog impeded visibility on some counts as described in **Section 5.2**. The assumptions related to acoustic data recorded during emergence counts are similar to those described for long-term acoustic monitoring (**Section 4.3**).

4.3 Long-term Passive Acoustic Monitoring

Bioacoustic technology is an efficient, non-invasive tool for examining bat activity patterns and species diversity over long durations. Acoustic detectors provide a metric of bat activity based on the number of bat calls recorded within approximately 50 m (Fraser et al. 2020; Lausen 2016). Year-round acoustic monitoring is used to assess ongoing bat activity and compare that activity between years and annual bat life stages. Acoustic data can be used to confirm the presence of individual species and document any changes in bat species diversity between years. Acoustic data can also be used to infer use of hibernacula. Evidence of hibernation occurring in proximity to the detector includes the following:

- relatively high bat activity recorded during the fall mating and swarming periods;
- limited and localized winter activity; and
- surges of activity during spring emergence.

4.3.1 Portage Mountain Detectors and Detector Locations

The rationale behind selection of locations for long-term bat detectors on the north and south cliffs of Portage Mountain (**Figure 2-1**; 'permanent bat detector') was described in Hemmera (2019).[1]

A single Songmeter detector was installed at each of 4 locations in November 2017 and those locations have been monitored continuously to date, although some data gaps have occurred due to equipment issues (Hemmera 2022). The SM2 detectors installed in 2017 at the beginning of the study period were replaced by new SM4BAT-ZC units equipped with SMM-U1 or SMM-U2 microphones in summer 2019. One detector (PM-C-NH) was deployed at the north cliff, two (279-SH and 294-SH) on the south cliff, and one (PM-S3) between the south cliff and the quarry (**Table 4-1**). Those four locations have been monitored year-round from 2017 through 2022. A fifth detector (PM-TAL) was installed on June 26, 2020, upslope from a talus field at the north cliff and has been operating continuously since its installation.

[1] **Figure 2-1** also depicts locations of bat detectors used in earlier investigations of bat activity on Portage Mountain ('historic' and 'short-term' detectors).

Table 4-1 Long-term Passive Acoustic Monitoring Sites, 2017 to 2022

Name	General Location	Distance (m) From Closest Quarry Boundary	Comment
PM-D-NH	North cliff	320	
PM-C-NH	North cliff	402	
PM-TAL	North cliff talus	330	Installed 2020
279-SH	South cliff	401	Suspected maternity roost 6287F
294-SH	South cliff	334	Suspected maternity roost 9427G
PM-S3	Quarry	81	

Detector settings have been described in Hemmera (2019). Microphones were calibrated in July 2022 to confirm sensitivity within the manufacturer's specified range and to maximize consistency in data collection. The detectors were visited every other month to download data and verify detector operation.

The detectors were prepared for winter with protected microphones and cables, a water- and snow-resistant housing, and a combination battery/solar power supply. Each detector was outfitted with a 12-volt battery (seven amp-hours) powered by a Renogy 100-watt solar panel, and a Morningstar SS 20L-12V SunSaver 20-amp solar charge controller.

4.3.2 Portage Mountain Data Processing

Acoustic data analysis methods used in 2022 were identical to those of 2020 and 2021. The acoustic data analysis followed a conservative approach as recommended by Lausen (2016); only files with two or more echolocation pulses (Vonhof 2006) separated by at least one second (termed a bat 'pass', 'call' or 'file') were included in the analysis and were considered for classification to species level or species group. A series of bat passes could be made by the same bat flying multiple times in front of the microphone or by multiple individuals (Adams et al. 2015); therefore, the results provide a relative index of bat activity (files per detector-night) but do not represent an estimate of bat populations in the study area.

Analysis methods were consistent with those used by the North American Bat Monitoring Program (NABat) as described in Smith (2020). Bat files were classified based on acoustic parameters for the targeted bat species (summarized in **Appendix A**) using two automated species classifications: Kaleidoscope Pro (V3.1.6 Wildlife Acoustics Inc.) and species-specific filters developed for AnalookW V4.5 (Titley Electronics, Ballina, New South Wales, Australia). Noise files, such as ambient background sounds, were excluded from the dataset using a filter in AnalookW. The automated classification results were then manually verified based on professional judgement. Bat calls were either classified according to species or grouped into categories based on their acoustic parameters (**Appendix A**). Files with multiple species or individuals were assigned to each of the relevant categories (i.e., were counted once for each species and individual). Social calls were identified through manual inspection.

The acoustic parameters used for the identification of each call were derived from accepted characteristics based on scientific studies and acoustic libraries (Lausen 2016). Updated provincial bat protocols for acoustic monitoring are not yet available. Therefore, the analysis methods used for 2020 to 2021 data (Hemmera 2018, 2020, 2022), which were developed through consultation between Hemmera and a bat specialist with the BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development (Hansen, I.J., pers. comm., September 2018), were repeated for the 2022 analysis (**Appendix A**).

Bat echolocation calls, especially those from the *Myotis* genus, can be difficult to identify to species due to high variability within species (Obrist et al. 2004) and overlap in call characteristics among some species. Where *Myotis* calls could not be definitively identified to species they were assigned to the *Myotis* category, which is composed of little brown myotis, long-eared myotis, northern myotis, and long-legged myotis because of overlap in call characteristics (**Appendix A**). The *Myotis* category (**Appendix A**) was assumed to indicate the potential presence of the endangered little brown myotis or northern myotis. Similarly, silver-haired and big brown bat are often grouped together, as are eastern red bat and little brown myotis, again because of overlap in call characteristics. Known or potential *Myotis* species files (including all files identified as any of the *Myotis* species, the *Myotis* category, and the 35K eastern red bat/little brown myotis category) were merged into a broader *Myotis* group for analysis. The ‘big brown bat’ broad species group used for some summaries included files categorized as big brown bat and as big brown bat / silver-haired bat.

A night of monitoring by a single detector was termed a ‘detector-night’, assigned to the date on which the night began even though the file itself may have been recorded in the early morning of the next day. The numbers of bat passes recorded per detector-night were compared between detectors and over time to examine patterns in bat activity.

An R script was created to identify dates when no bat or noise files were recorded by each detector (i.e., data gap). Each bat file was linked to hourly weather from BC Hydro’s Portage Mountain weather station (**Section 4.1**). A subjective number of consecutive days without data was chosen to assess whether a detector was functioning correctly: if no bat calls or noise files were recorded for a period of five nights or more in summer or 20 or more nights in winter, fall, or spring, the detector was considered inactive.

4.3.3 Sentinel Site Detectors and Detector Locations

Bat detectors were deployed at five known bat hibernacula in north-eastern BC (M. Kellner, pers. comm). All five sites represented cliff crevice habitat. Installation and servicing of the sentinel site detectors was carried out by a consultant under contract to the Province, and the information in this section was provided by Brian Paterson (pers. comm. 2022). The original deployment in April 2020 included four Anabat Swift detectors (Titley Scientific Ltd.) with US-0-V1 microphone and one SM2Bat+ detector with an SMX-US microphone (Wildlife Acoustics Inc.). In April 2021, all detectors were replaced with new Anabat Swift units equipped with US-0-V3 omnidirectional microphones and powered by 12-volt lithium batteries attached to 30-watt solar panels. The microphone of the SM2Bat+ was calibrated with the Wildlife Acoustics Inc. ultrasonic calibrator and the Swift units were calibrated using the on-board microphone sensitivity gauge set to 12 and tested using finger snaps and ambient background noise. Microphones were installed on a painter’s pole either extended upwards vertically or extended horizontally over the cliff edge. Secure digital (SD) cards with 64 GB capacity were initially installed; these were replaced with 192 GB SD cards in 2022.

The gain of the SM2Bat+ detector was set at 12 kHz (the Swift detectors do not have gain settings). All detectors were programmed to record with a two-second trigger window and maximum file length of 15 seconds. All detectors were set to record full-spectrum files between 16 and 200 kHz from 15 minutes before sunset until 15 minutes after sunset. A summary of the sentinel site detectors and locations is presented in **Table 4-2**.

Table 4-2 Sentinel Site Detector Locations and Specifications

Location	2020 Installation Date	Zone	UTM Easting	UTM Northing	Detector Type	Microphone Type	Microphone Height[1] (m)
Rainbow Rocks	April 12	10V	535294	6220897	Anabat Swift	US-0-V1 US-0-V3 (after Apr 2021)	50
Tea Creek	April 11	10V	624506	6235500	Anabat Swift	US-0-V1 US-0-V3 (after Apr 2021)	40
Bear Flats	April 11	10V	612658	6238223	Anabat Swift	US-0-V1 US-0-V3 (after Apr 2021)	40
Bergeron Cliffs	April 13	10U	625964	6116291	Anabat Swift	US-0-V1 US-0-V3 (after Apr 2021)	45
Hasler Bluffs	April 15	10U	568133	6163616	SM2Bat+ (Apr 2020-Apr 2021) Anabat Swift (from Apr 2021)	SMX-U1 (Apr 2020-Apr 2021) US-0-V3 (after Apr 2021)	40

Notes:

1. Height includes the height of the cliffs on which the microphone was located.

4.3.4 Sentinel Site Data Processing

Classification of the sentinel site bat acoustic data was completed by a contractor chosen by the province. Analysis methods were consistent with those used by NABat (Rae and Lausen 2022) and are described below (B. Paterson, pers. comm. 2022)

> *"Full spectrum data were processed through two auto-ID programs (Kaleidoscope Pro and Sonobat), followed by manual review to identify files with discrepancies or deviations from expected results. Species and species group labels followed BC NABat (Rae and Lausen 2022). Species and classifications were typically given an 'm' or an 'f' prefix to denote whether the analyst (B. Paterson) observed diagnostic characteristics (such as mEPFU) in each file or whether auto-ID was relied on for the classification (such as fEPFU). For final submission, 'm' and 'f' prefixes were removed to streamline results."*

Detector log files were used to quantify sampling effort and identify dates when the detectors were not functioning. The time of sunset and the temperature recorded at the closest weather station were linked to each bat file record as described in **Section 4.3.2** for the Portage Mountain data. The sentinel site data were grouped into the following species groups, which differed from that used for Portage Mountain data:

- Big brown bat
- Big brown and hoary bats
- Big brown, hoary, and silver haired bats
- Big brown and silver haired bats
- Big brown and long-eared bats
- Little brown myotis
- Little brown and long-legged myotis
- *Myotis* sp.
- Northern myotis
- Long-legged myotis.

4.3.5 Acoustic Data Analysis

The Portage Mountain and sentinel site acoustic data were summarized separately due to differences in the acoustic data classification process and study design (e.g., sampling effort, distance between detectors).

4.3.5.1 Bat Life Stages

Bat annual life stages include hibernation, emergence, maternity (summer), and swarming. Bat activity levels vary considerably through the year, driven by seasonal weather patterns and life stages. The beginnings and ends of these stages are gradual rather than sharply defined by a single date (BC Ministry of Environment 2016b). However, to aid with the seasonal examination of bat data, dates corresponding to annual life stages were defined for the Portage Mountain bats using yearly bat acoustic data.

The species detected at Portage Mountain are a mixture of migratory and hibernating bats (**Table 3-1**), and the onset and duration of annual life stages will vary between species (Whitaker Jr and Rissler 1992; van Schaik et al. 2015) and by overwintering strategy. Ideally, life stage dates would have been defined for each species, but *Myotis* sp. made up the majority of bat calls in the Portage Mountain dataset, with too few calls of other acoustic classes to complete a quantitative analysis of life stages. Therefore, life stage dates were only based on data classified as being *Myotis* sp. files. For the bat life stage analysis, the *Myotis* group consisted of the following identification categories: all *Myotis* species, the red bat / little brown myotis groups (assumes there are few to no red bats in the group), and high-frequency bats. Data from all detectors on Portage Mountain were combined as it was assumed that any seasonal effects would apply to all detectors.

The method described by Meyer et al. (2016) was used to define the start and end of emergence and hibernation, which is based on the cumulative number of calls within defined periods. Hibernation start was defined as the date between September 22 and November 15 by which 95% of the cumulative sum of files had occurred, and end was defined as the date between March 20 and June 1 by which 5% of the cumulative sum of files occurred (Meyer et al. 2016). Emergence start was defined as the date between March 20 and June 1 (i.e., hibernation end) on which 5% of the cumulative sum of files occurred, and emergence end was the date between March 20 and June 1 on which 50% of the cumulative sum of files occurred.

Bat activity increases just prior to hibernation at sites where they hibernate (Van Schaik et al. 2015). This increase in activity is termed 'swarming' and is believed to be associated with mating and the search for hibernacula (Parsons et al. 2003, Van Schaik et al. 2015). There is limited published work that uses a statistical approach to identify the swarming period with acoustic data. Hemmera previously used the methods of Parsons et al. (2003) to identify swarming periods or lack thereof. However, preliminary examination of the late summer and fall 2022 data did not detect swarming at Portage Mountain (**Appendix B**) and thus no further effort to quantify a swarming period was made.

4.3.5.2 Quantifying Bat Activity

To summarize bat activity at the Portage Mountain and sentinel sites during the respective sampling periods, bat activity was calculated as the number of bat call files per active detector-night. This accounts for differences in sampling effort that can occur due to different time periods detectors were active. For Portage Mountain bat activity was summarized by bat species group, detector, and bat life stages. For the sentinel sites, bat activity was summarized as bat call files per species group and detector but not the number of bat call files per active detector night.

5.0 Results

5.1 Portage Mountain Maternity Roost Emergence Counts

Early-season emergence counts at two roosts (6287 and 9427G) took place June 17 to June 22. No surveys were conducted June 16 or 18 due to heavy rain and low temperatures. Light rain also was noted during surveys on June 17. No precipitation was recorded on the remaining nights. Ten emergence counts were conducted during early-season surveys, all at the south cliff. Temperatures at the start of emergence counts ranged from 12 °C to 17 °C.

Late-season surveys at the three roosts took place July 19 to July 25, excluding July 22. No precipitation was recorded during the late-season surveys. Ten emergence counts were conducted during late-season surveys, eight at the south cliff and two at the north cliff. Temperatures at the start of emergence counts ranged from 16 °C to 22 °C.

Results of the 2022 emergence counts are presented in **Table 5-1**. Bats were counted emerging at six of the 10 early surveys and at six of the 10 late surveys. Counts at the 9427G roost ranged from 0 to 34 bats during the early surveys and 31 to 34 bats during late surveys. Early season counts at the 6287F roost ranged from zero to 11 bats and late season counts ranged from one to two bats. No early season counts took place at NHEC3b roost due to inclement weather, and no bats were recorded there during counts over two nights during the late season.

Table 5-1 2022 Emergence Count Results

Date	Location	Location	Survey Period	Emerging Bats Counted
17 June	9427G	south	early	0
17 June	6287F	south	early	11
19 June	9427G	south	early	0
20 June	6287F	south	early	2
20 June	9247G	south	early	21
21 June	6287F	south	early	0
21 June	6287F	south	early	0
21 June	9427G	south	early	34
22 June	6287F	south	early	2
22 June	9427G	south	early	9
19 July	6287F	south	late	2
19 July	9427G	south	late	34
20 July	6287F	south	late	1
20 July	9427G	south	late	32
21 July	NHEC3b	north	late	0
21 July	NHEC3b	north	late	0
23 July	NHEC3b	north	late	0
23 July	NHEC3b	north	late	0
25 July	6287F	south	late	2
25 July	9247G	south	late	31

5.2 Long-term Passive Acoustic Monitoring

Results of acoustic monitoring at Portage Mountain and the five sentinel sites are presented below.

5.2.1 Portage Mountain Acoustic Results

A summary of cumulative survey effort for the 2021 - 2022 season at Portage Mountain is available in **Table 5-2**. The five permanent detectors recorded data on 1,433 detector-nights between November 4, 2021 and November 14, 2022.

Table 5-2 Remote Detector Survey Effort (Nights When Detectors Were Operating) at Portage Mountain During the 2021 – 2022 Field Season

Detector	Detector- Nights
279-SH	376
294-SH	376
PM-C-NH	173
PM-S3	147
PM-TAL	361
Total Detector Nights	**1,433**

A summary of the data gaps by date is presented in **Table 5-3**. Only detector PM-C-NH had data gaps during the 2021 – 2022 season. These data gaps were due to a range of power supply issues that resulted in a low battery life. Cables, battery and solar charger were replaced in July, and in November a new solar panel and cables were installed.

Table 5-3 Timing of Data Gaps by Detectors at Portage Mountain During the 2021 – 2022 Field Season

Detector	Data Gap Dates	Gap Length (Nights)
PM-C-NH	Dec. 23, 2021 – Jan. 26, 2022	35
PM-C-NH	Mar. 10, 2022 – Apr. 10, 2022	32
PM-C-NH	May 6, 2022 – Jun. 19, 2022	45
PM-C-NH	Aug. 5, 2022 – Sep. 26, 2022	53
Total	-	**165**

Bats in the *Myotis* genus were the most commonly recorded species group at Portage Mountain during the 2021 – 2022 field season, followed by the big brown & silver-haired bat species group (**Table 5-4**). The *Myotis* species group, which contains the endangered little brown myotis, was most detected at 279-SH, followed closely by PM-S3, which were located furthest and closest to the quarry, respectively.

Table 5-4 Number of Files per Species Group Recorded by All Detectors at Portage Mountain During the 2021 – 2022 Field Season

Species Group	Number of Files	Files per Active Detector-night
Big brown	5,366	15.7
Big brown & silver-haired	42,404	136.8
Eastern red	503	1.7
Hoary	1,105	3.2
Myotis	127,964	463.8
Silver-haired	324	1.0

Table 5-5 Number of Files per Detector and Bat Species Group at Portage Mountain During the 2021 - 2022 Field Season

Detector	Species Group	Number of Files	Files per active detector night
279-SH	Big brown	3,651	9.7
	Big brown & silver-haired	16,636	44.2
	Eastern red	224	0.6
	Hoary	494	1.3
	Myotis	64,151	170.6
	Silver-haired	166	0.4
294-SH	Big brown	1,030	2.7
	Big brown & silver-haired	13,044	34.7
	Eastern red	148	0.4
	Hoary	433	1.2
	Myotis	22,465	59.8
	Silver-haired	106	0.3
PM-C-NH	Big brown	149	0.9
	Big brown & silver-haired	1,345	7.8
	Eastern red	69	0.4
	Hoary	22	0.1
	Myotis	9,734	56.3
	Silver-haired	11	0.1
PM-S3	Big brown	225	1.5
	Big brown & silver-haired	4,596	31.3
	Eastern red	32	0.2
	Hoary	40	0.3
	Myotis	22,211	151.1
	Silver-haired	20	0.1

Detector	Species Group	Number of Files	Files per active detector night
PM-TAL	Big brown	311	0.9
	Big brown & silver-haired	6,783	18.8
	Eastern red	30	0.1
	Hoary	116	0.3
	Myotis	9,403	26.1
	Silver-haired	21	0.1

5.2.2 Bat Annual Life Stages

Based on the number of bat files recorded in 2022, emergence occurred on April 19, the summer season extended from April 20 to September 1, and hibernation started September 22. There was no clear visual pattern of bat calls in the late summer/fall period (July 15 to September 30) from which a swarming period could be identified. Based on a previous analysis (Hemmera 2022), the fall period was defined as occurring from September 2 to September 21.

A summary of bat activity by life stage and detector between November 2021 and November 2022 is presented in **Table 5-6**. The highest number of bat files recorded during all life stages was at detector 279-SH during the summer life stage. This detector also happens to be furthest from the quarry.

Table 5-6 Comparison of Bat Activity by Life Stage and Detector at Portage Mountain

Detector	Bat Life Stage*	Total Files	Active Detector-Nights	Files Per Detector Night
279-SH	hibernation	1,832	220	8.3
	summer	72,712	134	542.6
	fall	10,778	21	513.2
294-SH	hibernation	1,530	220	7.0
	summer	29,990	134	223.8
	fall	5,706	21	271.7
PM-C-NH	hibernation	423	110	3.9
	summer	10,907	62	175.9
PM-S3	hibernation	699	54	12.9
	summer	18,654	72	259.1
	fall	7,771	21	370.1
PM-TAL	hibernation	899	205	4.4
	summer	13,672	134	102.0
	fall	2,093	21	99.7

*Bat life stage dates were based on *Myotis* activity but files are from all bat species detected.

The first bat call files recorded in 2022 by each detector are presented in **Table 5-7**. Detector PM-TAL recorded the first bat call files of the year on January 20, when both *Myotis* and big brown call files were recorded. Big brown, big brown & silver-haired and *Myotis* call files were also recorded in January by detectors 279-SH and 294-SH.

Table 5-7 First Bat Files Recorded in 2022 by Detector at Portage Mountain

Detector	Date of File	Species	Temperature °C
All Species Groups			
279-SH	January 25	Big brown	1.4
294-SH	January 23	Big brown & Silver-haired	5.8
PMC-NH	February 10	Big brown	6.2
PM-S3	June 21	*Myotis*	10.9
PM-TAL	January 20	Big brown, *Myotis*	3.7
Myotis Species Groups			
279-SH	January 27	*Myotis*	-1.5
294-SH	April 18	*Myotis*	-7.4
PMC-NH	April 21	*Myotis*	-0.3
PM-S3	June 21	*Myotis*	10.9
PM-TAL	January 20	*Myotis*	3.7

5.2.3 Sentinel Site Acoustic Results

The sentinel site detector dataset obtained by Hemmera/Ausenco in November 2022 consisted of identifications of files from the five sentinel sites dating from April 11, 2020 until June 24, 2021. The sentinel site detectors were active from spring (March to April) for sampling periods ranging from 11 to 181 days. The Bergeron Cliffs detector recorded until as late as mid-October in 2020 but recording ceased at the other sites at various times during the spring and summer months due to the SD cards filling to capacity with full-spectrum calls. The detectors were not deployed throughout the fall and winter. Additional data were recorded in 2022 but are not yet available and will be presented in future reporting.

During the time detectors were deployed, there were no gaps in the data longer than four nights during the summer period or 19 nights during spring, fall, and winter. Based on these criteria there were no data gaps during the period the detectors were deployed. A summary of sentinel site detector downloads is presented in **Table 5-8**. The five detectors recorded data on 1,975 detector-nights between April 11, 2020 and June 24, 2021. There were ample data collected during the time detectors were deployed, with the number of bat call files ranging from 5,446 to 18,583. However, the duration of sampling was relatively short compared to Portage Mountain, with some detectors recording for fewer than 50 nights and none longer than 180 nights.

Table 5-8 Sentinel Site Detector Download Summary

Location	Year	Detector Type	Start Date Or Visit Date	Sampling End Date	Active Detector Nights	Number of Bat Files
Bear Flats	2020	Swift	April 11	August 5	117	17,296
	2021	Swift	April 15	June 24	70	14,194
Bergeron Cliffs	2020	Swift	April 13	October 11	180	6,919
	2021	Swift	April 9	June 20	73	11,543
Hasler Bluffs	2020	SM2Bat+	April 15	April 26	11	5,446
	2021	Swift	April 9	May 11	33	14,938
Rainbow Rocks	2020	Swift	April 12	July 12	92	18,583
	2021	Swift	April 15	May 10	30	13,250
Tea Creek	2020	Swift	April 11	June 12	63	12,007
	2021	Swift	April 15	June 1	47	12,220

The dates that the first bat files were recorded by the sentinel site detectors in 2020 and 2021 are presented in **Table 5-9**. The first bat call files at Bergeron Cliffs were recorded three nights after detector installation in 2021, while for other detectors, and for Bergeron Cliffs in 2020, the first bat call files were recorded the date the detector was installed or on the following night.

Table 5-9 Dates of First Bat Files Recorded at Sentinel Sites in 2020 and 2021

Detector	Year	Date of File	Species	Comment
Bear Flats	2020	April 11, 2020	Big brown	Installed April 11
			Big brown or Silver-haired	
			Silver-haired bat	
	2021	April 16, 2021	Big brown	Installed April 15
			Big brown or Hoary	
			Big brown or Long-eared	
			Big brown or Silver-haired	
			Myotis	
			Silver-haired bat	
Bergeron Cliffs	2020	April 13, 2020	Big brown	Installed April 13
	2021	April 12, 2021	Big brown	Installed April 9
Hasler Bluffs	2020	April 15, 2020	Big brown	Installed April 15
			Big brown or Silver-haired	
			Myotis	
	2021	April 9, 2021	Big brown	Installed April 9
			Big brown or Silver-haired	

Detector	Year	Date of File	Species	Comment
Rainbow Rocks	2020	April 12, 2020	Big brown	Installed April 12
			Big brown or Silver-haired	
	2021	April 11, 2021	Big brown	
Tea Creek	2020	April 11, 2020	Big brown	Installed April 11
			Big brown or Silver-haired	
	2021	April 16, 2021	Big brown	Installed April 15
			Big brown or Hoary	
			Big brown or Silver-haired	
			Myotis	
			Silver-haired bat	

A summary of the numbers of bat call files recorded at the sentinel sites in 2020 and 2021 is presented in **Appendix C**. The identification assigned to the largest number of files (42,416) was big brown bat. Eastern red bat, silver-haired bat, hoary bat, little brown myotis, long-eared myotis, northern myotis, and long-legged myotis were also confirmed.

6.0 Conclusions

Based on the acoustic detections of *Myotis* and big brown bat files during winter 2021-2022 (**Table 5-6, Table 5-7**), bats continue to hibernate at Portage Mountain. Bats continue to use two of the three roosts being monitored, with an average of 32 individuals observed per night during three emergence surveys at roost 9427G during the late maternity period. The 2022 counts represent the highest numbers of emerging bats counted at this roost since 2018, when an average of 40.5 bats was observed over two counts (Hemmera 2022).

The sentinel site study design differs from the design at Portage Mountain. Sentinel site data were collected from five detectors spaced relatively far apart (e.g., > 5 km), and therefore each site has different environmental characteristics that are likely to influence bat activity. In comparison, all the Portage Mountain detectors are relatively close together (e.g., < 1.5 km). It may be important to consider site characteristics for each sentinel site detector and understand how this could affect bat activity at sentinel sites relative to Portage Mountain. There is also some variation in acoustic file classification groups but differences in classification can largely be rectified by reclassifying the files before comparing the datasets.

There are differences in sampling duration between the first years of sentinel site data collection and Portage Mountain data collection. The intent of the sentinel program was to have year-round monitoring but from 2020 – 2021 data were only collected during the spring and summer periods with no fall or winter data collected. Data are expected to be recorded year-round at sentinel sites in 2022 and beyond (M. Kellner, BC Ministry of Water, Land and Resource Stewardship, pers. comm. March 6, 2023), which should facilitate future comparison of seasonal bat activity between sentinel sites and Portage Mountain. An updated comprehensive report is planned once 2024 sentienl and Portage Mountain data have been collected and analysed. That comprehensive report will build on the 2020 - 2021 comprehensive report (Hemmera 2022) and present all data collected to date at Portage Mountain and the sentinel sites. The comprehensive report will use all collected data to assess the effects of development, operation and closure of the Portage Mountain quarry on bat activity.

Reclamation of the Portage Mountain quarry is being planned. Reclamation will include the experimental creation of rock crevice features intended to function as bat roosting and hibernating habitat.

7.0 Closure

We sincerely appreciate the opportunity to have assisted you with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

Report prepared by:
Ausenco Sustainability Inc.

ORIGINAL SIGNED

Lorraine Andrusiak, M.Sc., R.P.Bio.
Senior Terrestrial Biologist

Report prepared by:
Ausenco Sustainability Inc.

ORIGINAL SIGNED

Meghan Anderson, M.Sc., R.P.Bio.
Technical Specialist

Report reviewed by:
Ausenco Sustainability Inc.

ORIGINAL SIGNED

Jay Brogan, M.Sc., R.P.Bio.
Biologist

8.0 References

Adams, A.M., L.P. McGuire, L.A. Hooton, and M.B. Fenton. 2015. How High is High: Using Percentile Thresholds to Identify Peak Bat Activity. Canadian Journal of Zoology 93(4):307–313.

Andrusiak, L. 2014. Peace River Site C Hydro Project Portage Mountain Bat Hibernacula. Prepared for BC Hydro.

Barclay, R.M.R. 1989. The Effect of Reproductive Condition on the Foraging Behavior of Female Hoary Bats, Lasiurus cinereus. Behavioral Ecology and Sociobiology 24(1):31–37.

BC Conservation Data Centre (BC CDC). 2022. BC Species and Ecosystems Explorer. Ministry of Environment (MOE). Available at https://a100.gov.bc.ca/pub/eswp/.

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Prepared for BC Hydro by Keystone Wildlife Research Ltd. Available at https://www.ceaa-acee.gc.ca/050/evaluations/document/85328?culture=en-CA.

BC Hydro. 2020. Site C Vegetation and Wildlife: Bat Mitigation and Monitoring Program.

Boyles, J.G. 2017. Benefits of Knowing the Costs of Disturbance to Hibernating Bats: Managing DIsturbances to Hibernating Bats. Wildlife Society Bulletin(41):388–392.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2013. COSEWIC Assessment and Status Report on the Little Brown *Myotis Myotis* lucifugus Northern *Myotis Myotis* septentrionalis Tri-colored Bat Peri*Myotis* subflavus in Canada, Ottawa, ON. Available at http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Little%20Brown%20*Myotis*%26Northern%20*Myotis*%26Tri-colored%20Bat_2013_e.pdf.

Fraser, E.E., A. Silvis, R. M. Brigham, and Z. J. Czenze, Editors. 2020. Bat Echolocation Research: A Handbook for Planning and Conducting Acoustic Studies. Bat Conservaton International, Austin, TX, USA. Available at https://www.researchgate.net/publication/344446390_Bat_Echolocation_Research_A_handbook_for_planning_and_conducting_acoustic_studies_Second_Edition_EDITORS_ii_Bat_Echolocation_Research_A_handbook_for_planning_and_conducting_acoustic_studies_Second_Edi.

Hansen, I.J. 2018. Personal communication. Consultation on Provincial Bioacoustic Monitoring Standards. E-mail. September 28, 2018.

Hemmera Envirochem Inc. (Hemmera). 2018. Bat Monitoring at Portage Mountain Quarry: Site C Wildlife Monitoring BCO 95055.

Hemmera Envirochem Inc. (Hemmera). 2019. Site C Vegetation and Wildlife Portage Mountain Bat Studies: Fall 2017 to Fall 2018. Report Prepared for BC Hydro.

Hemmera Envirochem Inc. (Hemmera). 2020. Portage Mountain Bat Studies Fall 2017 to Fall 2019: Site C Wildlife Monitoring BCO 95055.

Hemmera Envirochem Inc. (Hemmera). 2022. Site C Wildlife Monitoring - Portage Mountain Bat Studies: 2020 and 2021 Annual Report. Report to BC Hydro, Site C Clean Energy Project, Burnaby, BC.

Henry, M., D.W. Thomas, R. Vaudry, and M. Carrier. 2002. Foraging Distances and Home Range of Pregnant and Lactating Little Brown Bats (*Myotis* lucifugus). Journal of Mammalogy 83(3):767–774.

Kurta, A., G.P. Bell, K.A. Nagy, and T.H. Kunz. 1989. Energetics of Pregnancy and Lactation in Freeranging Little Brown Bats (*Myotis* lucifugus). Physiological Zoology 62(3):804–818.

Lausen, C. 2016. Bat Acoustic Training Workshop. Wildlife Conservation Society Canada, Creston, BC.

Lausen, C.L., D. Nagorsen, M. Brigham, and J. Hobbs. 2022. Bats of British Columbia. Second Edition. Royal BC Museum, Victoria, BC.

Lemen, C.A., P.W. Freeman, and J.A. White. 2016. Winter Activity of *Myotis* septentrionalis: Role of Temperature in Controlling Emergence from a Hibernaculum. Transactions of the Nebraska Academy of Sciences and Affiliated Societies 36:6–8.

Loeb, S.C., T.J. Rodhouse, L.E. Ellison, C.L. Lausen, J.D. Reichard, K.M. Irvine, T.E. Ingersoll, J.T.H. Coleman, W.E. Thogmartin, and J.R. Sauer. 2015. A Plan for the North American Bat Monitoring Program (NABat).

Ministry of Environment (MOE). 2016a. Best Management Practices for Bats in British Columbia: Chapter 3: Caving, Rock Climbing, Geocaching and Other Activities around Cave and Crevice Habitat. BMP Series. Ministry of Environment (MOE), Victoria, BC. Available at https://a100.gov.bc.ca/pub/eirs/viewDocumentDetail.do?fromStatic=true&repository=BDP&documentId=12460.

Ministry of Environment (MOE). 2016b. Best Management Practices Guidelines for Bats in British Columbia: Chapter 1: Introduction to Bats of British Columbia. BMP Series. Ministry of Environment (MOE), Victoria, BC. Available at https://a100.gov.bc.ca/pub/eirs/viewDocumentDetail.do?fromStatic=true&repository=BDP&documentId=12460.

Ministry of Environment (MOE). 2016c. Best Management Practices Guidelines for Bats in British Columbia. Chapter 2: Mine Developments and Inactive Mine Habitats. Ministry of Environment (MOE), Victoria, BC.

Nagorsen, D.W., R.M. Brigham, and I. McTaggart-Cowan. 1993. Bats of British Columbia. Volume 1. UBC Press, Vancouver, BC.

Nagorsen, D.W., and B. Paterson. 2012. An Update on the Status of Red Bats, Lasiurus blossevillii and Lasiurus borealis, in British Columbia. Northwestern Naturalist 93(3):235–237.

Obrist, M.K., R. Boesch, and P.F. Flückiger. 2004. Variability in Echolocation Call Design of 26 Swiss Bat Species: Consequences, Limits and Options for Automated Field Identification with a Synergetic Pattern Recognition Approach. Mammalia 68(4).

Paterson, B. 2019. Personal communication. Life Cycle of Bats in the Peace Region. E-mail. July 23, 2019.

Sarell, M., and W. Alcock. 2017. Bat Hibernacula Assessment for Portage Mountain: Prepared for BC Hydro. Ophiuchus Consulting.

Sedgeley, J.A. 2001. Quality of Cavity Microclimate as a Factor Influencing Selection of Maternity Roosts by a Tree-dwelling Bat, Chalinolobus tuberculatus, in New Zealand. Journal of Applied Ecology 38(2):425–438.

Sheffield, S., J. Shaw, G. Heidt, and L. McClenaghan. 1992. Guidelines for the Protection of Bat Roosts. Journal of Mammalogy 73(3):707–710.

Simpson, K., T.K. Simpson, L. Simpson, L. Andrusiak, S. Hilton, M. Kellner, K. Klafki, I.J. Mattson, and A. Creagh. 2013. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project Environmental Assessment: Appendix R-7. Part 7 Mammals. Keystone Wildlife Research Ltd. (Keystone). Available at https://www.ceaa.gc.ca/050/documents_staticpost/63919/85328/Vol2_Appendix_R-7-Mammals.pdf.

Smith, D., B. Reichert, C. Lausen, S. Loeb, T. Weller, R. Allen, E. Britzke, T. Hohoff, J. Siemers, B. Burkholder, and M. Verant. 2020. A Guide to Processing Bat Acoustic Data for the North American Bat Monitoring Program (NABat): Version 1.2 (Draft). Open-File Report 2020–XXXX. US Dept. of Interior, US Geological Survey.

Thomas, D.W. 1995. Hibernating Bats Are Sensitive to Nontactile Human Disturbance. Journal of Mammalogy 76(3):940.

Vonhof, M.J. 2006. Handbook of Inventory Methods and Standard Protocols for Surveying Bats in Alberta. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division, Calgary, AB.

Weller, T.J., V. Seidman, and C. Zabel. 1998. Assessment of foraging activity using Anabat II: A cautionary note. Bat Research News 39:61–65.

White, J.A., P.W. Freeman, H.W. Otto, and C.A. Lemen. 2020. Winter Use of a Rock Crevice by Northern Long-Eared *Myotis* (*Myotis* septentrionalis) in Nebraska. Western North American Naturalist 80(1):114.

Appendix A
Acoustic Characteristics Used to Identify Bat Species

Table A-1. Text description of call characteristics of bat species in the study area, modified from Lausen, C. 2017. Bat data analysis cheatsheet. Unpubl.

Common Name	Scientific Name (Species Code)	Description*
Big brown bat / silver-haired bat	*Eptesicus fuscus / Lasionycteris noctivagans* (EPFU/LANO)	Calls are very similar. Diagnostic features include: LANO produces flat calls at 25 kHz, which EPFU does not; EPFU tends towards higher frequencies in clutter seen as an Fmax that can start above 60 kHz, whereas even with higher clutter calls (call duration < 6 ms), LANO tends towards Fmax values <50 kHz. The presence of second harmonic can aid in making differentiation because an Fmax <50 kHz can be attributed to species differences rather than distance of bat from microphone.
Eastern red bat	*Lasiurus borealis* (LABO)	Can have a low Sc <45 in open environments. Fmin ranges from 35 – 45 kHz and calls often have a characteristic "upturn" to the toe. MYLU in open environments can produce calls with very low Sc values also, so in an uncluttered situation, differentiating LABO and MYLU should be done using more than just call parameters. MYLU will generally have a more pronounced "elbow" or bend to its call (like a hockey stick shape) that you do not see in LABO (which instead is a smoothly curving call) Also, LABO, being a lasiurine, will tend to have an undulating up/down call pattern
Hoary bat	*Lasiurus cinereus* (LACI)	Long passes containing numerous pulses will be needed to differentiate this species from other low-frequency bats unless the calls are obviously <20 kHz with long duration (>10 ms) and TBC* (>400 ms). When call Fmin is >20 kHz, the duration and TBC is substantially less, but there will generally be an "up and down Fmin pattern" which characterizes this species
Long-eared myotis	*Myotis evotis* (MYEV)	Calls are generally steep (Sc>250+ but as low as 150 in some cases), with Fmin varying from 30 kHz up to 40. Can overlap with northern *Myotis* at its highest Fmin (~39 - 42 kHz). At higher frequencies where MYEV and MYSE can overlap, these passes should be placed into a general "long-eared" category. EPFU/ LANO can produce calls around 25 kHz that are steep, so there is possibility of overlapping with this species group, however, their Sc+ values are usually <150, whereas long-eared calls are steeper than this
Northern myotis	*Myotis septentrionalis* (MYSE)	Calls are generally steep, but unlike some of the other long-eareds, their call body slopes are more often low (as low as 150 OPS). Individual calls are generally Fmin 38-48 kHz. Below 43 kHz, MYSE overlaps with MYEV and would thus be grouped within the "Long-eared" category.
Little brown myotis	*Myotis lucifugus* (MYLU)	Often included in a more general "*Myotis*" or "High-frequency" category as MYLU calls resemble those of other *Myotis* species. Generally, MYLU echolocates with Fmin 32-45 kHz with a highly variable slope (Sc can be as low as 20 OPS in extremely uncluttered situations, but higher than 400 OPS in a cluttered situation such as interacting with another bat or encountering vegetation). In low clutter, the low slope of MYLU generally allows it to be discerned from other *Myotis*; a pronounced bend (elbow) in the pulse may be seen in low clutter, and this feature is typically not present in other 40 kHz *Myotis*. MYLU is widespread across Canada and is versatile in its echolocation, such that variation is immense.
Long-legged myotis	*Myotis volans* (MYVO)	Similar call to that of MYLU. Include in a more general "*Myotis*" or "High-frequency" category.

Note: * Fmin = minimum frequency, ms=milliseconds, OPS = octaves per second, Sc = Slope of the call, TBC = time between calls

Sources Nagorsen and Paterson (2012), Weller et al. (1998).

Table A-2. Acoustic Characteristics of Bat Species in the Study Area (modified from Lausen 2016 with input from Hansen, I-J [pers. comm. 2018])

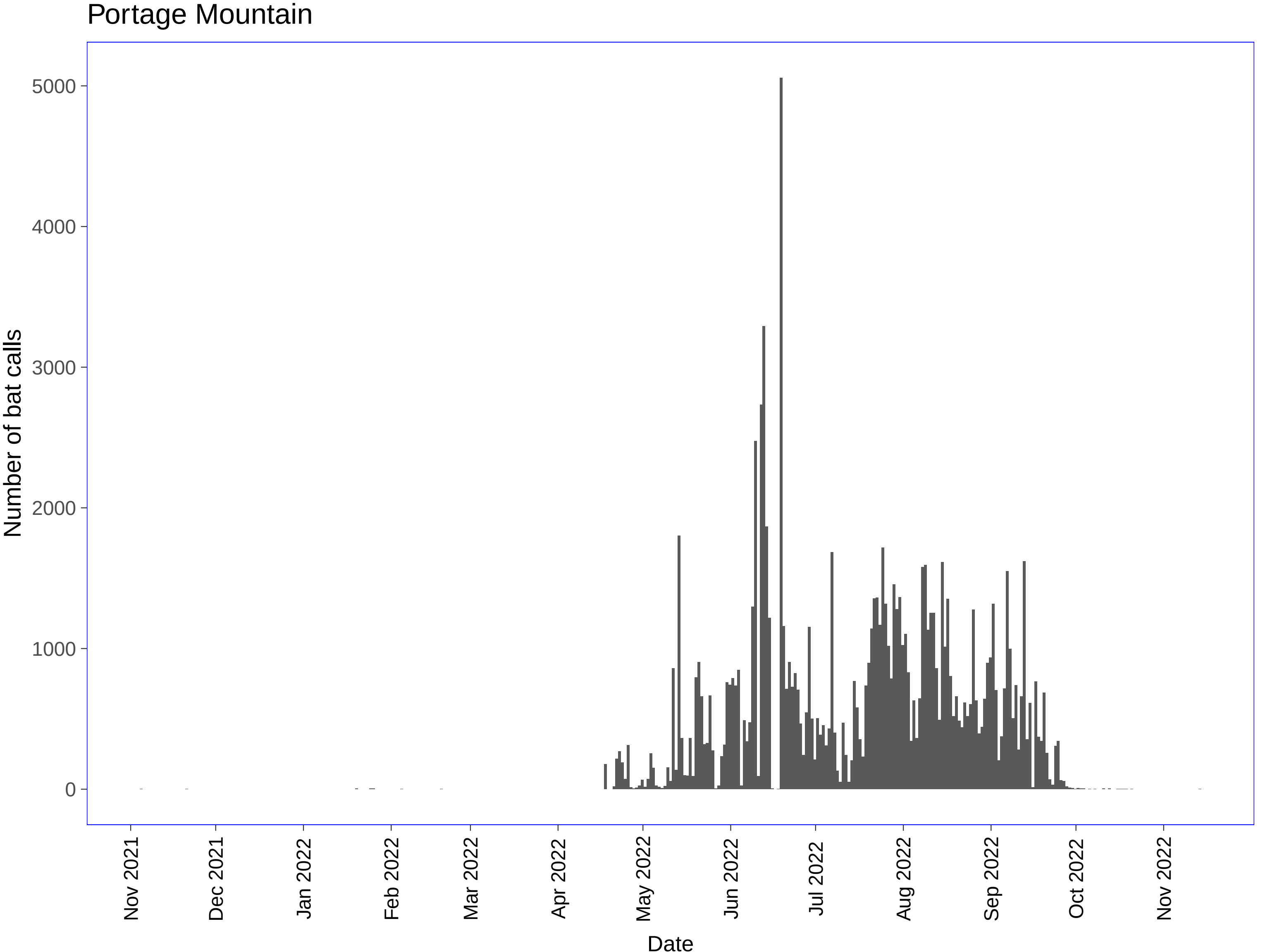
Species Group*						Common Name	Acoustic Parameters									
Little Brown Myotis / Eastern Red Bat	*Myotis* Species	Big Brown / Silver-haired Bat	High-frequency Bat	Bats with Minimum Frequency 30 kHz	Low- frequency Bat	Species	Duration (milliseconds)		Maximum Frequency (kHz)		Minimum Frequency (kHz)		Characteristic Frequency (kHz)		Slope of Call Body (Octaves per second)	
							Avg**.	Range of Averages	Avg.	Range of Averages	Avg.	Range of Averages	Avg.	Range of Averages	Avg.	Range of Averages
						Hoary bat	9.5	7.2–3.5	34	24–42	21	18 - 23	22	20 - 24	29	13 - 57.5
						Silver-haired bat	7.3	4.9–12.1	37	28–49	25.5	23–27	27	25–28	36.5	11–73.5
						Big brown bat	7	3.3–13.3	41	26–62	25.5	21–31	27	21–32	48	12–135
						Long-eared myotis	4.1	1.4–2.4	64	49–88	34	29–41	42.8	34.5–66.6	343	158–855
						Long-legged myotis	3.2	1.7–6.3	68	56–85	41	36–45	47	39–63	202	64–503
						Eastern red bat	6.5	5–8	53	49–59	41	37–45	41	37–45	29	23–41
						Little brown myotis	3.5	1.6–6.7	76.5	49–91	42	32–47	48	38–57	175	63–464
						Northern myotis	1.9	1.0–2.7	71.5	51–81	42	38.5–44	51	45–57	354	211–484

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

**Avg. = average

Appendix B

Temporal Trend in *Myotis* sp.
Activity at Portage Mountain from Fall 2021 to Fall 2022


Portage Mountain
Number of bat calls
0
1000
2000
3000
4000
5000
Nov 2021
Dec 2021
Jan 2022
Feb 2022
Mar 2022
Apr 2022
May 2022
Jun 2022
Jul 2022
Aug 2022
Sep 2022
Oct 2022
Nov 2022
Date

Appendix C

Summary of Bat Files Recorded at Sentinel Sites

Table C-1. Numbers of Files Recorded at Sentinel Sites by Species in 2020 and 2021

Year	Sentinel Site Name					
	Bear Flats	Bergeron Cliffs	Hasler Bluffs	Rainbow Rocks	Tea Creek	Grand Total
Big brown bat						
Total	12,726	6,809	3,912	5,759	13,210	42,416
2020	5,283	2,644	1,291	1,857	6,555	17,630
2021	7,443	4,165	2,621	3,902	6,655	24,786
Big brown bat or hoary bat						
total	2,431	799	252	259	298	4,039
2020	2,150	395	168	258	3	2,974
2021	281	404	84	1	295	1,065
Big brown bat or hoary bat or silver-haired bat						
total	163	0	0	0	13	176
2020	163	0	0	0	0	163
2021	0	0	0	0	13	13
Big brown bat or silver-haired bat						
total	5,421	2,856	1,818	1,463	3,747	15,305
2020	3,067	1,441	546	686	2,055	7,795
2021	2,354	1,415	1,272	777	1,692	7,510
Big brown bat or long-eared myotis						
total	73	40	12	9	30	164
2020	29	3	0	0	20	52
2021	44	37	12	9	10	112
Eastern red bat						
total	11	2	1	0	12	26
2020	8	0	1	0	12	21
2021	3	2	0	0		5
Eastern red bat or little brown myotis						
Total	245	220	11	265	306	1,047
2020	87	77	3	229	201	597
2021	158	143	8	36	105	450
Hoary bat						
Total	763	34	4	0	2	803
2020	763	30	2	0	2	797
2021	0	4	2	0	0	6
Silver-haired bat						
Total	1,471	784	391	359	1.072	4,077
2020	849	247	156	176	469	1,897
2021	622	537	235	183	603	2,180

Year	Sentinel Site Name					
	Bear Flats	Bergeron Cliffs	Hasler Bluffs	Rainbow Rocks	Tea Creek	Grand Total
Long-eared myotis						
Total	561	469	76	960	438	2,504
2020	349	146	23	757	255	1,530
2021	212	323	53	203	183	974
Little brown myotis						
total	3,618	2,134	592	4,101	1,474	11,919
2020	2,556	491	36	3,458	707	7,248
2021	1,062	1,643	556	643	767	4,671
Little brown myotis or long-legged myotis						
total	4	0	5	19	2	30
2020	4	0	0	19	2	25
2021	0	0	5	0	0	5
Myotis						
total	3,511	2,809	4,905	8,177	1,950	2,1352
2020	1,847	1,061	1,404	5,087	929	1,0328
2021	1,664	1,748	3,501	3,090	1,021	1,1024
Northern myotis						
Total	52	23	107	67	18	267
2020	44	1	0	42	15	102
2021	8	22	107	25	3	165
Long-legged myotis						
Total	440	1,483	8,298	10,395	1,655	22,271
2020	97	383	1,816	6,014	782	9,092
2021	343	1,100	6,482	4,381	873	13,179

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Appendix 8. Downstream Vegetation Monitoring 2022 Annual Report

ECOLOGIC CONSULTANTS LTD.
UNIT 224 – 998 HARBOUR DRIVE
NORTH VANCOUVER BC V7P 3T2
PHONE: 604 836 2273

MEMORANDUM

DATE:	January 26, 2023
TO:	Brock Simons, M.Sc., R.P.Bio. – Terrestrial Biodiversity Specialist, Site C Clean Energy Project
FROM:	Claudia Houwers, B.Sc., R.P. Bio, P. Biol. Danielle Mai, B.Sc., R.P. Bio, P. Biol. Jason Jones Ph.D., R.P.Bio., P.Biol.
SUBJECT:	Site C Clean Energy Project - Downstream Vegetation Monitoring Project 2022

1 PROGRAM BACKGROUND AND OBJECTIVES

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

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

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

The following questions will be addressed under this program:

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

2 PROGRAM PROTOCOLS

2.1 SELECTION OF POLYGONS FOR SAMPLING

2.1.1 Pre-field

Protocols presented in the Downstream Vegetation Monitoring Workplan (Tables 1 and 2 in EcoLogic and Tetra Tech 2018) were used as the basis for selection of plant species and ecosystems at risk in the Downstream Vegetation Monitoring study area. The tables were cross-referenced with the most current data from the BC Conservation Data Centre (BC CDC 2022) to confirm the listings had not changed in the interim and to determine whether any other plant or ecosystems at risk had the potential to occur in the Downstream Vegetation Monitoring study area.

Plant species at risk with the potential to occur within the Project area were identified prior to field surveys by reviewing literature and online sources such as Douglas et al. (2002), eFlora BC (2022), and the BC Species and Ecosystem Explorer (BC CDC 2022). All plant species Red- and Blue-listed in BC (i.e., species at risk) with mapped known occurrences or the potential for occurrence (based on ecological and biogeographic considerations) were subsequently identified as targets for survey. There are no federally listed plant species at risk with potential to occur in the Project area.

Table 2.1-1 represents Table 2 from the EcoLogic and Tetra Tech (2018) work plan with the addition of Map Code and Site Series columns. Fifteen ecosystems have been identified in the downstream vegetation monitoring area. Ecosystems at risk within the Project area were identified by reviewing the most current BC CDC database (2022). The search criteria for potentially occurring at-risk ecosystems included those that are Red- or Blue-listed, within the BWBSmw and the Peace Forest District.

Table 2.1-1. Distribution of site series in Downstream Vegetation Monitoring study area.

ID #	Map Code	Site Series	Site Series Name	CDC Status	Spatial Area (ha)
1	ATcp	101$6B.1	$At – Rose – Creamy peavine	Yellow	812
2	Fm20 (formerly Fm02)*	112	AcbSw – Mountain alder – Dogwood	Blue	307
3	SW	103	SwPl – Soopolallie – Fuzzy-spike rye	Yellow	179
4	SH	111	Sw – Currant – Horsetail	Blue	133
5	ATsw	103$6B.1	$At – Rose – Fuzzy-spiked wildrye	Yellow	107
6	GB	00	Gravel Bar	n/a	75
7	Fl06	00	Pacific willow – Red-osier dogwood – Horsetail	Red	74
8	AM	101	Sw – Trailing raspberry – Step moss	Yellow	57
9	Gb51	00	Saskatoon – Blue wildrye	Yellow	41
10	Gg51	00	Slender wheatgrass – Pasture sage	Yellow	37
11	SHac	111$6B.1	$At – Highbush cranberry – Oak fern	Yellow	35
12	SO	110	Sw – Oak fern – Sarsaparilla	Blue	30
13	ATsk	102$6B.1	$At – Soopolallie – Kinnikinnick	Yellow	26
14	Wf02	00	Scrub birch – Water sedge	Blue	5
15	Wf01	00	Beaked sedge – Water sedge	Yellow	1

*Note: $ = seral; Acb = balsam poplar; At = trembling aspen, Sw = white spruce, Pl = lodgepole pine; *BC CDC name change.*

The 2022 sampling plan was prepared with 31 polygons selected as potential sampling locations based on transects that were sampled in 2019 and 2020 and polygons that were inaccessible in 2020 due to high water (Appendix A). Priority was given to polygons that were Red- or Blue-listed, riparian, on Crown land and accessible by boat. Not all 31 polygons were to be sampled but the extras provided back-up options. A land access form was completed indicating land ownership and instructions for landowner contact and was submitted to BCH for review.

2.1.2 In the Field

The objective of the sampling plan was to document the response of downstream vegetation, including ecosystems at risk and known rare plant occurrences, to changes in the surface water regime between the dam and the confluence of the Peace and Pine rivers. All else being equal, areas on BC Hydro or Crown land were preferentially selected because of their greater ease of access and a lower likelihood of land use changes or development.

In 2019, field sampling was conducted mid August and 14 polygons (86 sample plots) were sampled. To maximize the likelihood of detecting changes that may occur, preference was given to those polygons most likely to be affected by river activities (10 polygons), along with four polygons outside the river's influence for comparison. In 2020, field sampling was conducted in early July and twenty polygons (104 plots) were sampled. The majority of the polygons were on Crown land with a few exceptions that were categorized as unknown land-ownership status (islands in the river or along the shoreline). Extremely high-water levels placed limitations on the number of polygons that could be effectively sampled or reduced the number of plots that could be completed along transects. In 2022, many of the 31 polygons selected had been sampled previously in 2019 and 2020 with the intent to monitor any changes that may have occurred. During the field work additional polygons not included in the sampling plan were sampled based on site conditions and suitability at the time field crews were present.

2.2 Sampling Design

Selected polygons were sampled using ecosystem classification plots (10-m radius) placed along two parallel 50-m transects set 25 m apart. One pair of transects, oriented approximately parallel to and in increasing distance from the shoreline, was established for each polygon, with three plots completed along each of these transects (Figure 2.2-1). This resulted in the completion of six sampling plots in each polygon. Exceptions to this sampling design occurred when the polygon was limited in size and unable to accommodate six plots or where sediment made sampling ineffective, as well as the very first polygon where nine plots were located as a pilot trial. All plot centres were georeferenced, and photographs were obtained for each plot.

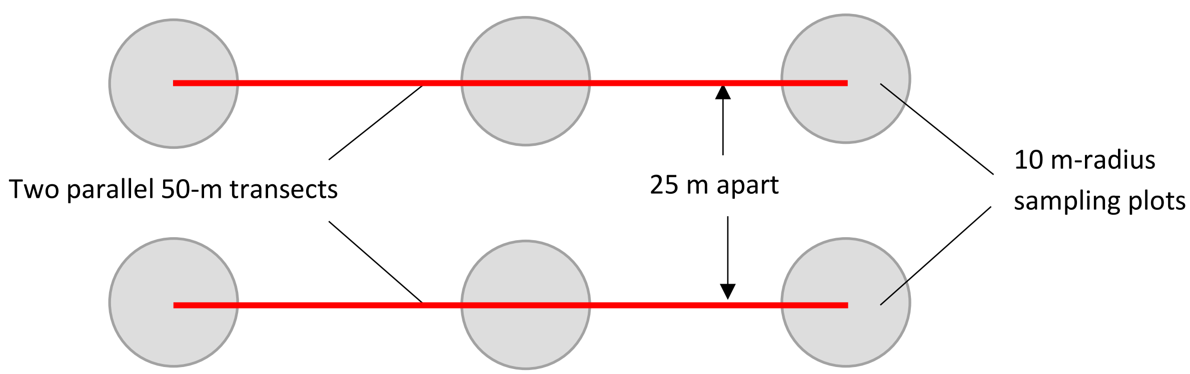


Figure 2.2-1. Sampling design for ecosystem classification used in Downstream Vegetation Monitoring Program.

2.3 Ecosystem Classification/Verification

Ecosystem classification protocols followed provincial standards, as prescribed by the Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2010). Ecosystem characteristics specific to the Peace River region were informed by reference to the regional ecosystem identification guide (BC MOFR 2011). Three categories of information were recorded in each sampling plot in the field: (i) site characteristics, (ii) soils, and (iii) vegetation characteristics (Table 2.3-1).

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

Site Characteristics	
Site series	Soil moisture regime
Seral association (where applicable)	Soil nutrient regime
Map code	Surface shape
Slope	Mesoslope position
Aspect	Substrate/ground cover types (%)
Soils	
Drainage code	Depth of mottling (when present)
Humus form	Presence of seepage
Humus thickness	Depth of seepage (when present)
Presence of gleying	Presence of root restrictive layer
Depth of gleying (when present)	Depth of root restrictive layer (when present)
Presence of mottling	Type of root restrictive layer (when present)
For each soil horizon, the following data were collected:	
Horizon depth	% stones
Horizon colour	Total coarse fragments
Horizon texture	Root abundance
% gravels	Root size
% cobbles	
Vegetation	
Structural stage	% shrub cover
Successional stage	% herb cover
Canopy composition	% moss/lichen cover
Canopy closure	% cover of each vascular plant species in each layer
% tree cover	

2.4 PLANT SPECIES AT RISK

Each polygon sampled was assessed for the presence of plant species at risk by using the "intuitive meander" protocol described in BC MOECCS (2018). This protocol prescribes that the surveying botanist relies on his or her knowledge of the ecology of plant species at risk within the region of interest to guide the surveys. This approach seeks to maximize the probability of detection of rare species that often exist at low densities on the landscape, particularly in habitats that have low potential for rare plant occurrences. Where high-potential habitats are located, the survey botanist conducts formal, plot-based surveys of the high-potential area, as described in Section 4.3.2 of the Downstream Vegetation Monitoring Plan. Incidental collecting of bryophytes, particularly from within unusual microsites or habitats, was completed to broaden the survey scope beyond vascular plants. These bryophyte collections were reviewed and identified after the field session with the assistance of standard identification literature (primarily Morin et al. 2015).

3 FIELD WORK

3.1 SITE VISIT DETAILS

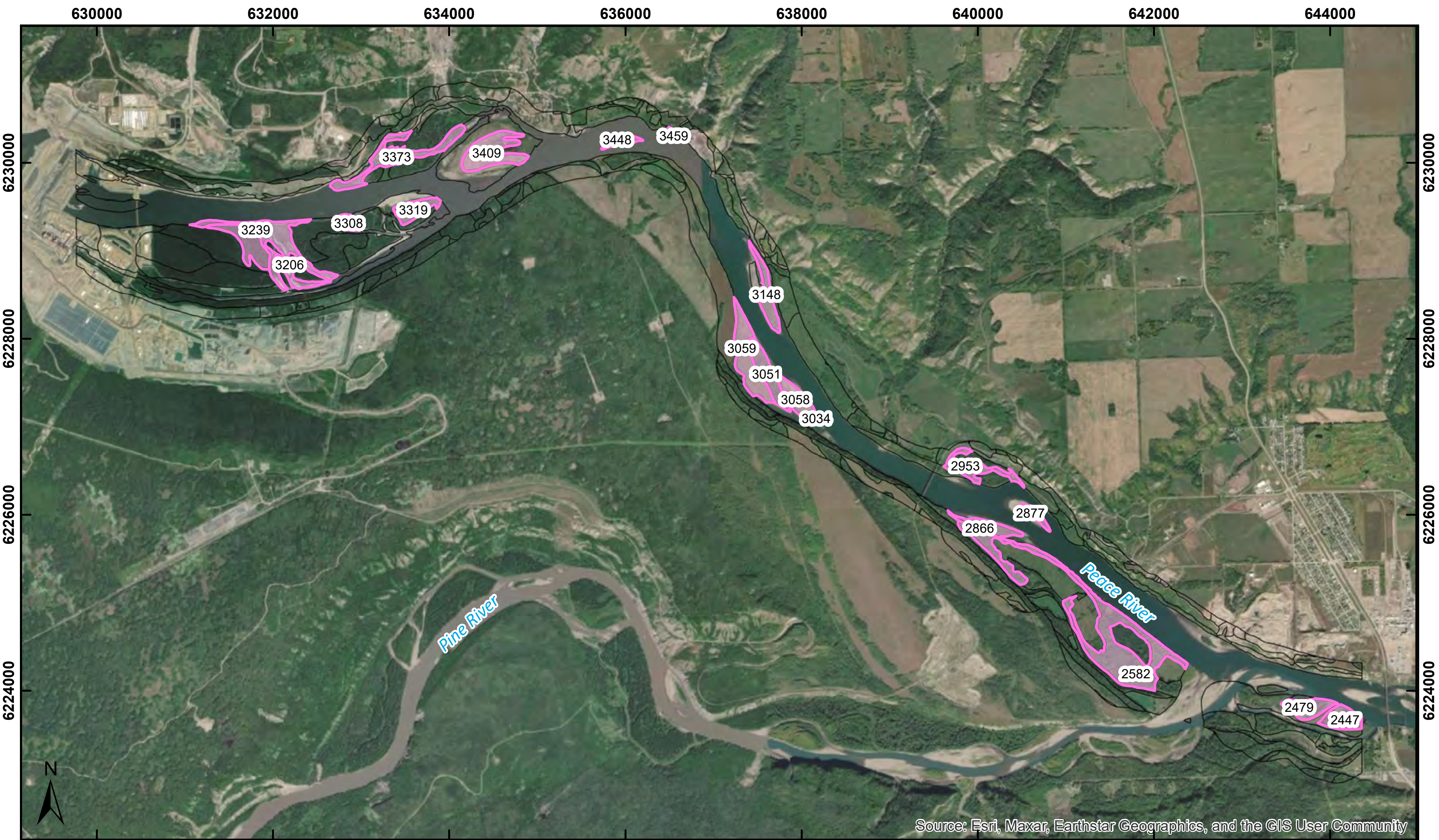
Field sampling was conducted August 19–23, 2022. The 2022 sampling took place during extreme hot weather (i.e., over 35°C) and polygons sampled were selected in order of increasing shade as the day progressed starting with open sites with no canopy cover to sites with dense tall shrub or tree cover later in the day. The 2022 sampling included 19 polygons and a total of 101 plots (Figure 3.1-1). Five repeats from 2019, twelve repeats from 2020, and two new polygons were sampled. An additional polygon (Poly #3367) was visited but could not be sampled due to ongoing disturbance for fish habitat enhancement works. All polygons were accessed via jet boat.

3.2 RESULTS

3.2.1 Ecosystem Classification

Ecosystems in 12 of the 19 sampled polygons are classified as ecosystems at risk (i.e., Red- or Blue-listed by the BC CDC) based on sampling conducted in 2022. Some changes have taken place since sampling began in 2019. Changes include a partial conservation status upgrade, ecosystem reclassification, ecosystem code name change, site alteration and bank erosion (Table 3.2-1).

The conservation status for polygon 3059 was partially upgraded due to the addition of a new plot along the shoreline that contained a Red-listed shrubland community: Narrow-leaf willow (Fl06; Table 3.2-1). This community was added even though it did not follow the sampling design methodology as defined in section 2.2; however, it was deemed a valuable addition for monitoring the response of a Red-listed community because of construction and operation of the upstream Site C dam. Ecosystem reclassification took place in Polygon 3459 based on a review of 2019 data and the visit in 2022 resulting in a change of one plot from Pacific willow – Red-osier dogwood – Horsetail (Fl03) to Narrow-leaf willow (Fl06). Both are Red-listed communities; therefore, there was no change in conservation status for polygon 3459.



Site C Downstream Monitoring

Polygons Sampled 2022

Figure 3.1-1

Date: 11/24/2022

Map Number: BCHD-009

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC

Legend

Polygons Completed 2022

Terrestrial Ecosystem Mapping (TEM)

Table 3.2-1. Sampling summary and ecosystem classification for polygons visited in 2022. Note that some polygons contained more than one ecosystem type.

Original Year Sampled	Poly #	# of Plots	Mapped Ecosystem	BC Conservation Status of Ecosystems within each Polygon	Actual Ecosystem	BC Conservation Status of Ecosystems within each Polygon	Change in Conservation Status of Ecosystems within each Polygon due to Ecosystem Re-classification (a)	Ecosystem 2022	BC Listing	BC Listing Change 2022	Comments
2020	2447	6	Fm02	Blue	SHac	Blue	No change	SHac	Blue	no change	Bank erosion evident
2020	2479	5	Fm02	Blue	Fm02	Blue	No change	Fm20(formerly Fm02)	Blue	Ecosystem name change	
2020	2582	6	Fm02	Blue	SHac	Blue	No change	SHac	Blue	no change	
2022	2866	5	WHaf	n/a				Fl01/Fm20	Partial Blue	n/a	new - flooded in 2020
2020	2877	3	Fl03/Fl06	Red	Fl	n/a	Downgraded	Fl00	n/a	no change	
2020	2953	6	Fm02	Blue	Fm02	Blue	No change	Fm20(formerly Fm02)	Blue	Ecosystem name change	
2020	3034	6	Fm02	Blue	Fl	n/a	Downgraded	Fl00	n/a	no change	
2020	3051	6	Fm02	Blue	Fm02	Blue	No change	Fm20(formerly Fm02)	Blue	Ecosystem name change	
2022	3058	6	GB/Fm02	Blue				Fl00	n/a	n/a	new - flooded in 2020
2019	3059	7	Fl03/Fl06	Red	Fm	n/a	Downgraded	Fm00/Fl06	partial Red (Fl06)	Partial upgrade	added new plot Fl06
2019	3148	6	Fm02	Blue	Fm	n/a	Downgraded	Fm00	n/a	no change	
2020	3206	6	Fm02	Blue	Fm02	Blue	No change	Fm20(formerly Fm02)	Blue	Ecosystem name change	
2019	3239	6	SHa	Blue	SH	Blue	No change	SH	Blue	no change	
2020	3308	6	SH	Blue	SH	Blue	No change	SH	Blue	no change	
2020	3319	6	Fm02/WH	Blue	Fm02	Blue	No change	Fm20(formerly Fm02)	Blue	Ecosystem name change	

Original Year Sampled	Poly #	# of Plots	Mapped Ecosystem	BC Conservation Status of Ecosystems within each Polygon	Actual Ecosystem	BC Conservation Status of Ecosystems within each Polygon	Change in Conservation Status of Ecosystems within each Polygon due to Ecosystem Re-classification (a)	Ecosystem 2022	BC Listing	BC Listing Change 2022	Comments
2019	3367	6	GB/WH	n/a	GB	n/a	No change	n/a	n/a	Site condition change	all plots altered due to fish habitat works, unable to sample due to equipment on site
2020	3373	4	GB	n/a	Fl	n/a	No change	Fl00	n/a	no change	
2020	3409	6	Fm02	Blue	Fl	n/a	Downgraded	Fl00	n/a	Site condition change	5 out of 6 plots altered as a result of fish habitat enhancement works
2019	3448	6	GB	n/a	GB	n/a	No change	GB	n/a	no change	
2019	3459	5	Fl03/Fl06	Red	Fl03/Fl06	Red/Red	No change	Fl06	Red	Re-classification	Fl03 was changed to Fl06 in 2022 due to review of the 2022 and 2019 data. Better fit.

The BC CDC annually updates species and ecosystem names and conservation status. For example, the Black cottonwood - Hybrid white spruce / Red-osier dogwood (Fm02) was changed to the Balsam poplar - White spruce / Mountain alder - Red-osier dogwood (Fm20) (BC CDC 2022). The site characteristics remain the same but the dominant tree species is balsam popular (*Populus balsamifera* ssp. *balsamifera*) rather than black cottonwood (*P. balsamifera* ssp. *trichocarpa*).

Active construction for fish habitat enhancement works at polygons 3409 and 3367 has resulted in disturbance and alteration of the ecosystems present (Figure 3.1-1). In polygon 3409, five out of six plots previously sampled were no longer present and were buried by large deposits of silt and sand. In polygon 3367 large machinery and equipment was present, and shoreline deposits were being dug up and transported to another location.

Bank erosion was evident along the shoreline of polygon 2447. Tree roots growing along the stream were undercut by bank erosion leaving exposed roots and fallen trees. The polygon is comprised of sandy and silty textured soils with no coarse fragments and only the abundance of roots provides resistance to erosion forces (Figure 3.2-2). Appendix B provides a comprehensive description of each polygon sampled including site, soil, and vegetation data and representative photos that were collected for each polygon.

Figure 3.2-2: Active construction works in polygons 3409 and 3367.

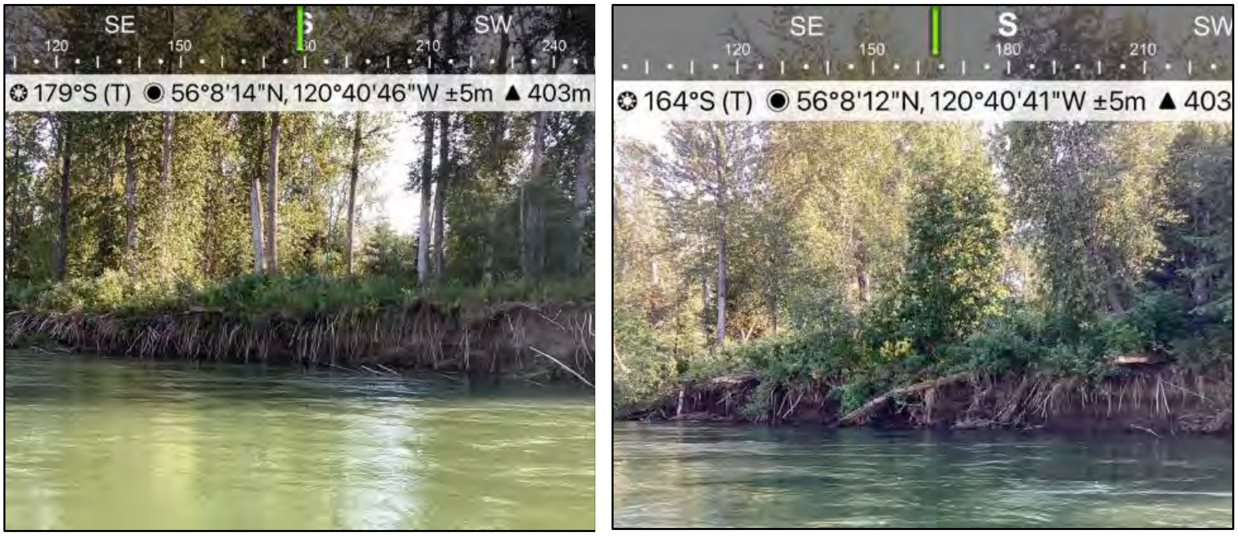


Figure 3.2-2: Bank erosion polygon 2447

3.2.2 Rare Plants

Davis's locoweed (*Oxytropis campestris* var. *davisii*)—observed in 2019, 2020, and 2022—has been downgraded from provincially Blue-listed (S3?) to Yellow-listed (S3S4). No Red or Blue-listed plant species were observed during the 2022 surveys.

3.2.3 Invasive Plants

Four species that are tracked as invasive plants by the Invasive Species Council of British Columbia (ISCBC) were documented during the 2022 field surveys (Table 3.2-2; Figure 3.2-2a-c). In 2020, burdock (*Arctium* sp.), another regionally noxious weed, was observed in polygon 2565 but that polygon was not sampled in 2022.

Table 3.2-2. Invasive plants documented within polygons sampled in 2020.

Species	Scientific Name	Status (ISCBC)	Polygon No.
Canada Thistle	*Cirsium arvense*	Provincially Noxious	2866, 2877, 3034, 3059, 3148, 3206, 3259, 3373, 3448, 3459
Perennial Sow-thistle	*Sonchus arvensis*	Provincially Noxious	2877, 3034, 3206, 3373, 3448, 3459
Oxeye Daisy	*Leucanthemum vulgare*	Regionally Noxious (Peace)	2866
Quackgrass	*Elymus repens*	Regionally Noxious (Peace)	3319, 3206, 3051, 3034, 3058, 3059, 3148, 3239, 3448, 3459

Site C Downstream Monitoring

Invasive Plants - Map 1

Figure 3.2-3a

Date: 2022-11-16

Map Number: BCHD-010a

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

Legend

Terrestrial Ecosystem Mapping (TEM)

Invasive Plants 2022

Canada Thistle *(Cirsium arvense)*

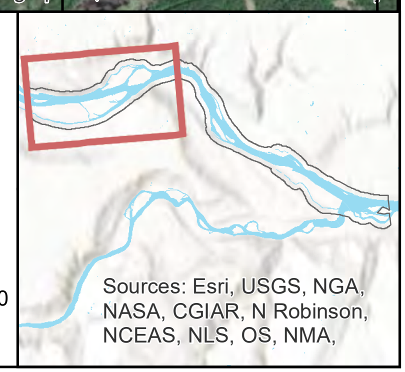
Oxeye Daisy *(Leucanthemum vulgare)*

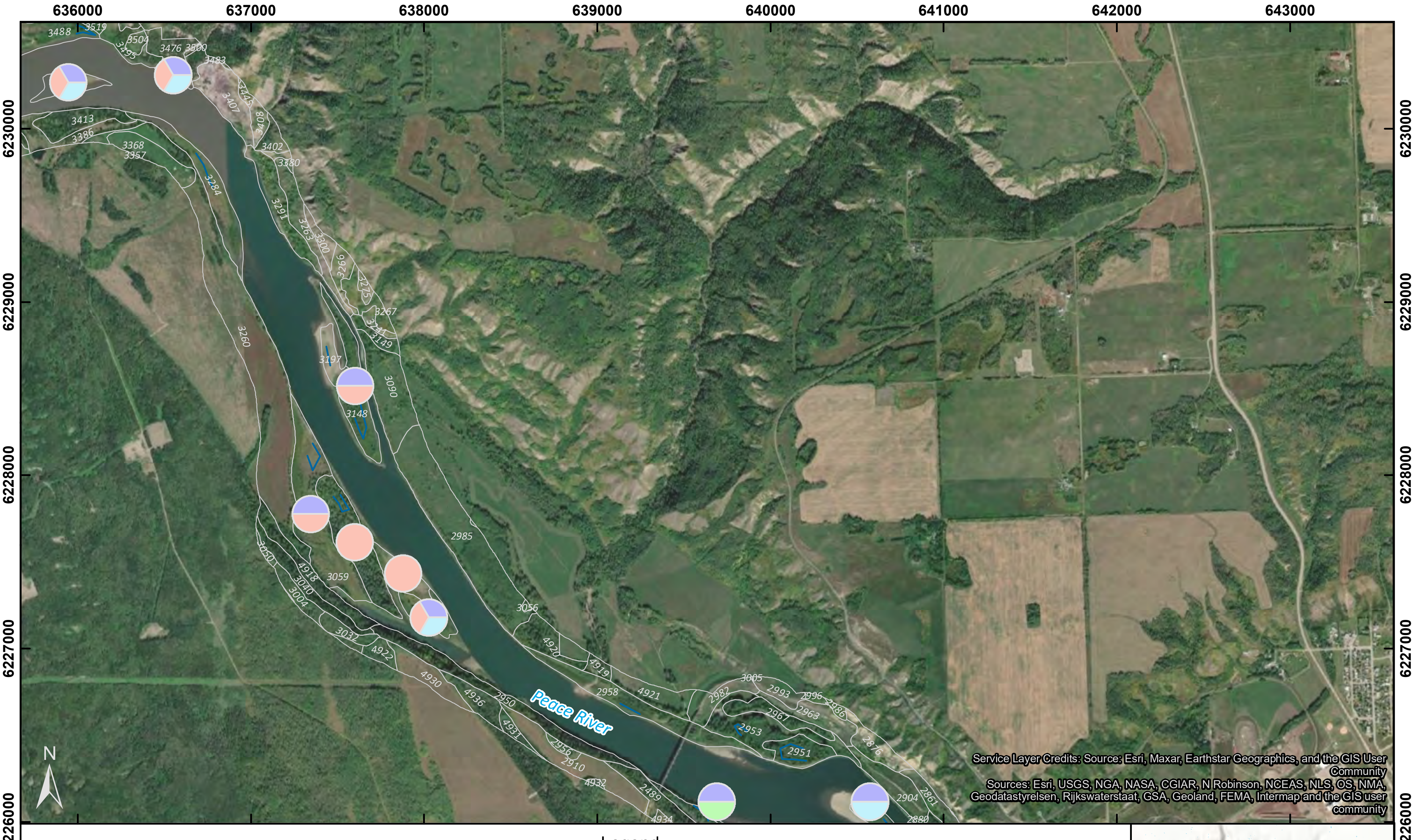
Quackgrass *(Elymus repens)*

Perennial Sow-thistle *(Sonchus arvensis)*

0 250 500 750

1:24,000 m





Site C Downstream Monitoring

Invasive Plants - Map 2

Figure 3.2-3b

Date: 2022-11-16

Map Number: BCHD-010b

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC

Legend

Terrestrial Ecosystem Mapping (TEM)

Invasive Plants 2022

Canada Thistle *(Cirsium arvense)*

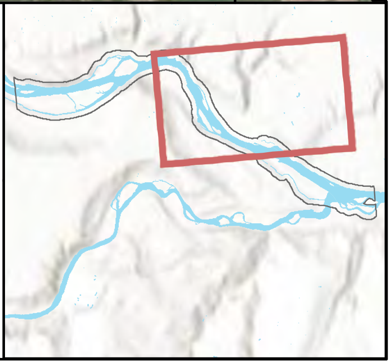
Oxeye Daisy *(Leucanthemum vulgare)*

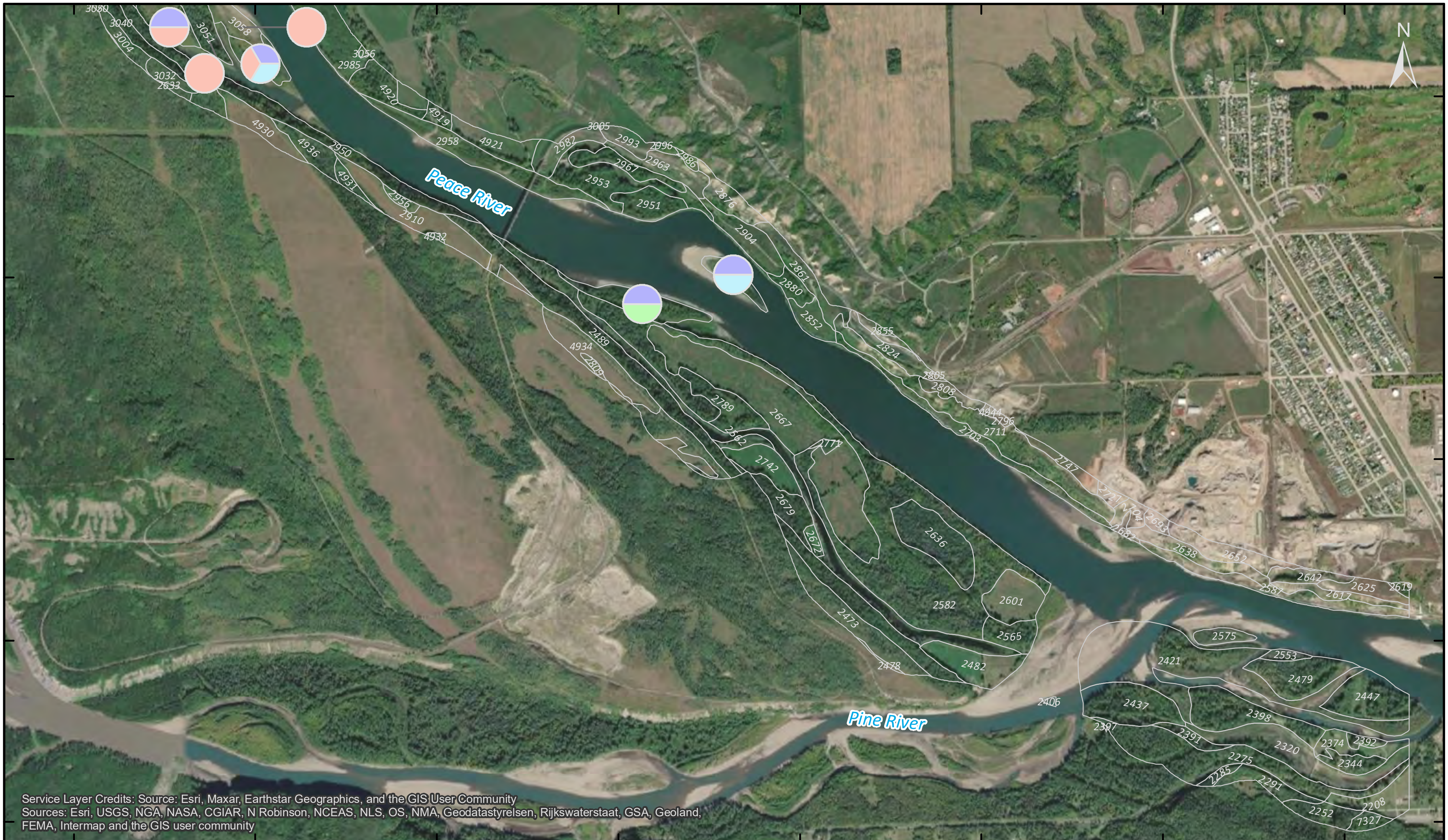
Quackgrass *(Elymus repens)*

Perennial Sow-thistle *(Sonchus arvensis)*

0 250 500 750

1:30,000 m





Site C Downstream Monitoring

Invasive Plants - Map 3

Figure 3.2-3c

Date: 2022-11-16

Map Number: BCHD-010c

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC

Legend

Terrestrial Ecosystem Mapping (TEM)

Invasive Plants 2022

Canada Thistle *(Cirsium arvense)*

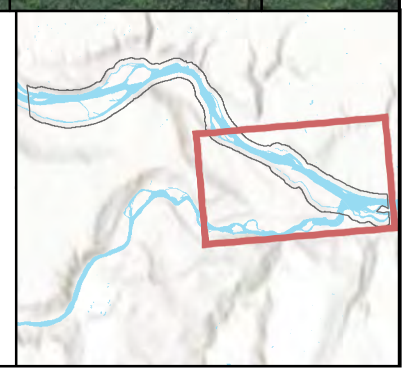
Oxeye Daisy *(Leucanthemum vulgare)*

Quackgrass *(Elymus repens)*

Perennial Sow-thistle *(Sonchus arvensis)*

0 250 500 750

1:30,000 m



4 SUMMARY

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

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

To capture a picture of current conditions downstream of the dam site, a total of 19 polygons and 101 plots were surveyed in 2022; five polygons were previously sampled in 2019, 12 were previously sampled in from 2020, and two new polygons were sampled. An additional polygon was visited but could not be sampled due to ongoing fish habitat enhancement works.

Sampling sites were spatially distributed throughout the study area and extended from the dam site downstream to the Pine River confluence. Sensitive and at-risk plant populations and ecosystems that were characterized as part of this program may be subject to adverse impacts from dam completion, such as changes in soil erosion rates, changes in sediment deposition, changes in the abundance of invasive plant species, declines of populations of plant species at risk, and increases or decreases in soil moisture and nutrient regimes that could drive changes in the existing ecosystems.

This program represents an assessment of the current ecological conditions within these polygons prior to the large-scale effects that will follow the completion of the Site C dam. Changes have occurred since the monitoring program began in 2019 including natural and anthropogenic site alteration (i.e., flooding, bank erosion and fish habitat enhancement work), changes to the conservation status of rare species, and changes to ecosystem names and classifications. It is currently unclear whether changes to such as flooding and bank erosion are the result of Site C dam construction and associated changes in surface water regimes. The flood event in 2020 was most likely a natural flood event for which floodplain ecosystems are well adapted to endure. Bank erosion is a natural process along streams and rivers; however, anthropogenic activities can accelerate this process. Continued monitoring will provide additional data to clarify the observations to date and changes over time.

5 REFERENCES

BC CDC. 2022. BC Species & Ecosystems Explorer. BC Ministry of Environment and Climate Change Strategy, Conservation Data Centre. Available online: https://www2.gov.bc.ca/gov/content /environment/plants-animals-ecosystems/conservation-data-centre/explore-cdc-data/species-and-ecosystems-explorer

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

BC MOFR and BC MOE. 2015. Field Manual for Describing Terrestrial Ecosystems, 2nd Edition. BC Ministry of Forests and Range and BC Ministry of Environment, Land Mgmt. Handbook No. 25.

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

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

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

eFlora BC. 2021. E-Flora BC: Electronic Atlas of the Flora of British Columbia. Available online: https://ibis.geog.ubc.ca/biodiversity/eflora/. Date access: June 2022.

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

Pathfinder Endeavours Ltd. 2020. 2019 Year End Project Summary. Invasive Species Management Program. Report Prepared for BC Hydro.

APPENDIX A. SAMPLING PLAN 2022

Label	TEM POLY #	TEM Label	BC Listing	2020 Comments	Ownership
22-37	2447	5Fm02a:6-5Fm02a:3	Blue	111$6B.1/SHac:6 Acb(Sx)	Crown
22-51	2479	10Fm02a:6	Blue	Fm02:5	Crown
22-03	2553	10WHac:3	Red	replaced with poly2479: check in field	Crown
22-01	2562	10WHa:3b	Red	111$6B.1 / SHac 3b/5 highbenchFA - 4 plots	Crown
22-34	2565	10Fm02a:6	Blue	111/SH:6 Acb(Sx) - 3 plots	Crown
22-35	2575	10Fm02ab:3b	Blue	Flooded in 2020; suspect Fl not Fm	Unknown
22-31	2582	8Fm02a:3-2SHa:6	Blue	111$6B.1/SHac:5	Crown
22-32	2703	6WS:3b-4SHac:6	Blue	Fm02:3b - 3 plots	Private
22-02	2866	8WHaf:2-2WHaf:3	Red	Flooded in 2020	Unknown
22-04	2877	10WHaf:3a	Red	Fl:2b/3b - 3 plots	Unknown
22-62	2951	10Fm02a:5	Blue	111$6B.1/SH:3b/5 - sampled in 2019	Crown
22-29	2953	5Fm02a:3-4Fm02a:6-1OW	Blue	Fm02:5 / Fm02:4, Fm02:6	Crown
22-28	2958	10Fm02ab:3	Blue	Flooded in 2020	Unknown
22-27	3034	10Fm02ab:3a	Blue	Fl:3b	Unknown
22-26	3051	10Fm02a:6	Blue	Fm02:5	Unknown
22-49	3058	5GB:1-5Fm02ab:3a		Flooded in 2020	Unknown
22-61	3059	8WHaf:2-2GB:1	Red	Fm:3b - sampled in 2019	Unknown
22-63	3148	10Fm02ab:3	Blue	Fm:3b - sampled in 2019	Unknown
22-50	3197	10GB:1		Flooded in 2020	Unknown
22-48	3202	5GB:1-5Fm02ab:3a		GB:2a	Crown
22-17	3206	8Fm02ab:3-2GB:1	Blue	Fm02:3b	Crown
22-19	3240	6Fm02a:3-4Fm02a:5	Blue	101/AM:4-111$6B.1/SHac:5/3b	Crown
22-16	3254	10Fm02a:4	Blue	101/Am:4 - 111$6B.1/SHac:5	Crown
22-60	3284	9WHa:3a-1RI	Red	Fl:3b - sampled in 2019	Unknown
22-15	3308	10SHa:7	Blue	111/SH:5	Crown
22-10	3319	8Fm02a:3-2WHa:2	Blue	Fm02:5	Crown
22-46	3373	8GB:1-2WHac:2		Fl03:3b - 4 plots	Crown
22-09	3409	10Fm02ab:3	Blue	Fl:3b	Unknown
22-45	3470	10GB:1		Fl:3b - 4 plots	Unknown
22-44	3488	8CFt:2-2AMt:ap3		111$6B.1/SHac:3b/5	Private
22-41	4909	10GB:1		Flooded in 2020	Crown

Appendix B. Data Summary by Polygon – 2022

Table 1: Polygon 2447

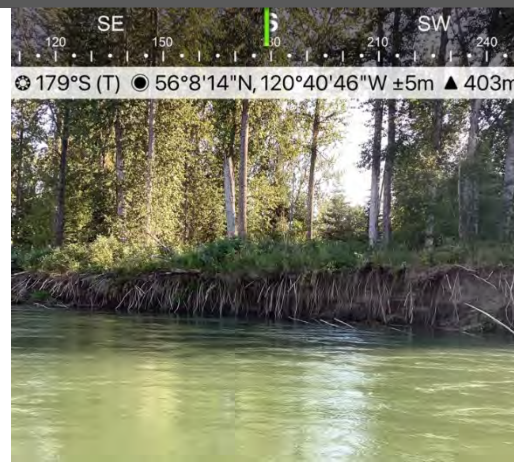
Polygon:	2447	TEM Code: SHac
TEM Name:	$At - Highbush cranberry – Oakfern	
Plot #s	22-37-1 – 22-37-6	
Years Sampled	2020, 2022	
Change	Bank erosion but no ecosystem changes	
	Ecosystem	
	$At - Highbush cranberry – Oakfern (SHac)	
Slope (%)	0	
Aspect (deg)	999	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Level (LV)	
Structural Stage	Young Forest (5), Mature Forest (6)	
Humus Form	Mull	
Ah (cm)	None	
Soil Texture	Loamy Sand (LS), Silty Loam (SiL), Silt (Si)	
Coarse Fragments (%)	0	
Drainage	moderate (m), (imperfect (i))	
Seepage	None	
Mottling	None (Yes to faint mottles 15-20cm deep in 22-37-5 and 22-37-6)	
Gleying	None	

Dominant Vegetation

Trees	*Picea glauca* *Populus balsamifera*	
Shrubs	*Alnus incana ssp. tenuifolia* *Cornus sericea* *Picea glauca* *Rosa acicularis* *Rubus idaeus* *Symphoricaros albus* *Symphoricarpos occidentalis* *Viburnum edule*	

Appendix B. Data Summary by Polygon – 2022

Polygon:	2447	TEM Code:	SHac
TEM Name:	$At - Highbush cranberry – Oakfern		
Plot #s	22-37-1 – 22-37-6		
Years Sampled	2020, 2022		
Change	Bank erosion but no ecosystem changes		

Herbs	*Achillea millefolium* *Aralia nudicaulis* *Bromus inermis* *Calamagrostis canadensis* *Equisetum arvense* *Galium boreale* *Geum aleppicum* *Lathyrus ochroleucus* *Maianthemum canadensis* *Maianthemum stellatum* *Poa palustris* *Solidago altissima* *Stachys palustris* *Taraxacum officinale*	 *Poly 2447: Bank Erosion*
	 Poly 2447 – Plot 22-37-01: $At - Highbush cranberry – Oakfern (SHac) - Vegetation	 Poly 2447 – Plot 22-37-01: $At - Highbush cranberry – Oakfern (SHac) – Soil Pit

Appendix B. Data Summary by Polygon – 2022

Table 2: Polygon 2479

Polygon	2479	TEM Code: Fm20 (formerly Fm02)
TEM Name:	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood	
Plot #s	22-51-1 – 22-51-5	
Years Sampled	2020, 2022	
Change	No ecosystem changes	
	Ecosystem	
	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood	
Slope (%)	0	
Aspect (deg)	999	
SMR	Subhygric (5)	
SNR	Poor (B), Medium (C)	
Mesoslope	Level (LV)	
Structural Stage	Young Forest (5)	
Humus Form	Moder (D), Mull (L)	
Ah (cm)	None	
Soil Texture	Sand (S), Loamy Sand (LS), (Silt (Si))	
Coarse Fragments (%)	None	
Drainage	well (w), (moderate (m))	
Seepage	None	
Mottling	None	
Gleying	None	
Dominant Vegetation		
Trees	*Populus balsamifera*	
Shrubs	*Alnus incana ssp. tenuifolia* *Cornus sericea* *Eleagnus commutata* *Picea glauca* *Rubus idaeus* *Ribes oxyacanthoides* *Rosa acicularis* *Symphoricarpos occidentalis*	

Appendix B. Data Summary by Polygon – 2022

Polygon	2479	TEM Code: Fm20 (formerly Fm02)
TEM Name:	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood	
Plot #s	22-51-1 – 22-51-5	
Years Sampled	2020, 2022	
Change	No ecosystem changes	
Herbs	*Aralia nudicaulis* *Bromus inermis* *Equisetum hyemale* *Lathyrus ochroleucus* *Maianthemum stellatum* *Prosartes trachycarpa* *Solidago altissima* *Symphyotrichum lanceolatum* *Taraxacum officinale*	
	 Poly 2479 – Plot 22-51-02: Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) - Vegetation	 Poly 2479 – Plot 22-51-02: Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) – Soil Pit

Appendix B. Data Summary by Polygon – 2022

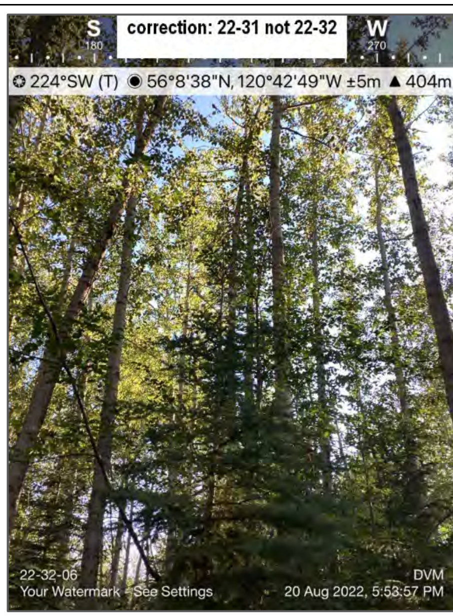
Table 3: Polygon 2582

Polygon:	2582	TEM Code: SHac
TEM Name:	$At - Highbush cranberry - Oakfern	
Plot #s	22-31-1 – 22-31-6	
Years Sampled	2020, 2022	
Changes	No ecosystem changes	
	Ecosystem	
	$At - Highbush cranberry – Oakfern (SHac)	
Slope (%)	2-4	
Aspect (deg)(	42, 222, 296, 999 (x3)	
SMR	Subhyrgric (5)	
SNR	Medium (C)- Rich (D)	
Mesoslope	Level (LV), (Mid (MD))	
Structural Stage	Young Forest (5)	
Humus Form	Mull (L)	
Ah (cm)	None	
Soil Texture	Silt Loam (SiL), Sand (S)	
Coarse Fragments (%)	0	
Drainage	moderate (m)	
Seepage	None	
Mottling	None	
Gleying	None	

Dominant Vegetation		
Trees	*Populus balsamifera*	
Shrubs	*Picea glauca* *Alnus incana ssp. tenuifolia* *Betula papyrifera* *Cornus serica* *Rosa acicularis* *Rubus idaeus* *Symphoricarpos occidentalis* *Ribes triste* *Viburnum edule*	

Appendix B. Data Summary by Polygon – 2022

Polygon:	2582	TEM Code: SHac
TEM Name:	$At - Highbush cranberry - Oakfern	
Plot #s	22-31-1 – 22-31-6	
Years Sampled	2020, 2022	
Changes	No ecosystem changes	
Herbs	*Aralia nudicaulis* *Astragalus cicer* *Bromus inermis* *Calamagrostis stricta* *Cornus canadensis* *Equisetum arvense* *Equisetum scirpoides* *Fragaria vesca* *Fragaria virginiana* *Galium boreale* *Linnaea borealis* *Maianthemum canadense* *Prosartes trachycarpa* *Pyrola asarifolia* *Symphyotrichum foliaceum*	



Poly 2582 – Plot 22-31-01: $At - Highbush cranberry – Oakfern (SHac) - Vegetation

Poly 2582 – Plot 22-31-01: $At - Highbush cranberry – Oakfern (SHac) – Soil Pit

Appendix B. Data Summary by Polygon – 2022

Table 4: Polygon 2866

Polygon: 2866	TEM Code: Fl01 / Fm20 (formerly Fm02)	
TEM Name:	Mountain alder - Common horsetail / Balsam poplar - White spruce / Mountain alder - Red-osier dogwood	
Plot #s	22-02-1 – 22-02-5	
Years Sampled	2022	
Changes	n/a	
	Ecosystem 1	**Ecosystem 2**
	Mountain alder – Common horsetail	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood
# of Plots		
Slope (%)	0	0
Aspect (deg)	999	999
SMR	Subhygric (5)	Subhygric (5)
SNR	Rich (D)	Rich (D)
Mesoslope	Level (LV)	Level (LV)
Structural Stage	Tall Shrub (3b)	Pole-Sapling (4)
Humus Form	None	None
Ah (cm)	None	None
Soil Texture	Silt (Si)	Silt (Si)
Coarse Fragments (%)	0	0
Drainage	moderate (m)	moderate (m)
Seepage	None	None
Mottling	None	None
Gleying	None	None
Dominant Vegetation		
Trees	*None*	*Populus balsamifera*
Shrubs	*Alnus incana ssp. tenuifolia* *Cornus sericea*	*Alnus incana ssp. Tenuifolia* *Cornus sericea* *Rosa acicularis* *Salix interior*
Herbs	*Bromis inermis* *Calamagrostis canadensis* *Equiseteum arvense* *Taraxacum officinale* *Agrostis scabra*	*Astragalus cicer* *Bromis inermis* *Maianthemum stellatum* *Melilotus albus* *Solidago altissima* *Trifolium hybridum* *Trifolium pratense* *Taraxacum officinale*

Appendix B. Data Summary by Polygon – 2022

Polygon: 2866	TEM Code: Fl01 / Fm20 (formerly Fm02)
TEM Name:	Mountain alder - Common horsetail / Balsam poplar - White spruce / Mountain alder - Red-osier dogwood
Plot #s	22-02-1 – 22-02-5
Years Sampled	2022
Changes	n/a

Poly 2866 – Plot 22-02-01: Mountain alder – Common horsetail (Fl01) - Vegetation

Poly 2866 – Plot 22-02-03: Balsam poplar - White spruce / Mountain alder - Red-osier dogwood (Fm20) – Vegetation

Poly 2866 – Plot 22-02-01: Mountain alder – Common horsetail (Fl01) – Soil Pit

Poly 2866 – Plot 22-02-03: Balsam poplar - White spruce / Mountain alder - Red-osier dogwood (Fm20) - Vegetation

Appendix B. Data Summary by Polygon – 2022

Table 5: Polygon 2877

Polygon	2877	TEM Code: Fl00
TEM Name:	Low Bench Floodplain	
Plot #s	20-04-1 – 20-04-3	
Years Sampled	2020, 2022	
Changes	No ecosystem changes	
	Ecosystem	
	Low Bench Floodplain (Fl)	
Slope (%)	0	
Aspect (deg)	999	
SMR	Hygric (6)	
SNR	Rich (D)	
Mesoslope	Level (Lv)	
Structural Stage	Herbaceous (2a)	
Humus Form	Mull (L)	
Ah (cm)	None	
Soil Texture	Sandy Loam (SL), Sand (S), Loamy Sand (LS), Silt Loam (SiL), Silt (Si)	
Coarse Fragments (%)	0, (90, 100 – gravels and cobbles)	
Drainage	Moderate (m)	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*None*	
Shrubs	*Alnus incana ssp. Tenuifolia* *Populus balsamifera* *Salix prolixa* *Salix interior* *Symphoricarpos occidentalis*	

Appendix B. Data Summary by Polygon – 2022

Polygon	2877	TEM Code: Fl00
TEM Name:	Low Bench Floodplain	
Plot #s	20-04-1 – 20-04-3	
Years Sampled	2020, 2022	
Changes	No ecosystem changes	
Herbs	*Astragalus cicer* *Bromus inermis* *Cirsium arvense* *Melilotus albus* *Phalaris arundinacea* *Poa palustris* *Solidago altissima* *Sonchus arvensis* *Taraxacum officinale*	
	 *Poly 2877 – Plot 22-04-03: Low Bench Floodplain (Fl00) - Vegetation*	 *Poly 2877 – Plot 22-04-03: Low Bench Floodplain (Fl00) – Soil Pit*

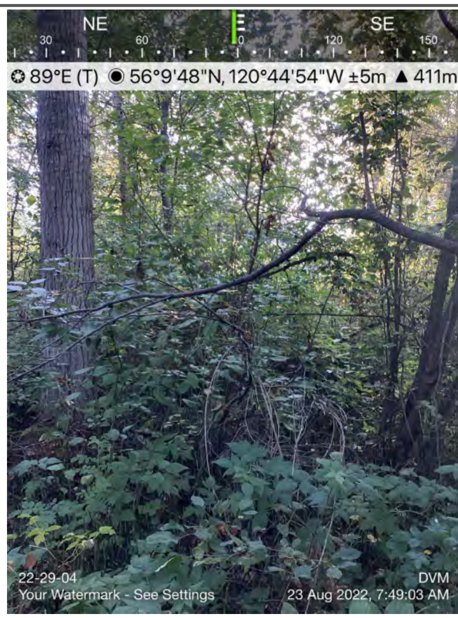
Appendix B. Data Summary by Polygon – 2022

Table 6: Polygon 2953

Polygon:	**2953**	**TEM Code:**	**Fm20**
TEM Name:	**Balsam poplar - White spruce / Mountain alder - Red-osier dogwood**		
Plot #s	**22-29-1 – 22-29-6**		
Years Sampled	**2020, 2022**		
Changes	**No ecosystem changes**		
	Ecosystem		
	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood		
Slope (%)	0		
Aspect (deg)	999		
SMR	Subhygric (5)		
SNR	Rich (D), ((Medium (C))		
Mesoslope	Level (LV)		
Structural Stage	Young Forest (5)		
Humus Form	Mull (L)		
Ah (cm)	None		
Soil Texture	Sandy Loam (SL), Sand (S), Silt Loam (SiL), Silt (Si)		
Coarse Fragments	0		
Drainage	Moderate		
Seepage	None		
Mottling	None		
Gleying	None		
Dominant Vegetation			
Trees	*Populus balsamifera*		
Shrubs	*Alnus incana ssp. tenuifolia* *Betula papyrifera* *Cornus sericea* *Picea glauca* *Populus balsamifera* *Rosa acicularis* *Rubus ideaus* *Salix bebbiana* *Symphoricarpos albus* *Viburnum edule*		

Appendix B. Data Summary by Polygon – 2022

Polygon:	2953	TEM Code: Fm20
TEM Name:	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood	
Plot #s	22-29-1 – 22-29-6	
Years Sampled	2020, 2022	
Changes	No ecosystem changes	
Herbs	*Aralia nudicaulis* *Astragulis cicer* *Bromus inermis* *Chamaenerion angustifolium* *Dryopteris spp* *Equiseteum arvense* *Equiseteum hymenale* *Galium boreale* *Lathyrus ochroleucus* *Maianthemum canadense* *Maianthemum stellatum* *Poa palustris*	



Poly 2953 – Plot 22-29-04: Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) - Vegetation

Poly 2953 – Plot 22-29-03: Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) – Soil

Appendix B. Data Summary by Polygon – 2022

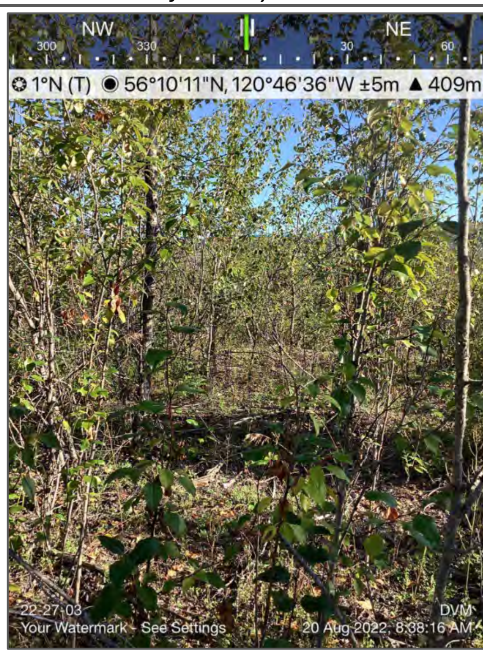
Table 7: Polygon 3034

Polygon:	3034	TEM Code: FI00
TEM Name:	Low Bench Floodplain	
Plot #s	22-27-1–20-22-6	
Years Sampled	2020, 2022	
Changes	No ecosystem changes	
	Ecosystem	
	Low Bench Floodplain	
Slope (%)	0, (5, 10)	
Aspect (deg)	999 (170, 172, 190)	
SMR	Subhygric (5), (mesic (4), hygric (6))	
SNR	Rich (D), (Poor, (4))	
Mesoslope	Level (LV), (Depression (DP), Lower (LW), Mid (MD))	
Structural Stage	Tall Shrub (3b)	
Humus Form	Mull (L), (Moder (D), None)	
Ah (cm)	None	
Soil Texture	Sand (S), (Sandy Loam (SL), Silt (Si))	
Coarse Fragments (%)	0 (65 – 77)	
Drainage	Well (w), (Moderate (m), Imperfect (i))	
Seepage	None	
Mottling	None	
Gleying	None, (Distinct gleying at one site)	

Dominant Vegetation		
Trees	*None*	
Shrubs	*Alnus incana ssp. Tenuifolia* *Cornus sericea* *Picea glauca* *Populus balsamifera* *Salix interior* *Salix prolixa* *Symphoricarpos occidentalis*	

Appendix B. Data Summary by Polygon – 2022

Polygon:	3034	TEM Code: Fl00
TEM Name:	Low Bench Floodplain	
Plot #s	22-27-1–20-22-6	
Years Sampled	2020, 2022	
Changes	No ecosystem changes	
Herbs	*Achillea millefolium* *Artemisia norvegica* *Astragalus cicer* *Bromus inermis* *Calamagrostis canadensis* *Cirsium arvense* *Dryas drummondii* *Elymus repens* *Equisetum arvense* *Equisetum scirpoides* *Festuca spp.* *Medicago lupulina* *Medicago sativa* *Melilotus albus* *Melilotus officinalis* *Maianthemum racemosum* *Melilotus albus* *Phalaris arundinacea* *Poa pratensis* *Oxytropis campestris* *Trifolium hybridum*	



Poly 3034 – Plot 22-27-03: Low Bench Floodplain (Fl00) - Vegetation

Poly 3034 – Plot 22-27-01: Low Bench Floodplain (Fl00) – Soil Pit

Appendix B. Data Summary by Polygon – 2022

Table 8: Polygon 3051

Polygon	3051	TEM Code: Fm20 (formerly Fm02)
TEM Name:	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood	
Plot #s	22-26-1 – 22-26-6	
Years Sampled	2020, 2022	
Changes	No ecosystem changes	
	Ecosystem	
	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood (Fm20)	
Slope (%)	0	
Aspect (deg)	999	
SMR	Mesic (4) – Subhygric (5)	
SNR	Rich (D), (Poor (B)- Medium (C))	
Mesoslope	Level (LV)	
Structural Stage	Young forest (5)	
Humus Form	Mull (L)	
Ah (cm)	None (8)	
Soil Texture	Sand (S), Silt (S), (Loamy Sand (LS))	
Coarse Fragments (%)	0	
Drainage	Moderate (m), Well (w)	
Seepage	None	
Mottling	None	
Gleying	None	
Dominant Vegetation		
Trees	*Populus balsamifera*	
Shrubs	*Alnus incana ssp. tenuiflora* *Amelanchier alnifolia* *Cornus sericea* *Elaeagnus commutata* *Juniper communis* *Picea glauca* *Rosa acicularis* *Rubus idaeus* *Symphoricarpos occidentalis*	

Appendix B. Data Summary by Polygon – 2022

Polygon	**3051**	**TEM Code: Fm20 (formerly Fm02)**
TEM Name:	**Balsam poplar - White spruce / Mountain alder - Red-osier dogwood**	
Plot #s	**22-26-1 – 22-26-6**	
Years Sampled	**2020, 2022**	
Changes	**No ecosystem changes**	
Herbs	*Achillea millefolium* *Aralia nudicaulis* *Astragalus cicer* *Bromus inermis* *Elymus repens* *Equisetum hyemale* *Galium triflorum* *Hieracium canadense* *Lathyrus ochroleucus* *Maianthemum canadense* *Maianthemum stellatum* *Medicago sativa* *Melilotus albus* *Poa pratensis* *Solidago altissima* *Taraxacum officinale* *Trifolium hybridum*	

Poly 3051 – Plot 22-26-04 Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) – Vegetation

Poly 3051 – Plot 22-26-04 Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) – Soil Pit

Appendix B. Data Summary by Polygon – 2022

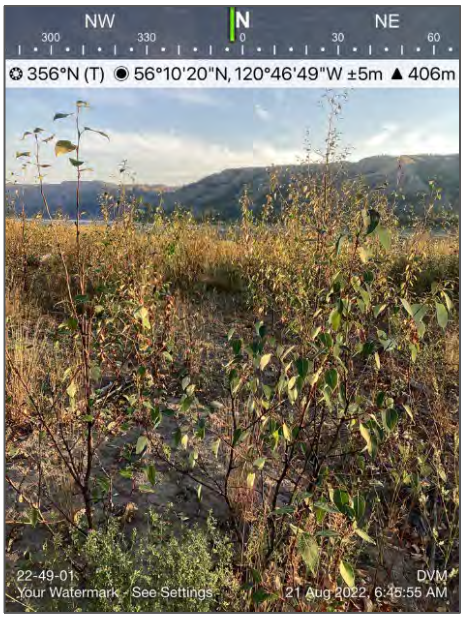
Table 9: Polygon 3058

Polygon:	3058	TEM Code: FI00
TEM Name:	Low Bench Floodplain	
Plot #s	22-49-1–22-49-6	
Years Sampled	2022	
	Ecosystem	
	Low Bench Floodplain	
Slope (%)	0	
Aspect (deg)	999	
SMR	Subhygric (5)	
SNR	Medium (C), (Poor (B))	
Mesoslope	Level (LV)	
Structural Stage	Tall Shrub (3b), (Low Shrub (3a))	
Humus Form	None	
Ah (cm)	None	
Soil Texture	Silt (Si), Sand (S)	
Coarse Fragments (%)	0, 45, 65, 70, 75, 80	
Drainage	Well (w)	
Seepage	None	
Mottling	None	
Gleying	None	

Dominant Vegetation

Trees	*None*	
Shrubs	*Elaeagnus commutata* *Picea glauca* *Populus balsamifera*	
Herbs	*Achillea millefolilum* *Agrostis stolonifera* *Astralagus cicer* *Bromus inermis* *Elymus repens* *Hieracium umbellatum* *Medicago lupulina* *Medicago sativa* *Melilotus albus* *Melilotus officinalis* *Plantago major* *Poa palustris*	

Appendix B. Data Summary by Polygon – 2022

Polygon:	3058	TEM Code:	Fl00
TEM Name:	Low Bench Floodplain		
Plot #s	22-49-1–22-49-6		
Years Sampled	2022		
	Poa pratensis *Symphyotrichum foliaceum* *Symphyotrichum lanceolatum* *Taraxacum officinale* *Trifolium repens*		
	 *Poly 3058 – Plot 22-49-01: Low Bench Floodplain (Fl00) - Vegetation*	 *Poly 3058 – Plot 22-49-01: Low Bench Floodplain (Fl00) – Soil Pit*	

Appendix B. Data Summary by Polygon – 2022

Table 10: Polygon 3059

Polygon:	**3059**	**TEM Code: Fm00/Fl06**
TEM Name:	**Mid Bench floodplain/ Narrow -leaf willow Shrubland**	
Plot #s	**22-61-01 – 22-61-7**	
Years Sampled	**2019, 2022**	
Changes	**No ecosystem changes, added one new plot in red-listed Fl06 along shoreline**	
	Ecosystem 1	**Ecosystem 2**
	Mid Bench Floodplain	Narrow-leaf willow Shrubland
# of Plots	6	1
Slope (%)	0, (4)	0
Aspect (deg)	999, (10)	999
SMR	Subhygric (5)	Subhygric (5)
SNR	Poor (B)	Medium (C)
Mesoslope	Level (LV)	Level
Structural Stage	Tall Shrub 3b (Low Shrub 3a)	3a
Humus Form	None	Rhizomull (ZL)
Ah	None	No
Soil Texture	Sand (S), Sandy Loam (SL), (Silt (Si))	Loamy Sand (LS)
Coarse Fragments (%)	45, 80, 85	0, 85
Drainage	Well (w)	Moderate (m)
Seepage	None	None
Mottling	None	None
Gleying	None	None
Dominant Vegetation		
Trees	*None*	*None*
Shrubs	*Populus balsamifera*	*Salix interior* *Salix prolixa*
Herbs	*Achillea millefolium* *Anemone parviflora* *Artemesia norvegica* *Astragalus cicer* *Bromus inermis* *Danthonia spp.* *Dryas drummondii* *Medicago lupulina* *Medicago sativa* *Melilotus albus* *Oxytropis campestris var. davisii*	*Bromus inermis* *Calamagrostis stricta* *Cirsium arvense* *Elymus repens* *Equiseteum arvense* *Melilotus albus* *Solidago altissima* *Symphyotrichum lanceolatum* *Trifolium pratense*

Appendix B. Data Summary by Polygon – 2022

Polygon:	3059	TEM Code: Fm00/Fl06
TEM Name:	Mid Bench floodplain/ Narrow -leaf willow Shrubland	
Plot #s	22-61-01 – 22-61-7	
Years Sampled	2019, 2022	
Changes	No ecosystem changes, added one new plot in red-listed Fl06 along shoreline	
	Poa pratensis *Solidago altissima* *Taraxacum officinale*	

Poly 3059 – Plot 22-61-04: Mid Bench Floodplain (Fm)

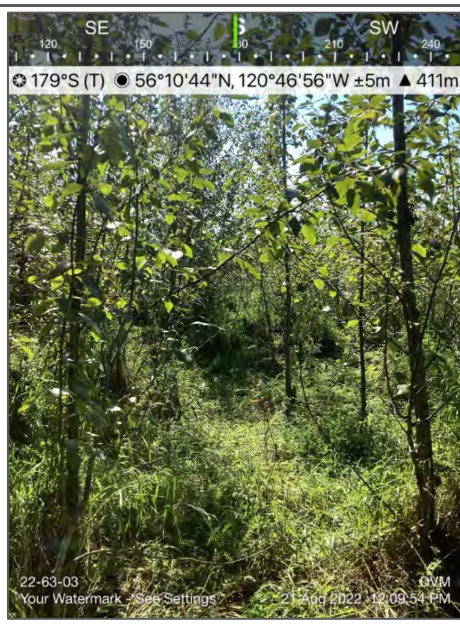
Poly 3059 – Plot 22-61-07: Pacific Willow – Red-osier Dogwood- Horsetail (Fl06)

Appendix B. Data Summary by Polygon – 2022

Table 11: Polygon 3148

Polygon	3148	TEM Code: Fm00
TEM Name:	Mid Bench floodplain	
Plot #s	22-63-1 – 22-63-6	
Years Sampled	2019, 2022	
Change	No ecosystem change	
	Ecosystem	
	Mid Bench Floodplain	
Slope (%)	0	
Aspect (deg)	999	
SMR	Subhygric (5)	
SNR	Rich (D) (Poor (B)- Medium (C))	
Mesoslope	Level (LV)	
Structural Stage	Tall Shrub 3b	
Humus Form	Mull	
Ah (cm)	None	
Soil Texture	Silty Loam (SiL), Loamy Sand (LS), (Silt (Si))	
Coarse Fragments (%)	0, 40, 45, 70, 80, 85 – cobbles and gravels	
Drainage	Moderate (m), (Well (w))	
Seepage	None	
Mottling	None	
Gleying	None	
Dominant Vegetation		
Trees		
Shrubs	*Amelanchier alnifolia* *Cornus serica* *Picea glauca* *Populus balsamifera* *Symphoricarpos albus* *Symphoricarpos occidentalis*	

Appendix B. Data Summary by Polygon – 2022

Polygon	**3148**	**TEM Code: Fm00**
TEM Name:	**Mid Bench floodplain**	
Plot #s	**22-63-1 – 22-63-6**	
Years Sampled	**2019, 2022**	
Change	**No ecosystem change**	
Herbs	*Achillea millefolium* *Astragalus cicer* *Bromus inermis* *Cirsium arvense* *Elymus repens* *Maianthemum stellatum* *Medicago sativa* *Melilotus albus* *Melilotus officinalis* *Poa Palustris* *Poa pratensis* *Solidago altissima* *Symphyotrichum ciliolatum* *Taraxum officinale*	
	 *Poly 3148 – Plot 22-63-03: Mid-Bench Floodplain (Fm00) – Vegetation*	 *Poly 3148 – Plot 22-63-02: Mid-Bench Floodplain (Fm00) – Soil Pit*

Appendix B. Data Summary by Polygon – 2022

Table 12: Polygon 3206

Polygon	**3206**	**TEM Code:**	**Fm20 (formerly Fm02)**
TEM Name:	**Balsam poplar - White spruce / Mountain alder - Red-osier dogwood**		
Plot #s	**22-17-1 – 22-17-6**		
Years Sampled	**2020, 2022**		
Change	**No ecosystem change**		
	Ecosystem		
	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood (Fm20)		
Slope (%)	0		
Aspect (deg)	999		
SMR	Mesic (4), Subhygric (5)		
SNR	Rich (D)		
Mesoslope	Level (LV)		
Structural Stage	Tall Shrub 3b, Low Shrub 3a		
Humus Form	Rhizomull (ZL), (Mull (L), (None)		
Ah (cm)	None		
Soil Texture	Silt (Si), Sand (S), (Loamy Sand LS))		
Coarse Fragments (%)	0, 60, 65, 70, 85 – gravels & cobbles		
Drainage	Moderate (m), Well (w)		
Seepage	None		
Mottling	None		
Gleying	None		
Dominant Vegetation			
Trees	*None*		
Shrubs	*Alnus incana ssp. tenuifolia* *Picea glauca* *Populus balsamifera* *Salix interior* *Salix prolixa*		

Appendix B. Data Summary by Polygon – 2022

Polygon	**3206**	**TEM Code: Fm20 (formerly Fm02)**
TEM Name:	**Balsam poplar - White spruce / Mountain alder - Red-osier dogwood**	
Plot #s	**22-17-1 – 22-17-6**	
Years Sampled	**2020, 2022**	
Change	**No ecosystem change**	
Herbs	*Achillea millefolium* *Bromus inermis* *Cirsium arvense* *Elymus repens* *Equisetum arvense* *Phalaris arundinacea* *Medicago lupulina* *Medicago albus* *Solidago altimissa* *Phalaris arundinacea* *Poa palustris* *Poa pratensis* *Solidago altissima* *Sonchus arvensis* *Symphyotrichum lanceolatum* *Taraxacum officinale* *Trifolilum hybridum*	

Poly 3206 – Plot 22-17-06: Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) - Vegetation

Poly 3206 – Plot 22-17-05: Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) – Soil Pit

Appendix B. Data Summary by Polygon – 2022

Table 13: Polygon 3239

Polygon:	**3239**	**TEM Code:**	**SH**
TEM Name:	**white spruce / red swamp currant / horsetails**		
Plot #s	**3239-1 – 3239-6**		
Years Sampled	**2019, 2022**		
Change	**No ecosystem change**		
	Ecosystem		
	White spruce / Red swamp currant / Horsetails		
Slope (%)	0		
Aspect (deg)	999		
SMR	Mesic (4)		
SNR	Rich (D)		
Mesoslope	Level (LV)		
Structural Stage	5		
Humus Form	Moder (D), (Mor, R)		
Ah (cm)	None		
Soil Texture	Silty Loam (SiL), Loamy Sand (LS), Silt (Si), Sand (S)		
Coarse Fragments (%)	0		
Drainage	Moderate (m)		
Seepage	None		
Mottling	None		
Gleying	None		
Dominant Vegetation			
Trees	*Picea glauca* *Populus balsamifera*		
Shrubs	*Alnus incana ssp. tenufolia* *Cornus serica* *Picea glauca* *Prunus virginiana* *Ribes lacustre* *Rubus idaeus* *Rosa acicularis* *Symphoricarpos albus*		

Appendix B. Data Summary by Polygon – 2022

Polygon:	**3239**	**TEM Code: SH**
TEM Name:	**white spruce / red swamp currant / horsetails**	
Plot #s	**3239-1 – 3239-6**	
Years Sampled	**2019, 2022**	
Change	**No ecosystem change**	
Herbs	*Aralia nudicaulis* *Calamagrostis canadensis* *Cornus canadensis* *Equisetum arvense* *Equisetum hyemale* *Fragaria vesca* *Galium triflorum* *Maianthemum canadensis* *Maianthemum stellatum* *Symphyotrichum lanceolatum* *Taraxacum officinale*	

Poly 3239 – Plot 3239-05: $At - Highbush cranberry - Oakfern (SHac) - Vegetation

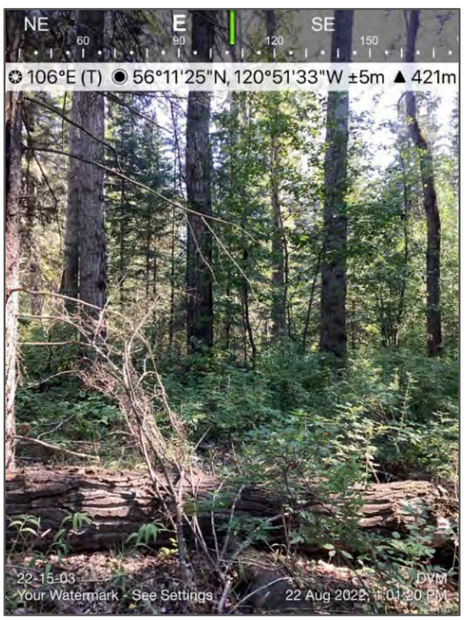
Poly 3239 – Plot 3239-05: $At - Highbush cranberry - Oakfern (SHac) – Soil Pit

Appendix B. Data Summary by Polygon – 2022

Table 14: Polygon 3308

Polygon:	**3308**	**TEM Code:**	**SH**
TEM Name:	**Sw – Currant - Horsetail**		
Plot #s	**22-15-1 – 22-15-6**		
Years Sampled	**2020, 2022**		
Change	**No ecosystem change**		
	Ecosystem		
	Sw-Currant-Horsetail (SH)		
Slope (%)	0, 3		
Aspect (deg)	999, 36		
SMR	Mesic (4), (Subhygric (5))		
SNR	Medium (C)		
Mesoslope	Level (LV)		
Structural Stage	Mature Forest (6), (Young Forest 5)		
Humus Form	Moder (D), (Mormoder (RD))		
Ah (cm)	None		
Soil Texture	Sand (S), Loamy Sand (LS), (Silt Si))		
Coarse Fragments (%)	0		
Drainage	Well (w), (Moderate (m))		
Seepage	None		
Mottling	None		
Gleying	None		
Dominant Vegetation			
Trees	*Populus balsamifera* *Picea glauca*		
Shrubs	*Alnus incana ssp. Tenuifolia* *Amelanchier alnifolia* *Cornus sericea* *Eleagnus commutata* *Picea glauca* *Ribes oxyacanthoides* *Ribes triste* *Rosa acicularis* *Rubus idaeus* *Symphoricarpos albus*		

Appendix B. Data Summary by Polygon – 2022

Polygon:	**3308**	**TEM Code: SH**
TEM Name:	**Sw – Currant - Horsetail**	
Plot #s	**22-15-1 – 22-15-6**	
Years Sampled	**2020, 2022**	
Change	**No ecosystem change**	
Herbs	*Aralia nudicaulis* *Bromis inermis* *Cornus canadensis* *Equisetum hyemale* *Eurybia sibirica* *Fragaria vesca* *Galium boreale* *Lathyrus ochroleucus* *Linnaea borealis* *Maianthemum racemosum* *Maianthemum stellatum* *Prosartes trachycarpa* *Pyrola asarifolia* *Pyrola chlorantha* *Solidago altissima* *Taraxacum officinale*	
	 *Poly 3308 – Plot 22-15-03 Sw-Currant-Horsetail (SH) - Vegetation*	 *Poly 3308 – Plot 22-15-05 Sw-Currant-Horsetail (SH) – Soil Pit*

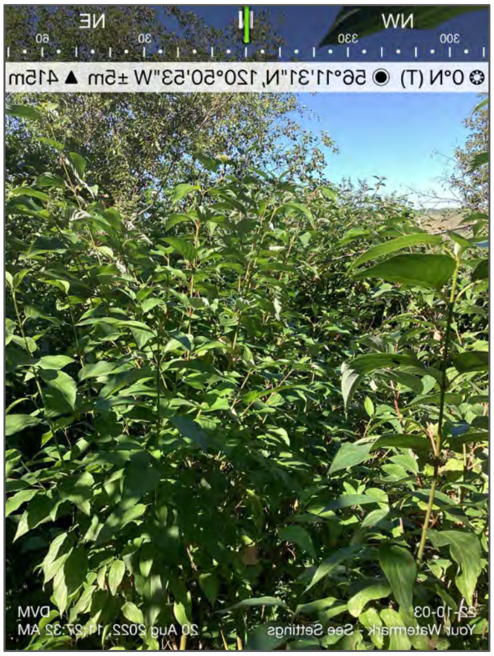
Appendix B. Data Summary by Polygon – 2022

Table 15: Polygon 3319

Polygon:	**3319**	**TEM Code:**	**Fm20 (formerly Fm02)**
TEM Name:	**Balsam poplar - White spruce / Mountain alder - Red-osier dogwood**		
Plot #s	**22-10-1 - 22-10-6**		
Years Sampled	**2020, 2022**		
Change	**No ecosystem change**		
	Ecosystem		
	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood (Fm20)		
Slope	0		
Aspect	999		
SMR	Subhygric (5)		
SNR	Rich (D)		
Mesoslope	Level (LV_		
Structural Stage*	Tall Shrub (3b)		
Humus Form	Mullmoder (MD), Lignomoder (LD), (Mull (L))		
Ah	None		
Soil Texture	Sand (S), Loamy Sand (LS), Silty Loam (SiL), (Sandy Loam (SL), Silt (Si))		
Coarse Fragments	0		
Drainage	Moderate (m)		
Seepage	None		
Mottling	None		
Gleying	None		
Dominant Vegetation			
Trees	*None*		
Shrubs	*Alnus incana ssp. tenufolia* *Cornus sericea* *Prunus virginiana* *Rosa acicularis* *Rubus idaeus* *Salix prolixa* *Shepherdia canadensis* *Symphoricarpos occidentalis*		
Herbs	*Actaea rubra* *Aralia nudicaulis* *Calamagrostis canadensis* *Elymus repens* *Equisetum arvense* *Galium triflorum* *Maianthemum canadense* *Stachys palustris* *Urtica dioica*		

Appendix B. Data Summary by Polygon – 2022

Polygon:	3319	TEM Code:	Fm20 (formerly Fm02)
TEM Name:	Balsam poplar - White spruce / Mountain alder - Red-osier dogwood		
Plot #s	22-10-1 - 22-10-6		
Years Sampled	2020, 2022		
Change	No ecosystem change		



Poly 3319 – Plot 22-10-03: Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) - Vegetation

Poly 3319 – Plot 22-10-04: Balsam poplar – White spruce / Mountain alder – Red-osier dogwood (Fm20) – Soil Pit

Appendix B. Data Summary by Polygon – 2022

Table 16: Polygon 3367

Polygon	3367	TEM Code: GB
TEM Name:	Gravel Bar	
Plot #s	10 - 15	
Year Sampled	2019, not sampled in 2022	
Change	All plots altered due to fish habitat works, unable to sample in 2022 due to equipment on site	
	Ecosystem	
Ecosystem Name	Gravel Bar	
Slope	0	
Aspect	999	
SMR	Hygric (6)	
SNR	Poor (B)	
Mesoslope	Level	
Structural Stage*	3a (1a)	
Humus Form	None	
Ah	None	
Soil Texture	Sand	
Coarse Fragments	85-100	
Drainage	Rapid (Moderate)	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	-	
Shrubs	*Populus balsamifera* *Salix prolixa*	
Herbs	*Allium schoenoprasum* *Agrostis gigantea*	

Appendix B. Data Summary by Polygon – 2022

Polygon	3367	TEM Code: GB
TEM Name:	Gravel Bar	
Plot #s	10 - 15	
Year Sampled	2019, not sampled in 2022	
Change	All plots altered due to fish habitat works, unable to sample in 2022 due to equipment on site	
	Agrostis stolonifera *Arnica chamissonis* *Brassica rapa* *Carex crawfordii* *Chenopodium album* *Crepis tectorum* *Deschampsia cespitosa* *Elymus repens* *Melilotus alba* *Solidago altissima* *Symphyotrichum lanceolatum* *Persicaria maculosa* *Taraxacum officinale* *Tripled rospermum*	 *Poly 3367 – Plot 11: Gravel Bar (GB)*

Appendix B. Data Summary by Polygon – 2022

Table 17: Polygon 3373

Polygon:	3373	TEM Code:	Fl00
TEM Name:	Low Bench Floodplain		
Plot #s	22-46-1–22-46-4		
Years Sampled	2020, 2022		
Change	No ecosystem change		
	Ecosystem		
	Low Bench Floodplain		
Slope (%)	0, 3, 5		
Aspect (deg)	136, 322, 999		
SMR	Subhygric (5)		
SNR	Medium (C)		
Mesoslope	Level (LV), Lower (LW)		
Structural Stage	Tall Shrub (3b)		
Humus Form	Mull (L)		
Ah (cm)	None		
Soil Texture	Loamy Sand (LS), Sand (S), (Sandy Loam (SL), Silt (Si))		
Coarse Fragments (%)	0		
Drainage	Moderate (m)		
Seepage	None		
Mottling	None		
Gleying	None		
Dominant Vegetation			
Trees	*Populus balsamifera*		
Shrubs	*Acer negundo* *Alnus incana ssp. tenufolia* *Cornus sericea* *Picea glauca* *Populus balsamifera* *Rosa acicularis* *Rubus ideaus* *Salix interior* *Salix prolixa*		

Appendix B. Data Summary by Polygon – 2022

Polygon:	3373	TEM Code: FI00
TEM Name:	Low Bench Floodplain	
Plot #s	22-46-1–22-46-4	
Years Sampled	2020, 2022	
Change	No ecosystem change	
Herbs	*Aralia nudicaulis* *Bromus inermis* *Calamagrostis canadensis* *Cirsium arvense* *Equisetum hyemale* *Maianthemum stellatum* *Poa pratensis* *Solidago altissima* *Sonchus arvensis* *Stachys palustris* *Symphyotrichum lanceolatum* *Trifolilum hybridum*	
	 *Poly 3373 – Plot 22-46-02 Low Bench Floodplain (FI00) - Vegetation*	 *Poly 3373 – Plot 22-46-02 Low Bench Floodplain (FI00) – Soil Pit*

Appendix B. Data Summary by Polygon – 2022

Table 18: Polygon 3409

Polygon:	3409	TEM Code:	Fl00
TEM Name:	Low Bench Floodplain		
Plot #s	22-09-1		
Years Sampled	2020, 2022		
Change	5 out of 6 plots altered as a result of fish habitat restoration work		

	Ecosystem
	Low Bench Floodplain
Slope (%)	0
Aspect (deg)	999
SMR	Subhygric (5)
SNR	Poor (B)
Mesoslope	Level (LV)
Structural Stage	Herbaceous (2a)/Tall Shrub (3b)
Humus Form	None
Ah (cm)	None
Soil Texture	Sand (S)
Coarse Fragments (%)	0 (gravels at 19 cm)
Drainage	Imperfect (i)
Seepage	None
Mottling	None
Gleying	None

Dominant Vegetation

Trees	*None*	
Shrubs	*Populus balsamifera* *Symphoricarpos albus*	
Herbs	*Achillea millefolium* *Bromus inermis* *Equisetum hyemale* *Melilotus alba*	

Appendix B. Data Summary by Polygon – 2022

Polygon:	3409	TEM Code: Fl00
TEM Name:	Low Bench Floodplain	
Plot #s	22-09-1	
Years Sampled	2020, 2022	
Change	5 out of 6 plots altered as a result of fish habitat restoration work	

Poly 3409 – Plot 22-09-1 Low Bench Floodplain (Fl00) - Vegetation

Poly 3409 – Plot 22-09-1 Low Bench Floodplain (Fl00) -Soil Pit

Appendix B. Data Summary by Polygon – 2022

Table 19: Polygon 3448

Polygon:	3448	TEM Code: GB
TEM Name:	Gravel Bar	
Plot #s	3448-01 – 3448-05	
Years Sampled	2019, 2022	
Change	No ecosystem change	
	Ecosystem	
	Gravel Bar	
Slope (%)	0	
Aspect (deg)	999	
SMR	Hygric (6), Subhygric (5)	
SNR	Medium (C), Rich (D)	
Mesoslope	Level (LV)	
Structural Stage	Herbaceous (2a)	
Humus Form	None	
Ah (cm)	None	
Soil Texture	Sand (S), Loamy Sand (LS), Silty Loam (SiL)	
Coarse Fragments (%)	90% at depth, gravels and cobbles	
Drainage	Imperfect (i), Well (m), (Moderately well (mw))	
Seepage	None	
Mottling	Faint Mottles at 3 plots	
Gleying	None	
Dominant Vegetation		
Trees	*None*	
Shrubs	*Salix interior* *Salix prolixa*	
Herbs	*Agrostis gigantea* *Agrostis scabra* *Allium schoenoprasum* *Arnica chamissonis* *Artemesia campestris* *Bromus inermis* *Calamagrostis stricta* *Cirsium arvense* *Elymus repens* *Eurybia sibirica* *Hordeum jubatum* *Lotus corniculatus* *Medicago lupulina*	

Appendix B. Data Summary by Polygon – 2022

Polygon:	3448	TEM Code: GB
TEM Name:	Gravel Bar	
Plot #s	3448-01 – 3448-05	
Years Sampled	2019, 2022	
Change	No ecosystem change	
	Melilotus albus *Phalaris arundinacea* *Plantago major* *Poa spp.* *Poa palustris* *Sonchus arvensis* *Symphyotrich lanceolatum* *Trifolilum hybridum* *Tripleurospermum inodorum*	
	 *Poly 3348 – Plot 3348-01 Gravel Bar (GB) - Vegetation*	 *Poly 3347 – Plot 3348-01 Gravel Bar (GB) – Soil Pit*

Appendix B. Data Summary by Polygon – 2022

Table 20: Polygon 3459

Polygon:	3459	TEM Code: Fl06
TEM Name:	Narrow-leaf willow Shrubland	
Plot #s	3459-01-3459-05	
Years Sampled	2019, 2022	
Change	Reclassified the Fl03 to Fl06 based on site and vegetation conditions	
	Ecosystem	
	Narrow-leaf willow Shrubland	
# of plots	5	
Slope (%)	0	
Aspect (deg)	999	
SMR	Subhygric (5), Hygric (6)	
SNR	Medium (C), Rich (D)	
Mesoslope	Level (LV)	
Structural Stage	3b	
Humus Form	None	
Ah (cm)	None	
Soil Texture	Silt (S)/Sand (S), Silt Loam (SiL)/Sand (S)	
Coarse Fragments (%)	0	
Drainage	Moderate (m), Imperfect (i)	
Seepage	None	
Mottling	2 plots with distinct mottling	
Gleying	None	
Dominant Vegetation		
Trees	*None*	
Shrubs	*Salix interior* *Salix prolixa* *Populus balsamifera* *Alnus incana ssp tenufolia*	

Appendix B. Data Summary by Polygon – 2022

Polygon:	3459	TEM Code: Fl06
TEM Name:	Narrow-leaf willow Shrubland	
Plot #s	3459-01-3459-05	
Years Sampled	2019, 2022	
Change	Reclassified the Fl03 to Fl06 based on site and vegetation conditions	
Herbs	*Agrostis gigantea* *Calamagrostis canadensis* *Calamagrostis stricta* *Cirsium arvense* *Elymus repens* *Equisetum arvense* *Fragaria vesca* *Phleum pratense* *Poa palustris* *Scirpus macrocarpus* *Sonchus arvense* *Taraxacum officinale* *Trifolium hybridum* *Tripleurospermum inodrorum*	
	 *Poly 3459 – Plot 3459-03-03: Narrow leaf Willow Shrubland (Fl06)*	 *Poly 3459 – Plot 3459-03-12: Narrow leaf Willow Shrubland (Fl06)*

Appendix 9. Experimental Rare Plant Translocation Program 2022 Annual Report

Experimental Rare Plant Translocation Program
2022 Annual Report

Date: March, 2023

PRESENTED TO:

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

PRESENTED BY:

EcoLogic Consultants Ltd.
224 - 998 Harbourside Drive
North Vancouver, BC V7P 3T2
Phone: 604 803-7146
and
Tetra Tech Canada Incorporated
on behalf of Saulteau EBA Environmental Services Joint Venture (SEES JV)
885 Dunsmuir Street, Suite 1000
Vancouver, BC V6C 1N5
Phone: 604 685-0275

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ACRONYMS & ABBREVIATIONS

Term	Definition
B.C. CDC	B.C. Conservation Data Centre
EIL	Erosion Impact Line
ERPT	Experimental Rare Plant Translocation
ENSCONET	European Native Seed Conservation Network
PAZ	Potential Activity Zone
PRS	Potential Recipient Site
QA/QC	Quality Assurance and Quality Control
spp.	The abbreviation "spp." (plural) indicates "several species".
sp.	The abbreviation "sp." Refers to a single species.

1. INTRODUCTION

As part of the federal and provincial regulatory approvals of the Site C project, BC Hydro committed to the creation of an Experimental Rare Plant Translocation (ERPT) program to support the viability of target rare plant species affected by the project.

The ERPT program is designed to establish new populations of target rare plant species in areas that are secure, contain analogous habitat to the source populations, and are within the Peace Region. This program uses an experimental approach to identify critical factors affecting germination, establishment, growth, and survival of the target species, the results of which inform the scope of the design such that informed variations on salvage, propagation, and transplant methods can be employed. The ERPT program is updated on an ongoing basis to incorporate relevant information related to target rare plant species and translocation methods as it emerges.

The program is founded on collaborative working relationships with First Nation-owned, local businesses, and other consultants, and benefits from the shared knowledge and experience. The knowledge acquired and lessons learned can be employed to maximize the success of the program and can be shared among these partners to increase the overall understanding of these systems within the community of contributors.

This report summarizes the measures and activities undertaken in 2022 for the ERPT program. Included is a summary of the plant species of conservation concern included in the program and the general methods and activities completed for the four phases of the program: Phase 1 - propagule collection; Phase 2 - *ex-situ* propagation; Phase 3 - translocation implementation; and Phase 4 - post-translocation care, maintenance, and monitoring. Information gained from the 2022 program will inform improvements to project methods and management in 2023.

1.1 PLANT SPECIES INCLUDED IN THE PROGRAM AND THEIR CONSERVATION RANKS

The B.C. Conservation Data Centre (B.C. CDC) annually assesses the provincial conservation ranks of vascular plants and bryophytes in the province. This annual assessment incorporates new information about the abundance and distribution of the province's flora, as well as newly recognized threats (or lack thereof) to known populations. The ranking update published by the B.C. CDC in 2022 (B.C. CDC 2022) changed the conservation status rank of 46 taxa in the province relative to their status in 2021.

One change to the conservation status rank of a species included in the ERPT program was made in 2022. The provincial listing for *Oxytropis campestris* var. *davisii* was changed from special concern to a range between special concern and apparently secure and its rank was changed from blue to yellow (Table 1.1-1). However, this taxon remains ranked as Globally Vulnerable (G5T3) by NatureServe, with the majority of the global population existing in B.C. (Natureserve 2023). Following the decision framework for species prioritization (see Section 6.0 of the Rare Plant Translocation program plan), *Oxytropis campestris* var. davisii changes from a priority 1 species/variety to a priority 2 species and the replacement ratio would change accordingly from a target of 1800 to 900. A total of 1,077 individuals have already been planted, and monitoring of this taxon will continue.

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

Scientific Name	Common Name	B.C. CDC Provincial Rank	NatureServe Provincial Status	NatureServe Global Status
Canada mountain-ricegrass	*Piptatheropsis canadensis*	Red	S1 (2019)	G4G5 (2016)
Davis' locoweed	*Oxytropis campestris* var. *davisii*	Yellow	S3S4 (2022)	G5T3 (2015)
Dryland sedge	*Carex xerantica*	Blue	S3 (2019)	G5 (2016)
Prairie buttercup	*Ranunculus rhomboideus*	Blue	S2S3 (2019)	G5 (2016)
Rocky Mountain willowherb	*Epilobium saximontanum*	Blue	S3 (2019)	G5 (1984)
Rock selaginella	*Selaginella rupestris*	Red	S2 (2019)	G5 (2016)
Slender penstemon	*Penstemon gracilis*	Blue	S3 (2019	G5 (2016)
Sprengel's sedge	*Carex sprengelii*	Blue	S3 (2019)	G5 (2016)
Torrey's sedge	*Carex torreyi*	Blue	S3? (2019)	G4G5 (2016)

2. GENERAL METHODS

2.1 PHASE 1. PROPAGULE COLLECTION

The standards for collecting and storing propagules for *ex-situ* conservation (e.g., timing, sampling, labelling, cleaning, processing, stratification, sowing, provenance) incorporate guidance outlined in Maslovat (2009) and by the European Native Seed Conservation Network (ENSCONET 2009).

The 2022 propagule collection phase included a combination of the following collection strategies:

- collection of seed from existing populations and sowing of seeds at a nursery, with the resulting seedlings targeted for out-planting at recipient sites; and
- collection of mature plants from existing populations, followed by out-planting material at recipient sites.

2.1.1 *In-situ* Seed Collection

The 2022 *in-situ* propagule collection efforts focused predominantly on augmenting existing seedbank resources for future propagation and for insurance against stochastic events (e.g., floods), human disturbance, and year-to-year climatic variability. Additional collection efforts focused on salvaging plants from within the project footprint and directly replanting them to areas outside of the footprint (Figure 2.1-1).

2.1.2 *Ex-situ* Seed Collection

Nursery staff collected seeds from the nursery stock derived from the 2019/2020 seed collection efforts. Nursery staff sorted the seeds to remove non-viable seeds (i.e., empty, or poorly developed), and the remaining seeds were cleaned and dried (where necessary) to maximize viability. Cleaning included the removal of waste material from around the seed capsule, and the use of sieves, hand separation, and air separation. Seeds were then placed in cold storage at the nursery to maintain seed quality and longevity. The provenance, seed collection procedures, and quantity collected were recorded.

2.2 PHASE 2. *EX-SITU* PROPAGATION

No *ex-situ* propagation was completed in 2022 as there was ample stock for outplanting for the majority of the species scheduled for further translocation (i.e., Sprengel's sedge and prairie buttercup). For those species where additional stock is needed (i.e., Canada mountain-ricegrass and Torrey's sedge), efforts focused on acquiring the seeds for future propagation. As the ERPT program progresses, the bulk of the effort will transition from a focus on seed collection, propagation, and translocation to a greater emphasis on monitoring, follow up care and maintenance.

In general, *ex-situ* propagation involved stratification and propagation for each individual target species in a nursery environment in 2018 to 2021. Curation protocols and recommendations (ENSCONET 2009) and professional horticultural experience were used to inform the methods for this aspect of the program (see description below).

Through the pre-treatment process, seeds have been treated to simulate the natural conditions for breaking seed dormancy and initiating germination. Seeds were scarified and/or stratified as relevant. Scarification treatments included a short hot-water bath or sandpaper, while stratification included immersing the seeds into cold temperatures with moisture to simulate natural germination conditions. Seeds that were not intended for planting in the subsequent year were not treated and are being stored as insurance for potential future use.

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

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

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

- provenance (i.e., origin of material collected);
- type of material collected (e.g., seed, live plant);
- location and date of collection; and

  growing conditions such as potting media, temperature of propagation area, watering, and treatment of seeds.

2.3 Phase 3. Translocation

Translocation implementation included four components: (i) recipient site selection; (ii) transport and plant preparation; (iii) selection of planting locations with the habitat matrix; and (iv) translocation at recipient sites.

2.3.1 Recipient Site Selection

Selection of suitable recipient sites, based on the species-specific preferred habitat characteristics, was informed by the extensive existing information collected for Site C along with the expert knowledge of qualified botanists and ecologists who performed the field verification work (see Appendix A provided by Eagle Cap Consultants [Eagle Cap]). Selected sites contained habitat analogous to the source populations and were situated in areas that are unlikely to be developed in the foreseeable future. All sites selected are located within the Peace Region.

The stated goal of recipient site selection in 2022 was to focus on distributing sites as widely as possible to disperse the translocated plants across a larger number of recipient sites. The intent is to build further resilience into the program and help alleviate the impacts of stochastic events (e.g., floods, fires, landslides) on the overall program objectives.

Qualified botanists from Eagle Cap undertook the process of identifying potentially suitable recipient sites for seven target rare plant species: Sprengel's sedge, Torrey's sedge, dryland sedge, Davis' locoweed, Canada mountain-ricegrass, prairie buttercup, and rock selaginella. The following text summarizes the recipient site selection process (refer to Appendix A for further details).

Before verifying and selecting recipient sites in the field, a desktop review was conducted to identify potential locations. The desktop review included literature reviews for each priority species to evaluate current and relevant species information such as habitat and translocation requirements, with a particular focus on reviewing new information that had been published since 2020. The updated B.C. CDC database was reviewed to ensure that all existing occurrences known were incorporated into the analysis, and queries were run on the project rare plant database to extract any habitat information that had been recorded during earlier years of the ERPT program.

The habitat requirements of the seven target species were grouped into four main types that represent potentially suitable habitats for translocation, with the following characteristics (Appendix A):

1. river or large stream with level, open, non-active cobble bars; shading open to partial; sparsely vegetated; sandy, well-drained soil;
2. moist, shrubby, level to moderate slope, shading open to full, aspect variable, densely vegetated, may dry out later in season, relatively rich clay/silt soil;
3. mesic to dry, open, south-facing hillcrest or gentle slope; relatively dense low shrubs; grassland vegetation with a green appearance on aerial imagery; or
4. dry, steep, open, south-facing hillcrest/hillside; relatively sparse, low shrubs; xeric grassland vegetation with a tan-coloured appearance on aerial imagery.

Aerial imagery and GIS attributes were visually evaluated to identify locations with potentially suitable ecological and logistical characteristics that would maximize opportunities for successful translocation. GIS layers that were assessed for these analyses included: (i) aerial imagery of the Peace River region; (ii) property ownership (provided by BC Hydro); (iii) known element occurrences of the target species; (iv) potential recipient sites identified during earlier years of the project; (v) the Site C Project Activity Zone (PAZ); and (vi) the Site C preliminary Erosion Impact Line (EIL). This analysis resulted in the following criteria that were identified as indicative of suitable Potential Recipient Sites (PRS):

1. accessible by road or boat during the entire growing season;
2. outside of the Site C PAZ;
3. not located below the reservoir preliminary Erosion Impact Line (i.e., a precautionary estimate of the amount of erosion that could occur over a 100-year period);
4. located on Crown land or BC Hydro land near the Peace River;
5. within range of cell service;
6. not requiring access through a locked gate or other landowner permission;
7. contains appropriate habitat for the priority species;
8. contains low density of non-native plants;
9. has low levels of existing and reasonably foreseeable future anthropogenic disturbance;
10. greater than one kilometre from known sites of the same taxon;
11. not already occupied by rare plant species; and
12. located close to a water source.

This list of desirable PRS qualities describes a hypothetical ideal site such that not all criteria are likely to be satisfied. For example, field botanists attempted to avoid occupied sites when reviewing potential planting locations; however, this was only partially successful because suitable planting sites were often found to host target rare plant species. As a result, no site is likely to fulfill all the listed criteria, and trade-offs will always be necessary to ensure that the project can proceed.

Recipient sites were selected primarily based on known species-specific habitat characteristics, and in part based on distance to other planting sites, with the aim of distributing them over a wide geographical extent. In some instances, a site was found to contain suitable habitat for several ERPT target species in close proximity, and so separate assessments of the microsite features were completed for each target species. Several of the target species occur together in wild populations, and thus their co-occurrence is consistent with natural conditions.

Thirty-three PRS were identified during this desktop exercise in 2022, of which 12 received field verification and were ranked for suitability using weighted desirable site characteristics. The 21 PRS not field-verified have been visited during earlier field surveys or are under consideration as future PRSs (see Appendix A). Of the sites that were checked, one area was removed from consideration due to the existence of pre-existing rare plant occurrences, eight PRS were investigated further, and three PRS plots were set aside for future consideration.

Despite challenges with avoiding sites in the vicinity of other rare plant populations and finding areas with water sources, the eight highest-quality PRS met the majority of the stated requirements. Five of the planting areas consisted of habitats that supported multiple target species (Appendix A) and the remaining PRS were specifically selected for a single taxon due to their distinct habitat requirements. Supplemental planting areas (i.e., specific microsites) were marked within suitable habitat to optimize plant placement.

2.3.2 Transport and Plant Preparation

Nursery seedlings (i.e., small plants in 50P or 75P size plugs) and adult plants (i.e., medium to large plants in 1-gallon pots) were shipped from NATS nursery on June 8 and August 29, 2022. Plants arrived at Dunvegan Gardens (Dunvegan) in Fort St. John on June 11 and August 31, 2022, respectively (Plate 2.3-1). The plants were housed at the garden centre and moved to a private residence in Fort St. John (Plate 2.3-2) until transplant at recipient sites in the following days. Plants were stored outside in June, August, and early September as temperatures were above freezing.

Plate 2.3-1. Plants shipped from NATS Nursery to Dunvegan Gardens on June 11, 2022

Plate 2.3-2. Plants were stored at a private residence in Fort St. John until translocation

2.3.3 Selection of Planting Locations within the Habitat Matrix

Planting locations within the larger habitat matrix at a recipient site were identified as those that were relatively easy to access, corresponded with known ecological conditions that support the species, supported plant diversity that is similar to the source populations, were on stable substrates that are not expected to undergo erosion or deposition, had low abundance of invasive plants, and were not accessible to cattle or used intensely by native herbivores. There was limited variability in the planting patterns within species, thereby minimizing constraints on comparability across sites within species. Within species, the planting plans sought to:

- establish plant groupings such that there were similar conditions in terms of microsite conditions (e.g., soils, slope, aspect);
- create plant groupings to encourage pollinator visitation; and
- space individuals to minimize potential trampling during planting and monitoring and to minimize interspecific competition for resources (e.g., minimize density-dependent effects on survival).

2.3.4 Translocation at Recipient Sites

The specific timing windows for planting were determined based on past years' experience regarding the average first and last frost-free days for Fort St. John, as well as plant phenology, the development stage of the propagated plants, the local weather, and soil moisture conditions. The timing for planting of two species also took into consideration the need to salvage plants prior to clearing activities occurring at one location.

Translocation in 2022 occurred from June 14 to 17, and further out-planting was attempted on September 3. Implementation of the translocation planting included the following:

- placement of plants into optimal microhabitats at the recipient sites, and in a spatial pattern suitable to the rare plant's biology as observed at the source populations or otherwise known;
- installation of durable, long-lasting tags to label individual plants and flagging tape to label plant groupings;
- code systems to differentiate various experimental trials as needed to retain as much information as possible on the pathway of a given plant (e.g., from seed collection to planting) to facilitate annual assessments of success;
- marked boundaries for plants, plant groupings, and translocation site boundaries using GPS points and imported into the project GIS system;
- care and maintenance at the time of planting, such as watering and creation of microhabitat as necessary;
- documentation of each translocation effort (including time spent on each phase), which included the methods used to prepare and transport the material from the nursery to the recipient site,

pre-translocation site preparation, environmental conditions, method of re-introduction, care and maintenance activities, planting density, and spatial pattern; and

- post-translocation follow-up to assess the health and status of a sample and to check for other possible problems, such as desiccation, pest insects, trampling, herbivory, or vandalism at a translocation site.

2.4 Phase 4. Monitoring

Two levels of monitoring were conducted in 2022: interim monitoring and year-end monitoring. Interim monitoring occurred at a frequency that permitted the timely identification of threats such as vandalism, desiccation, or herbivory, and allowed for subsequent mitigation measures to address these issues. Year-end monitoring included an assessment of: (i) **Survivorship** - to determine if individuals are surviving beyond the initial transplant year; (ii) **Maturity** - to determine if individuals are maturing to the flowering and fruiting stages; (iii) **Reproduction** - to determine if individuals are successfully producing seeds; and (iv) **Recruitment** - to determine if seeds from the population germinate successfully at the site and contributing to a second generation. The following population traits were assessed during the monitoring program:

- plant presence (summarized as number of live/dead/absent individuals);
- vegetative growth (width or height) and/or health (qualitative assessment);
- flower production per individual;
- seed production per individual; and
- spatial extent of the population.

Monitoring activities also re-evaluated sites for the one or more of the following to identify successes and failures to improve the survival of future plantings:

- invasive species presence, especially in close proximity to the translocated plants, and/or any species that may have inadvertently been introduced to the site during the translocation;
- herbivory or other possible problems (e.g., pest insects, trampling, ungulate grazing);
- human disturbance; and
- microsite habitat preferences.

Information gained from monitoring implementation of the various experimental translocation approaches used will help to identify which approaches are effective and to isolate inadequacies in specific methods, all within an adaptive management framework.

2.5 Quality Assurance and Control

Quality assurance and quality control (QA/QC) measures were used for collecting data within the field program so that methods were consistently replicated across all trials and years, and so that pertinent variables or any variations in methodology were recorded. The data form was designed to accommodate data collection at the transect, plot, or individual plant level across years (Appendix B). The data form included the following fields:

1. site details (i.e., Site ID, geographical location, slope, aspect, and elevation);
2. species information (i.e., species name, nursery of origin, seedlot, key metrics for survivorship, maturity, and reproduction);
3. potential threats (i.e., herbivory, drought, others); and
4. map outlining the relative location of each individual plant and plant grouping.

Photos were taken using the Solocator App (Civi Corp Pty Limited 2021), which were date- and time-stamped and included the UTM location of the site.

3. RESULTS

3.1 PHASE 1. PROPAGULE COLLECTION

The 2022 *in-situ* collection efforts focused on acquiring additional propagules for four species: Canada mountain-ricegrass, Sprengel's sedge, Torrey's sedge, and prairie buttercup. Collection efforts focused primarily on acquiring seeds for Canada mountain-ricegrass and Torrey's sedge as there was no stock previously available for these species in the nursery seedbank. Additional propagule collection efforts focused on Sprengel's sedge and prairie buttercup to augment the existing seedbank housed at NATS nursery.

Two grams of cleaned Canada mountain-ricegrass seeds were collected from nursery stock on August 30, 2022 (Table 3.1-1; Plates 3.1-1 and 3.1-2). One gram of cleaned prairie buttercup seeds was also collected from nursery stock on August 10, 2022 (Table 3.1-1; Plate 3.1-3). *Ex-situ* seed collections were planned for Sprengel's and Torrey's sedge, however, the seed collector did not observe seeds during the multiple collection attempts.

Table 3.1-1. Summary of Successful 2022 Propagule Collection Efforts

Common Name	Species Name	Propagule Amount and Type	Collection Timing	Collection Type	Collection Location
Sprengel's sedge	*Carex sprengelii*	<0.1 g of seed* (66 seeds)	August 2, 2022	*in-situ*	Dry Creek site
Prairie buttercup	*Ranunculus rhomboideus*	16 plants (in 9 clumps)	June 13, 2022	*in-situ*	Watson Slough
		1 g of seed*	August 10, 2022	*ex-situ*	NATS nursery
Canada mountain rice-grass	*Piptatheropsis canadensis*	2 g of seed*	August 30, 2022	*ex-situ*	NATS nursery

* Quantity provided from the nursery is an estimate based on seed weight.

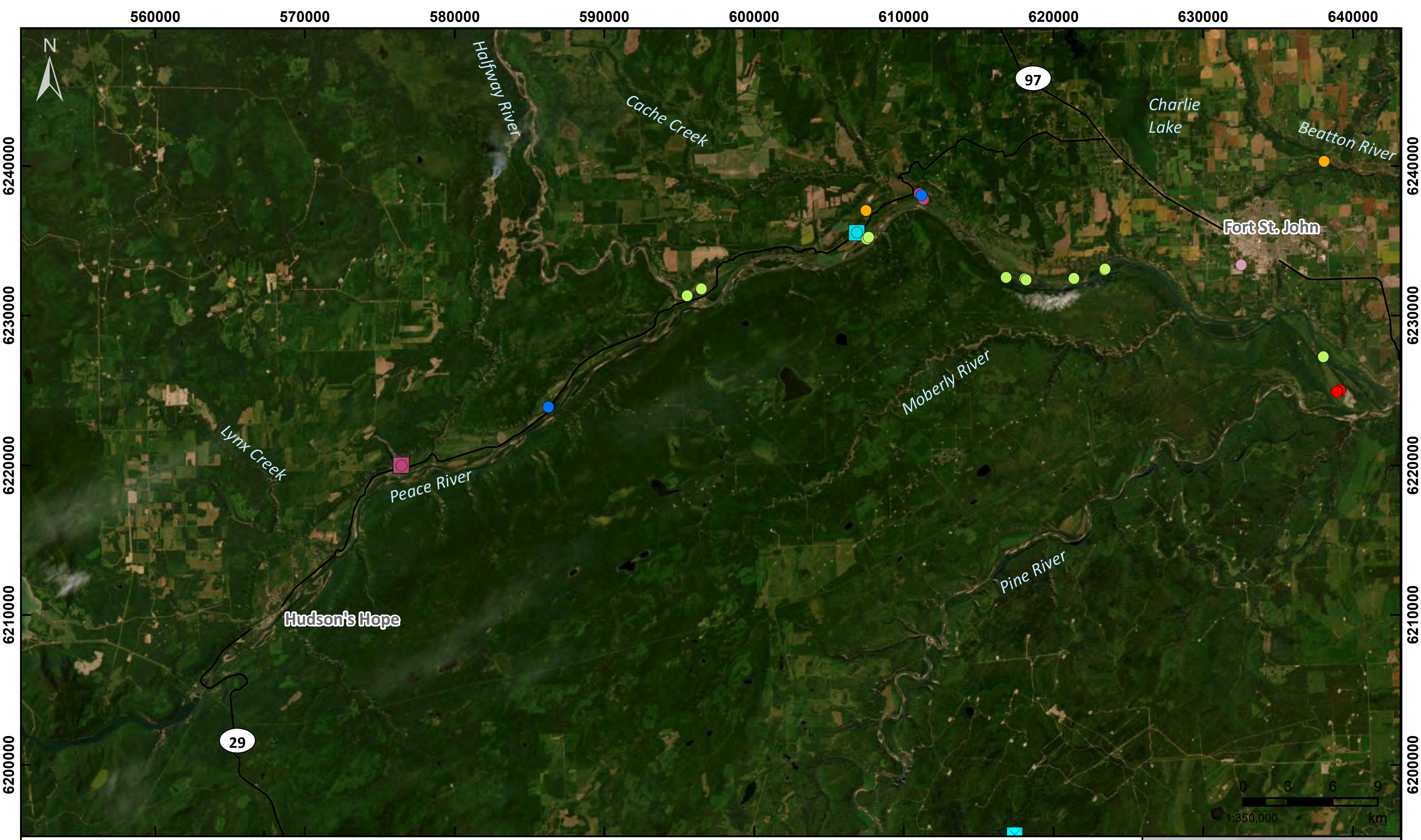
Plate 3.1-1. Canada mountain-ricegrass seeds collected from nursery stock in 2022 (Photo credit: NATS)

Plate 3.1-2. Cleaned Canada mountain-ricegrass seeds collected from nursery stock in 2022 (Photo credit: NATS)

Plate 3.1-3. Cleaned prairie buttercup seeds collected from nursery stock in 2022 (Photo credit: NATS)

Plate 3.1-4. Cleaned Sprengel's sedge seeds collected from the Fish Creek collection area in 2022 (Photo credit: NATS)

In-situ propagule collection efforts by Eagle Cap were successful for one target species, Sprengel's sedge, in which approximately 0.1 g of clean seed was collected from the Dry Creek site on August 2, 2022 (Figure 3.1-1; Table 3.1-1; Plate 3.1-4). The native plant nurseries will sow these seeds with the intent of generating future plant stock for transplant at recipient sites. Seeds from prairie buttercup plants were not collected in 2022 due to the low number of plants with flowers/seed heads. Instead, these plants were salvaged and translocated to another site (see section 3.3.1). Seed collection attempts for Torrey's sedge were made on August 3, 2022, at the Fish Creek site, a site that has resulted in successful collections in past years. At the time of collection no seeds were observed, despite observations of inflorescences on June 11, 2022. Seed collection attempts for Canada mountain-ricegrass were made on July 27, 2022, at the west end of the Cache Creek collection area. At the time of collection, the seeds had not yet ripened, and fewer plants had produced inflorescences compared to 2021. On August 3, 2022, at another Canada mountain-ricegrass seed collection site (east end of Fish Creek site), fruiting stems with seeds were observed, however, they were not collected due to the small number of seed heads detected. A larger patch of Canada mountain-ricegrass with seed heads was also observed at the west end of the Fish Creek site on August 30, 2022, however no wild seed was collected from the wild populations in light of the successful *ex-situ* collections of mountain-ricegrass from the nursery in 2022.



Site C Project

Experimental Rare Plant Translocation Propagule Collection Locations

Figure 3.1-1

Date: 2022-12-06

Map Number: BCH-063

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC

2017-2021	2022	Target Species
●	■	Sprengel's sedge (*Carex sprengelli*)
●		Torrey's sedge (*Carex torreyi*)
●		Dryland sedge (*Carex xerantica*)
●		Davis' locoweed (*Oxytropis campestris var. davisii*)
●		Slender penstemon (*Penstemon gracilis*)
●		Canada mountain-ricegrass (*Piptatheropsis canadensis*)
●	■	Prairie buttercup (*Ranunculus rhomboideus*)
●		Rock selaginella (*Selaginella rupestris*)

3.2 PHASE 3. TRANSLOCATION IMPLEMENTATION

Translocation implementation focused on planting trials at recipient sites that have greater long-term security than the locations of the source material. The recipient sites are within the known distribution range for the target plant within the Peace Region and have similar habitat to the location of the source material. Translocation efforts have also focused on out-planting larger individuals because adult translocated plants have shown higher survival than translocated seedlings (Dalrymple 2012; Bush 2022).

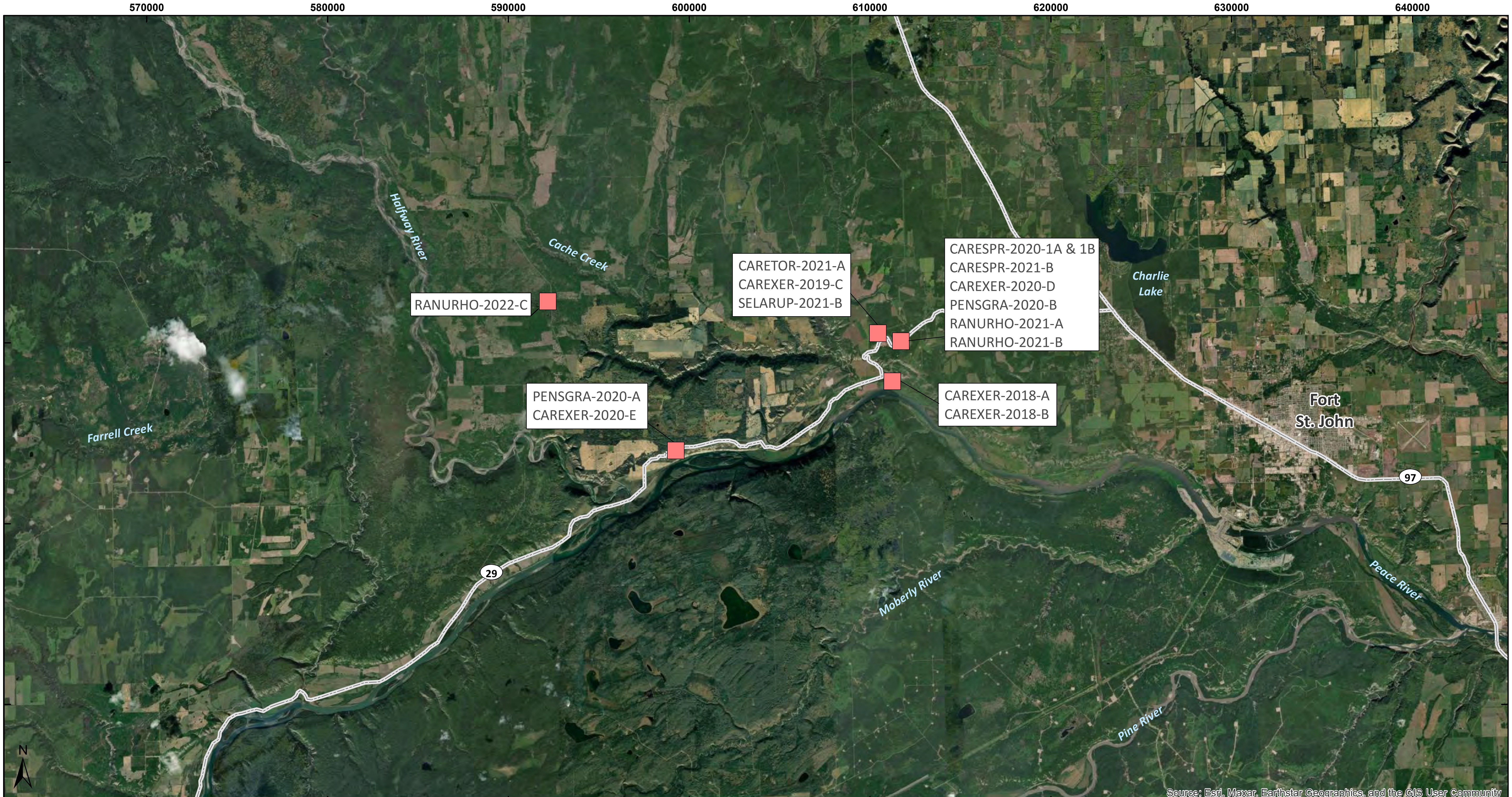
Translocation trials were completed in June 2022 with 459 individuals planted at seven recipient sites (Figures 3.2-1 to 3.2-2; Table 3.2-1). To date, more than 1,500 plants from a diversity of eight different rare plant species have been translocated for this project.

Table 3.2-1. Summary of Individuals Translocated by Species and Site ID in 2022

Species	Site ID	Translocation Date	No. of Seedlings*	No. of Adults **	Total
Davis' Locoweed	OXYTCAM3-2020-B	16-Jun	132	76	208
	OXYTCAM3-2020-C	15-Jun	0	174	174
	OXYTCAM3-2022-D	14-Jun	0	43	43
	OXYTCAM3-2022-E	16-Jun	0	11	11
Total			**132**	**304**	**436**
prairie buttercup	RANURHO-2021-B	17-Jun	0	4	4
	RANURHO-2022-C	13-Jun	0	16	16
Total					**20**
Torrey's sedge	CARETOR-2021-A	17-Jun	0	3	3
Total					**3**
Grand Total					**459**

* Seedlings are provided in 50P plug size containers which are 5" deep by 2" wide.

**Adults are provided in 1-gallon pots.



Site C Project

Experimental Rare Plant Translocation

Recipient Site Locations

Figure 3.2-1

Date: 2022-12-06

Map Number: BCH-064b

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC environmental consulting

Legend

- 2018-2022 Recipient Sites[1]
- Highway

[1]Site names correspond to the following species:

- CAREXER - Dryland sedge (*Carex xerantica*)
- CARETOR - Torrey's sedge (*Carex torreyi*)
- PENSGRA - Slender penstemon (*Penstemon gracilis*)
- RANURHO - Prairie buttercup (*Ranunculus rhomboideus*)
- SELARUP - Rock selaginella (*Selaginella rupestris*)

Site C Project

Experimental Rare Plant Translocation

Recipient Site Locations

Figure 3.2-2

Date: 2022-12-06

Map Number: BCH-064c

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC environmental consulting

Legend

2018-2022 Recipient Sites

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

Highway

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

In 2022, the bulk of the effort focused on transporting and translocating Davis' locoweed adult/whole plants to new recipient sites. Efforts focused on translocating adult plants because studies show that there is far greater survival with larger more developed plants than seedlings and seeds (Dalrymple et al. 2012). An entire day was focused solely on moving adult plants in a jet boat from the Taylor boat launch to recipient sites along the Peace River prior to translocation.

Translocation of 424 Davis' locoweed (292 adult plants and 132 seedlings) occurred at four sites between June 14-16, 2022 (Figure 3.2-2). Two of the sites had been planted in previous years (Site ID: OXYTCAM3-2020-C and OXYTCAM3-2020-B) and two sites were new (Site ID: OXYTCAM3-2022-D and OXYTCAM3-2022-E). One of the new sites contains an existing occurrence of Davis' locoweed and will serve as a reference population for the long-term monitoring for this variety.

The planting method was similar to past years in the cobble substrate, where excavated sandy soil was separated from the cobble and mixed with wetted nursery soil to be used as back-fill (Plate 3.2-1). The cobble was then used to fill in gaps and was placed around each plant to be consistent with the existing grade. Any mosses, lichens, and leaf litter that existed in the designated planting areas were carefully removed before excavation and replaced after planting. A water backpack was used to carry water from the river and add water to new and existing plantings.

Plate 3.2-1. Pre-planting trench for Davis' locoweed seedlings (2021 planting season)

Davis' locoweed were planted in clusters and arranged in relatively close proximity to each other (see arrangement of individual plots in the plates and figures below). This planting arrangement was intended to encourage pollinator visitation, to minimize potential trampling during planting and monitoring, and to minimize inter-individual resources (i.e., minimize density-dependent effects on survival). Stones were placed around each plot to improve identification of the plots for future monitoring and to minimize competition from other plant species (Plate 3.2-2 and 3.2-3).

Plate 3.2-2. Rock border around a group of translocated Davis' Locoweed

Plate 3.2-3. Cobbles available to minimize competition from other plant species.

3.2.1.1 Site OXYTCAM3-2020-C

Existing populations of Davis' locoweed (Site ID: OXYTCAM3-2020-C) were augmented with a total of 174 adults (Cohort 4) (Figures 3.2-1 to 3.2-3, Plates 3.2-4 and 3.2-6). An additional 108 individuals were planted directly adjacent to Cohort 3 that was planted in 2021 and 66 individuals were planted on another nearby cobble terrace north of the Cohort 3 planting area. Red tags were used in 2022 to improve plant and plot detectability due to greater contrast with the substrate and natural litter.

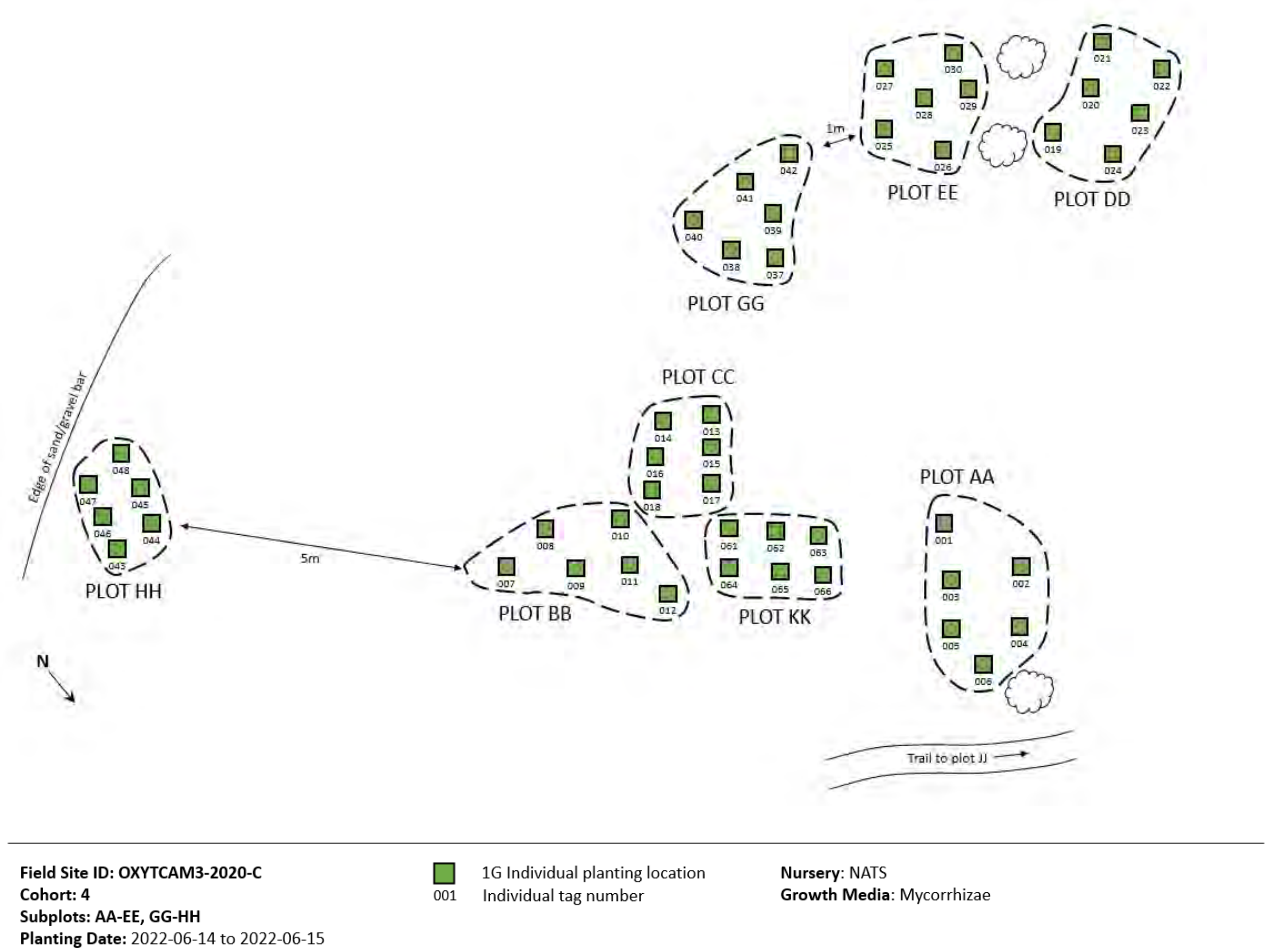


Figure 3.2-1. Planting Grid for Davis' Locoweed at Site ID: OXYTCAM3-2020-C (Subplots AA-EE, GG-HH)

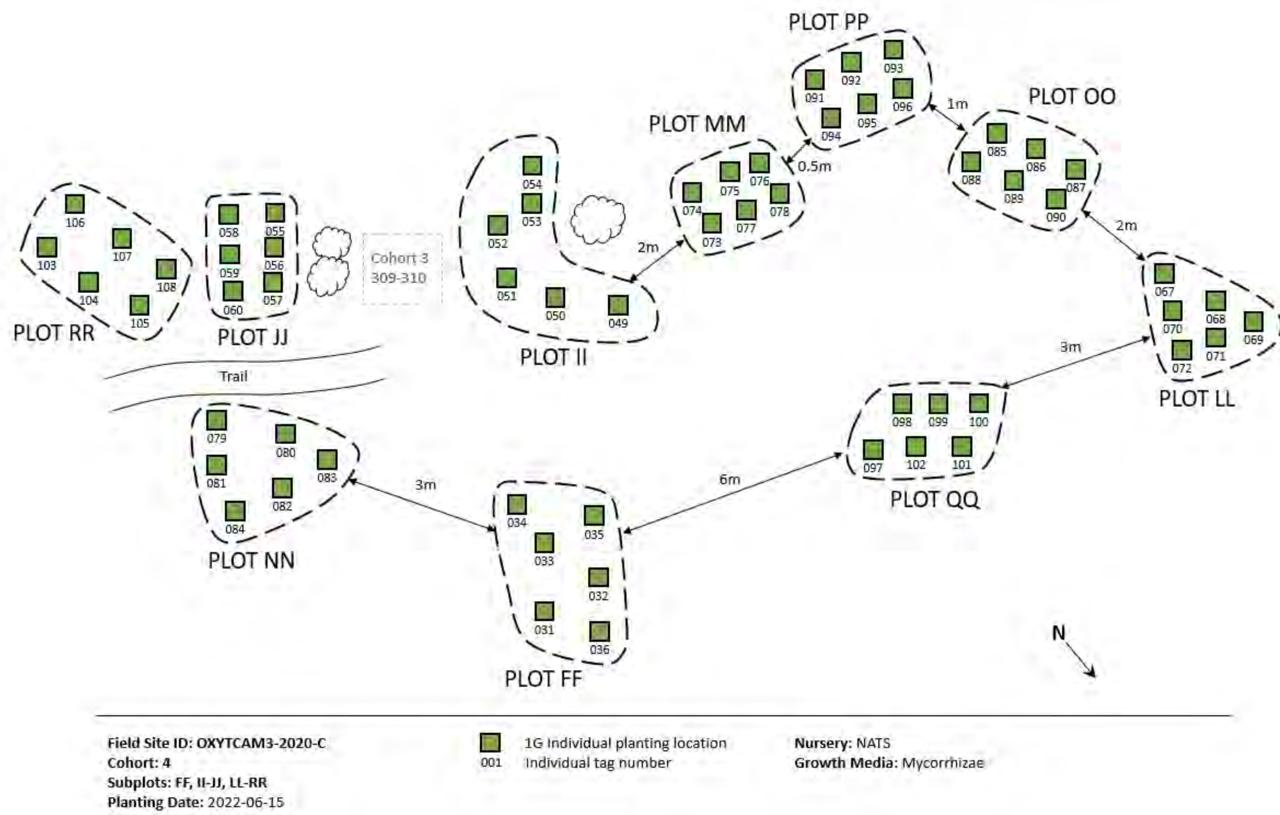


Figure 3.2-2. Planting Grid for Davis' Locoweed at Site ID: OXYTCAM3-2020-C (Subplots FF, II-JJ, LL-RR)

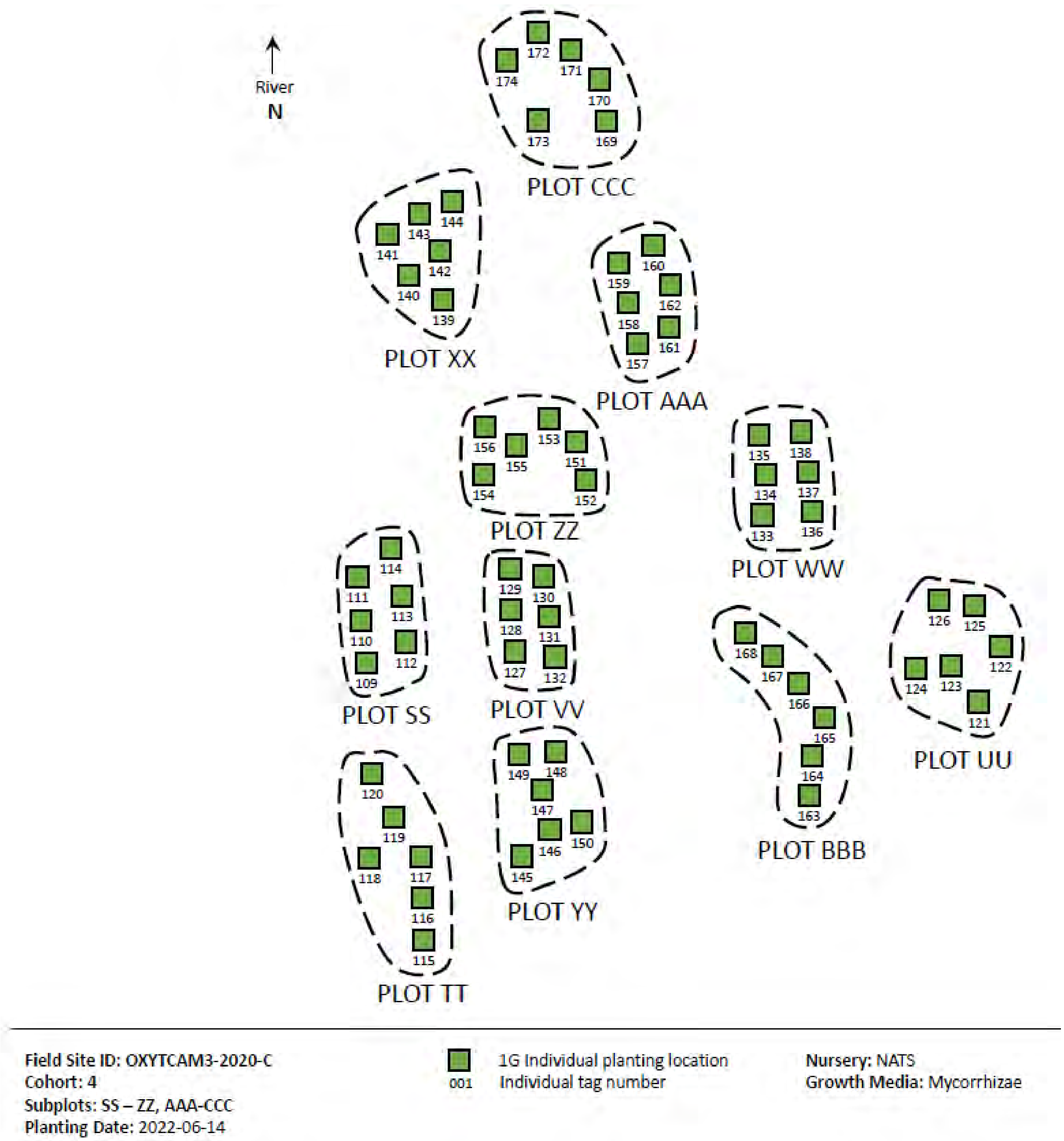


Figure 3.2-3. Planting Grid for Davis' Locoweed at Site ID: OXYTCAM3-2020-C (Subplots: SS-ZZ, AAA-CCC)

Plate 3.2-4. Grouping (plot GG) of adult Davis' locoweed (1G) transplanted at Site Id OXYTCAM3-2020-C

Plate 3.2-5. Grouping (plot VV) of an adult Davis' locoweed (1G) transplanted at Site Id OXYTCAM3-2020-C

Plate 3.2-6. Grouping (plot WW) of an adult Davis' locoweed (1G) transplanted in dappled shade at Site Id OXYTCAM3-2020-C

3.2.1.2 Site OXYTCAM3-2020-B

A plot at this site was established in an area with more canopy cover just north of the 2020 and 2021 plantings. On June 16, 132 seedlings and 76 adult Davis' locoweed were translocated at this site. Most plants were translocated to cobbly microsites within the historic flood plain/backwater channel (Figure 3.2-4; Plates 3.2-7 to 3.2-9). A selection of plants (plot NN: 60 seedlings and 12 adults) (Figure 3.2-5; Plates 3.3-10 and 3.3-11) were planted within a sandier substrate in a more open area to test whether herbivory and associated disturbance from wildlife may play a role in translocation success. In an earlier planting trial at a different location, several seedlings that were planted in sand-dominated microsites were found dislodged. It is possible that these seedlings were disturbed by wildlife, either birds or ungulates, such as elk, moose or deer that regularly frequent these sites.

Plate 3.2-7. Davis' locoweed (cohort 2) translocation site– OXYTCAM3-2020-B

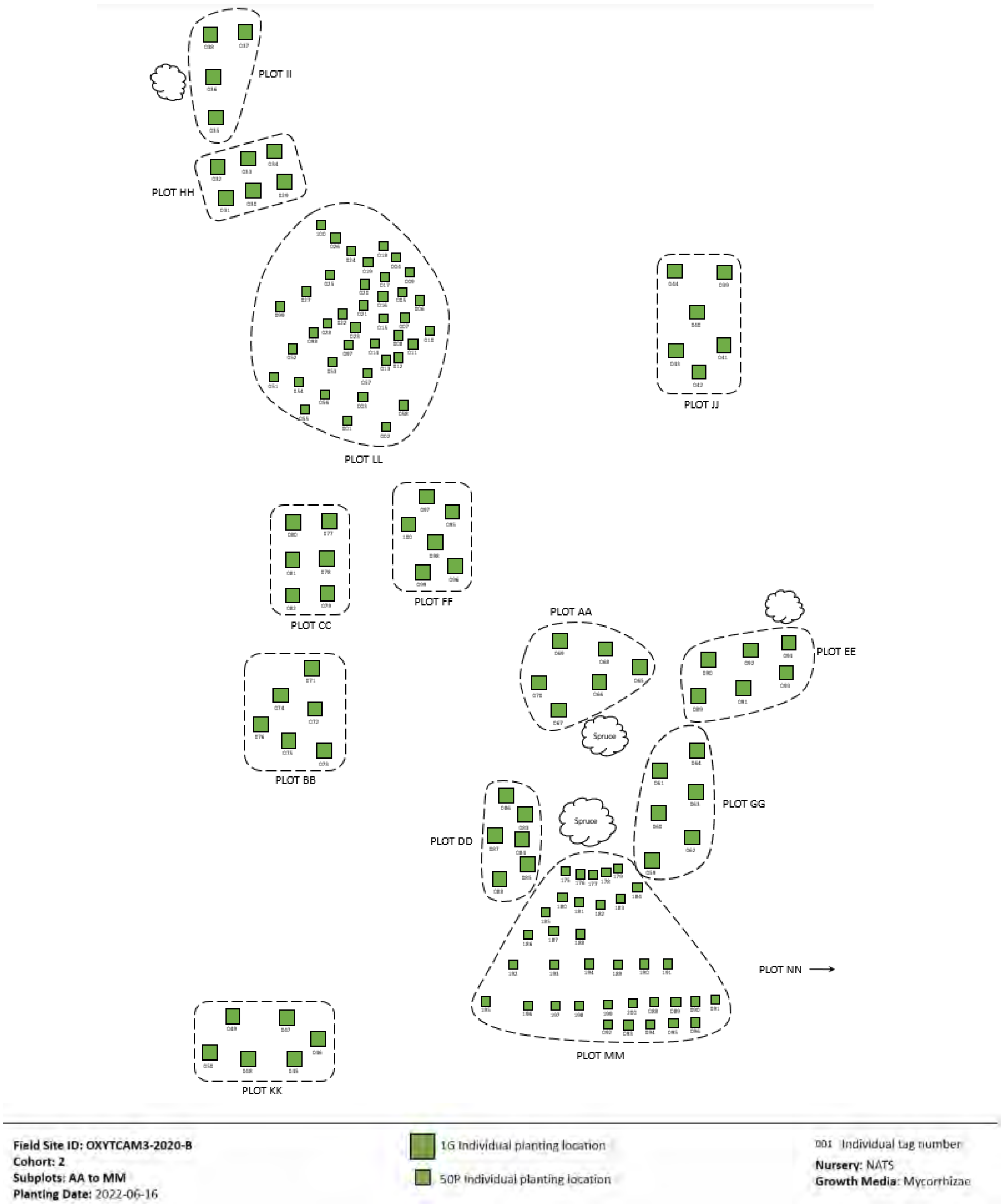


Figure 3.2-4. Planting Grid for Davis' Locoweed (Cohort 2, Plots AA-MM) at Site ID: OXYTCAM3-2020-B

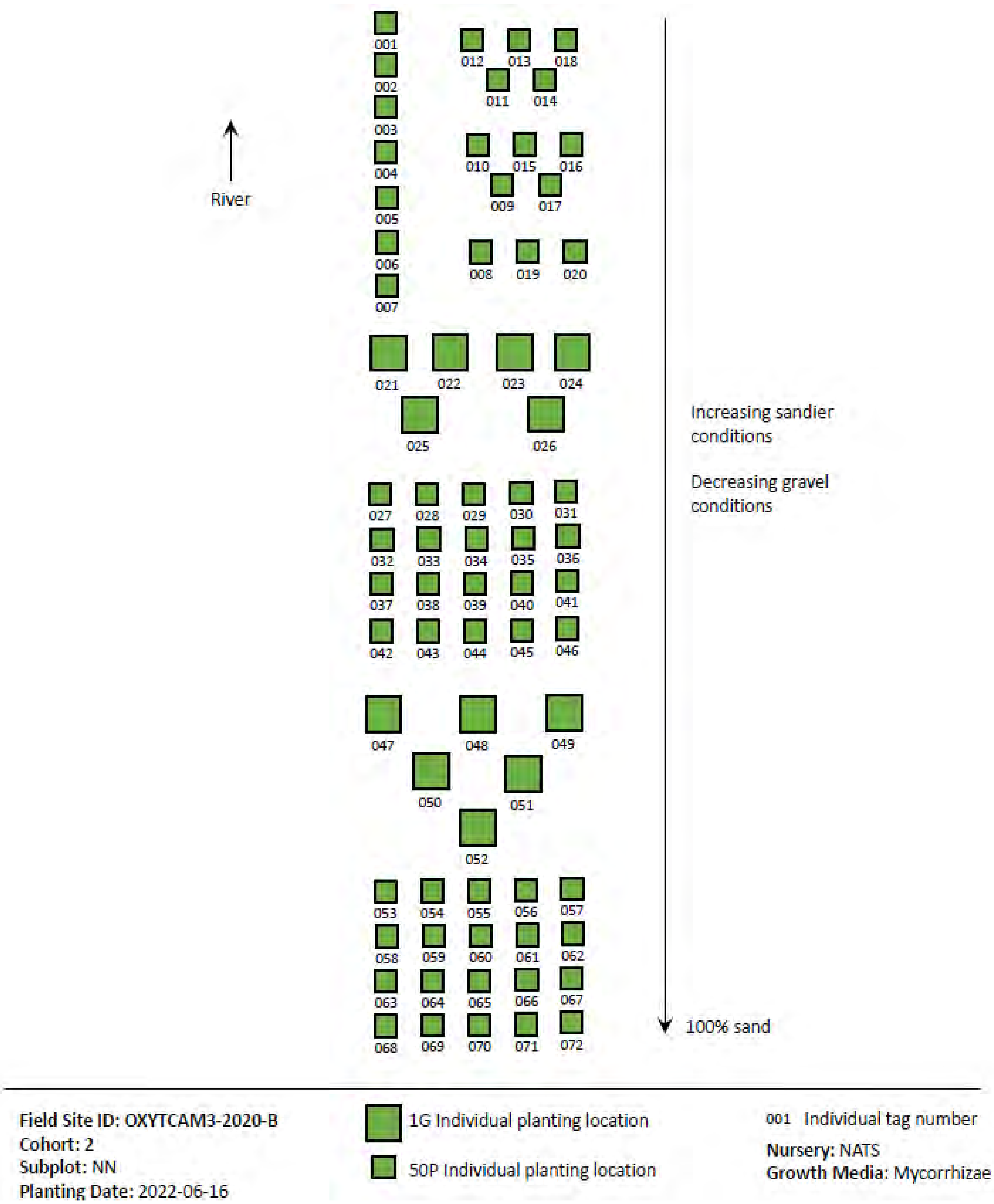


Figure 3.2-5. Planting Grid for Davis' Locoweed (Cohort 2, Plot NN) at Site ID: OXYTCAM3-2020-B

Plate 3.2-8. Grouping (plot JJ) of adult Davis' locoweed (1G) transplanted at Site Id OXYTCAM3-2020-B

Plate 3.2-9. Grouping (plot MM) of Davis' locoweed seedlings transplanted at Site Id OXYTCAM3-2020-B

Plate 3.2-10. Sample of adult Davis' locoweed transplanted at the sandier plot NN at Site Id OXYTCAM3-2020-B

Plate 3.2-11. Sample of Davis' locoweed seedlings transplanted at the sandier plot NN at Site Id OXYTCAM3-2020-B

3.2.1.3 Site OXYTCAM3-2022-D

On June 14, 43 adult Davis' locoweed were translocated into 7 plots (Figure 3.2-6; Plates 3.2-12 and 3.2-13).

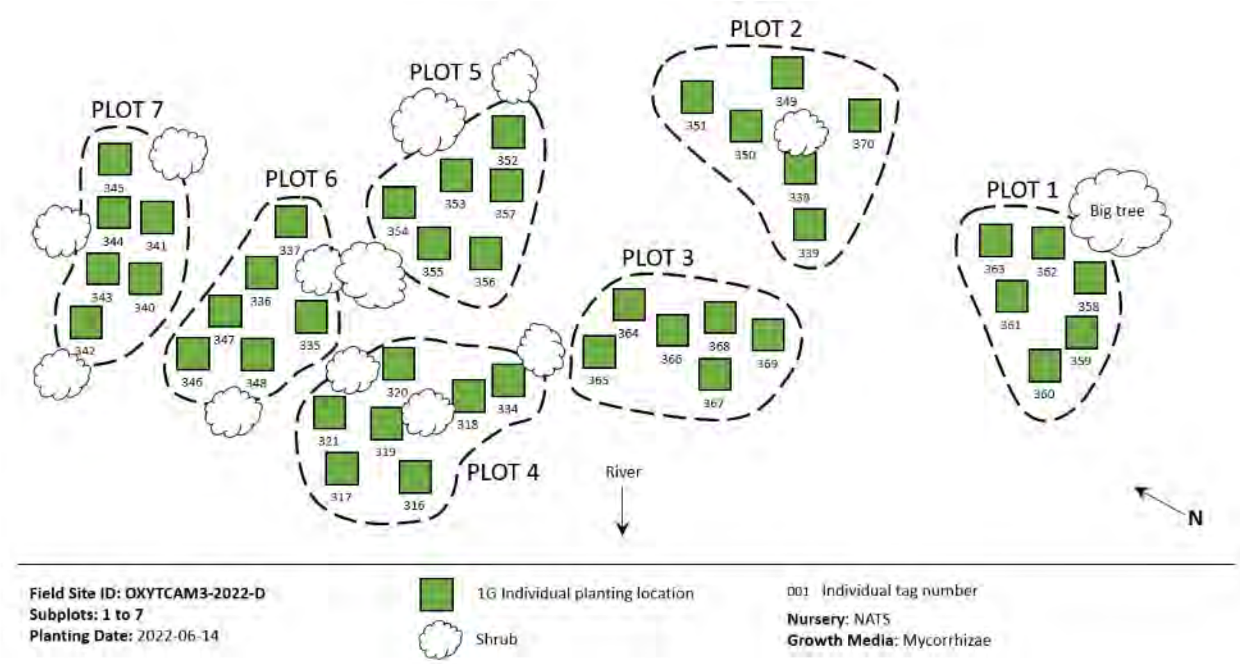


Figure 3.2-6. Planting Grid for Davis' Locoweed (Plots 1-7) at Site ID: OXYTCAM3-2022-D

Plate 3.2-12. Example of an adult Davis' locoweed (1G) transplanted at Site Id OXYTCAM3-2022-D

Plate 3.2-13. Example of an adult Davis' locoweed (1G) transplanted at Site Id OXYTCAM3-2022-D

3.2.1.4 Site OXYTCAM3-2022-E

On June 16, 2022, 11 adult Davis' locoweed were translocated into cobbly substrate at the edge of a row of conifers (Figure 3.2-7; Plates 3.2-14 and 3.2-15). These individuals were planted adjacent to a natural population of Davis' locoweed (Plate 3.2-16). Comparison of characteristics, such as plant condition, will be assessed from future monitoring results between translocated and natural populations.

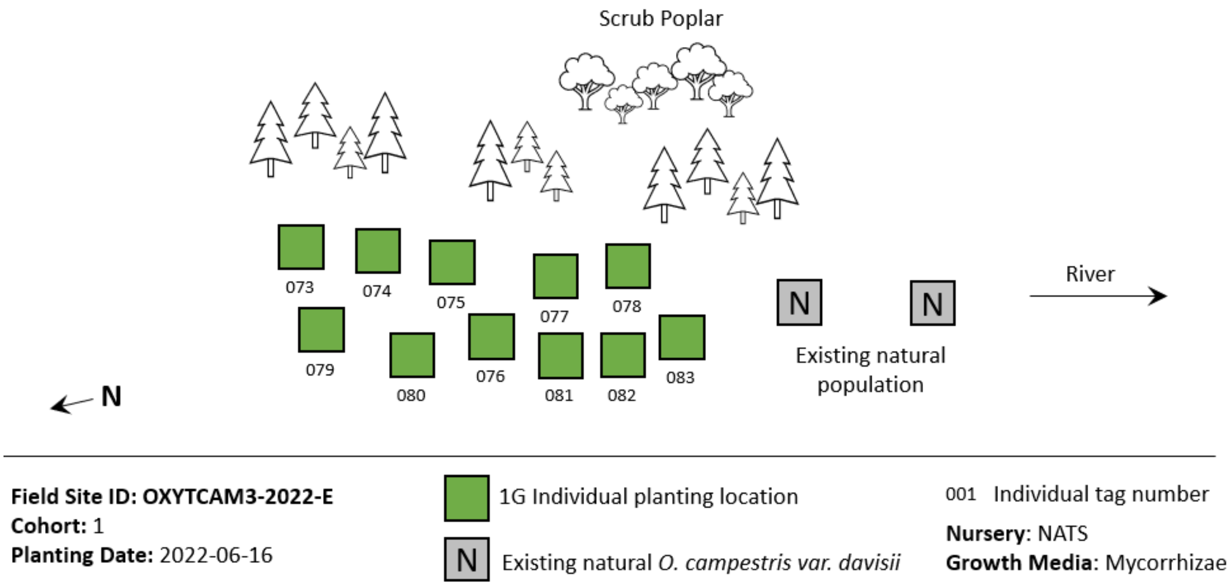


Figure 3.2-7. Planting Grid for Davis' Locoweed at Site ID: OXYTCAM3-2022-E

Plate 3.2-14. Example of an adult Davis' locoweed (1G) transplanted at Site Id OXYTCAM3-2022-E

Plate 3.2-15. Example of an adult Davis' locoweed (1G) transplanted at Site Id OXYTCAM3-2022-E

Plate 3.2-16. Example of naturally occuring adult at Site Id OXYTCAM3-2022-E

3.2.2 Sprengel's Sedge (*Carex sprengelii*)

Three adult Sprengel's sedge (Plate 3.2-17) were provided to the Twin Sister's Native Plant Nursery on September 5, 2022 for translocation. They are currently overwintering in a greenhouse for outplanting in the spring of 2023.

Plate 3.2-17. Sprengel's sedge for the Twin Sister's planting site

A south-facing grassland along Leahy Pit Road east of Taylor, B.C., was visited on June 12, 2022, to assess translocation viability for multiple species including Sprengel's sedge, Torrey's sedge, and prairie buttercup. The region was experiencing a wet spring, and as a result, lush conditions were observed at the site during this time (Plate 3.2-18). The soil was also observed to contain silt, which could improve moisture retention compared to sandier sites. On September 3, 2022, the site was further explored to locate suitable microsites for planting all three species. Translocation, however, did not occur due to the very dry conditions (Plate 3.2-19) and prevalence of grasshoppers observed (Plate 3.2-20 and 3.2-21). The high level of dryness was not anticipated based on site and soil conditions observed in the spring. Grasshopper abundance is dependent on multiple factors such as precipitation, temperature, and soil moisture (Powell et al., 2007). Although a late spring may have delayed egg development, warm and prolonged summers within the last few years may have resulted in optimal conditions for grasshopper reproduction. The swarms of grasshoppers observed in September may have been a result of swarming in search for food due to the lack of quality forage from the prolonged dry conditions. Although grasshopper populations may be difficult to predict, planting during moist, cool conditions may improve the likelihood of plant survival and establishment with a potentially lower risk of grasshopper damage and sufficient soil moisture to support initial growth. Based on the level of dryness observed, even within the forested ridges, planting of Sprengel's and Torrey's sedge at this site may be reconsidered.

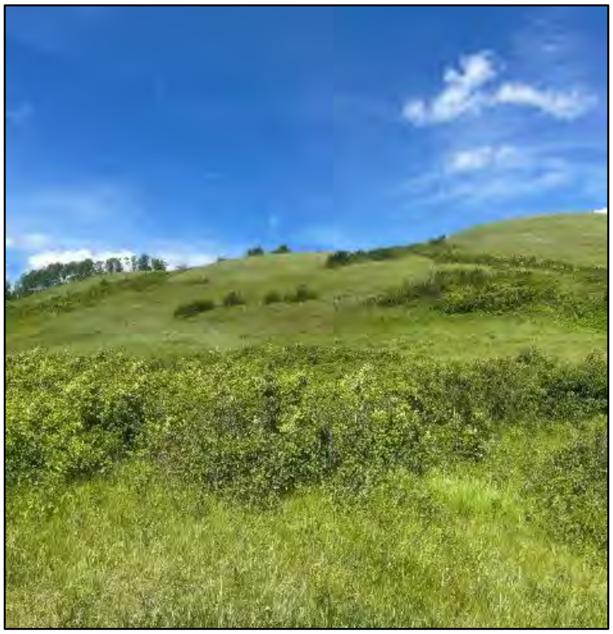


Plate 3.2-18. Leahy pit road recipient site in June

Plate 3.2-19. Leahy pit road recipient site in September

Plate 3.2-20. Several of many grasshoppers present in the area

Plate 3.2-21. Close-up of two-striped grasshoppers (*Melanoplus bivittatus*), an agricultural pest

3.2.3 Torrey's Sedge (*Carex torreyi*)

Torrey's sedge were translocated at two sites in 2022. Three adults were planted at CARETOR-2021-A (open area with grasses and forbs adjacent to aspen forest) on June 17, 2022 (Plates 3.2-22 to 3.2-24), where 5 seedlings had been planted in the previous year. Two adults were also provided to the Twin Sister's Native Plant Nursery for translocation on September 5, 2022 (Plate 3.2-25). These individuals are currently overwintering in a greenhouse for outplanting in the spring of 2023.

Like Sprengel's sedge, further plantings of Torrey's sedge were also planned for September 3, 2022, at the Leahy Pit Road site. However, the conditions were suboptimal for translocation to occur (see section 3.2.2 for details).

Plate 3.2-22. Planting site for Torrey's sedge – CARETOR-2021-A (Sept 16, 2021)

Plate 3.2-23. Example of adult Torrey's sedge adult with seed heads planted at site ID: CARETOR-2021-A

Plate 3.2-24. Example of adult Torrey's sedge adult planted at site ID: CARETOR-2021-A

Plate 3.2-25. Prairie buttercup (tag no. 100) and Torrey's sedge for the Twin Sister's planting site

3.2.4 Prairie buttercup *(Ranunculus rhomboideus)*

On June 13, 2022, nine clumps of 16 prairie buttercups were salvaged from Watson Slough (Plate 3.2-26 to 3.2-29), which will flood when Site C becomes operational. On the same day, these salvaged individuals were translocated to a site near a wetland along Upper Cache Road running north of highway 29 (Plates 3.2-30 to 3.2-32). The nine clumps were planted along two relatively linear transects totaling 120 m and covering various microsites. All plants were watered thoroughly after translocation.

Plate 3.2-26. Watson Slough prairie buttercup salvage area (photo credit: Eagle Cap)

Plate 3.2-27. A prairie buttercup "clump" during salvage activities (photo credit: Eagle Cap)

Plate 3.2-28. A salvaged prairie buttercup forming a seed head (photo credit: Eagle Cap)

Plate 3.2-29. Salvaged prairie buttercup "clumps" ready for transport (photo credit: Eagle Cap)

Plate 3.2-30. Recipient site off of Upper Cache Road (photo credit: Eagle Cap)

Plate 3.2-31. Sample of a translocated prairie buttercup (tag no. 323) (photo credit: Eagle Cap)

Plate 3.2-32. Sample of a translocated prairie buttercup (tag no. 324) (photo credit: Eagle Cap)

On June 17, 2022, four adult prairie buttercups were added to the RANURHO-2021-B site (open, shrub and grass matrix; Plate 3.2-33) and protected with a plastic collar to deter herbivory (Plates 3.2-34and 3.2-35).

Plate 3.2-33. Prairie buttercup translocation site– RANURHO-2021-B (June 8, 2021)

Plate 3.2-34. Prairie buttercup (tag no. 393) 1G plant installed at– RANURHO-2021-B and protected with plastic collar

Plate 3.2-35. Prairie buttercup (tag no. 394) 1G plant installed at– RANURHO-2021-B and protected with a plastic collar

More prairie buttercup translocation was planned for September 3, 2022, at the Leahy Pit Road site; however, the conditions were suboptimal for translocation to occur (see section 3.2.2 for details). Potential planting areas adjacent to saskatoon shrubs were flagged for potential future prairie buttercup translocation (Plate 3.2-36).

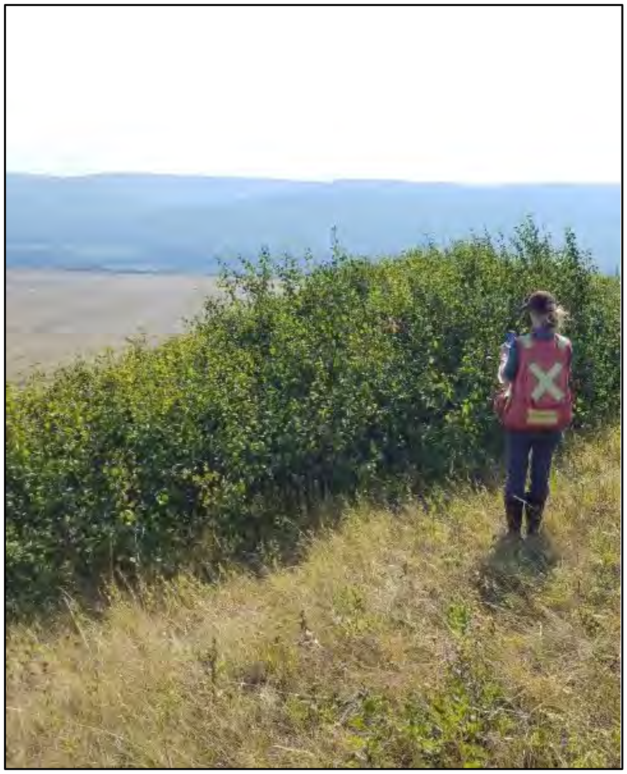


Plate 3.2-36. Scouting shrubby areas suitable for prairie buttercup translocation.

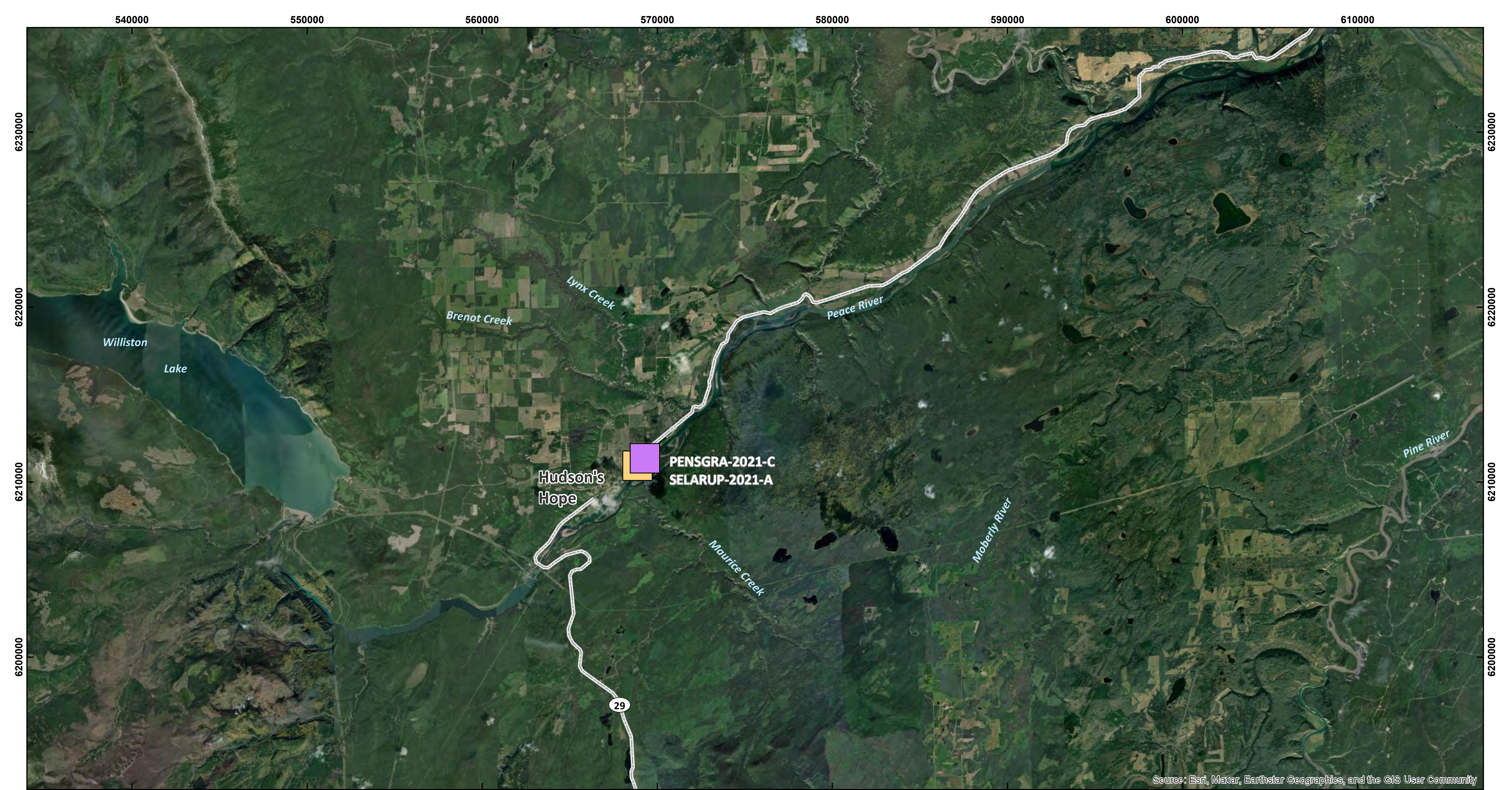
3.3 Monitoring

Translocated individuals were monitored one to three times in 2022 to correspond with seasonal changes in the phenology of each species. An early spring visit determined overwintering survival, a visit during the summer (targeted to correspond with the potential flowering period) assessed vigour and reproduction, and a visit during the fall assessed survival after transplant for those species planted in the preceding year (Table 3.3-1). Monitoring frequency was increased following any interventions to address population or health declines. Refer to Figures 3.2-1, 3.2-2, and 3.3-1 for respective monitoring locations. A summary of follow up measures identified in 2022 during the interim monitoring and the current status of the implementation of the follow up measures are summarized in Table 3.3-2.

Table 3.3-1. 2022 Species and Monitoring Sites

Species	Site ID	Interim Monitoring Date	Final Monitoring Date
Canada mountain-ricegrass	PIPTCAN-2020-A	-	August 17, 2022
	PIPTCAN-2020-B	-	July 31, 2022
Davis' locoweed	OXYTCAM3-2020-B	June 13, 2022-	September 2, 2022
	OXYTCAM3-2020-C	June 13, 2022-	September 2, 2022
	OXYTCAM3-2022-D	September 2, 2022	-
Dryland sedge	CAREXER-2020-D	June 10, 2022	July 31, 2022
	CAREXER-2020-E	-	August 2, 2022
Prairie buttercup	RANURHO-2021-A	June 10, 2022	September 5, 2022
	RANURHO-2021-B	June 17, 2022	September 5, 2022
	RANURHO-2022-C	-	July 29, 2022
Slender penstemon	PENSGRA-2020-A	June 10, 2022	August 2, 2022
	PENSGRA-2020-B	-	July 31, 2022
	PENSGRA-2021-C	August 7, 2022	September 5, 2022

Species	Site ID	Interim Monitoring Date	Final Monitoring Date
Rock selaginella	SELARUP-2021-A	August 7, 2022	September 5, 2022
Torrey's sedge	CARETOR-2021-A	June 17, 2022	September 5, 2022
Sprengel's sedge	CARESPR-2020-A	June 17, 2022	September 5, 2022
	CARESPR-2020-B	June 17, 2022	September 5, 2022
	CARESPR-2021-C	September 5, 2022	-



Site C Project

Experimental Rare Plant Translocation Monitoring Locations

Figure 3.3-1

Date: 2022-12-06

Map Number: BCH-064a

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC environmental consulting

Legend

2022 Monitoring Sites

- Slender penstemon (*Penstemon gracilis*)
- Rock selaginella (*Selaginella rupestris*)
- Highway

0 2 4 6 km

1:200,000

N

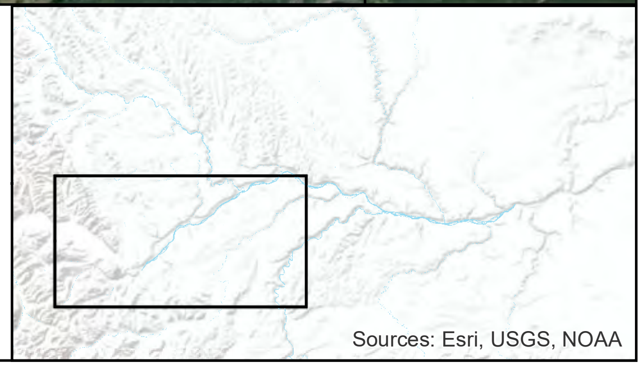


Table 3.3-2. Summary of Recipient Sites and Current Status

Species	Site Name	Status	Follow-up Measures	Current Status	Follow-up Measures to address in 2023
Dryland Sedge (*C. xerantica*)	CAREXER-2018-A	Inactive	na	na	na
	CAREXER-2018-B	Inactive	na	na	na
	CAREXER-2019-C	Active	Not determined	-	-
	CAREXER-2020-D	Active	Initiate invasive plant removal and continue watering.	2022: invasive plants (e.g., goatsbeard) removed if observed. 2021: invasive plants removed and plants were watered	Continue invasive plant removal and water if necessary
	CAREXER-2020-E	Active	Restrict site visits to 2 per year to minimize erosion of fine textured soils. Water if necessary.	2022: site visits were restricted to 2. Did not water due to wet spring.	Continue to minimize site visits per year and water if necessary
Canada mountain-ricegrass (*P. canadensis*)		Active	None determined	-	Improve means of detection
Davis' locoweed (*O. campestris* var. *davisii*)	OXYTCAM3-2018-A	Active	Reassess site to determine if further monitoring of the plant trials is warranted. Site currently contains an	2022: not visited	Continue reassessment

Species	Site Name	Status	Follow-up Measures	Current Status	Follow-up Measures to address in 2023
			existing occurrence of *O. campestris* and may serve as a future reference site.		
	OXYTCAM3-2018-As	Active	Monitor a selection of seed trials in 2022.	2022: not visited	Continue reassessment
	OXYTCAM3-2020-B	Active	Install fencing if required to address herbivory.	2022: fencing not required	Continue to assess if fencing is required
	OXYTCAM3-2020-C	Active	Evaluate the efficacy of trial fencing to address herbivory. Consider re-establishing phenocamera to track herbivory.	2022: fencing continues to be effective. Phenocamera not installed	Continue to evaluate efficacy of fencing. Fencing may need readjusting. Consider re-establishing phenocamera. Remove clover from some plots
	OXYTCAM3-2022-D	Active	None determined	-	Evaluate the need for protection from herbivory
	OXYTCAM-2022-E	Active	None determined	-	Evaluate the need for protection from herbivory

Species	Site Name	Status	Follow-up Measures	Current Status	Follow-up Measures to address in 2023
Prairie buttercup (*R. rhomboideus*)	RANURHO-2021-A	Active	Bear encounter and signs of disturbance to plants in 2019	2022: cages and collars installed around plants in 2021 found to be effective in deterring herbivory. All cages found to be flattened slightly.	Readjust and maintain cages
	RANURHO-2021-B	Active	Establish fencing to address herbivory	2022: Collars installed around plants in 2021 were found to be effective in deterring herbivory. However, some collars were removed. Fencing not yet required.	Readjust collars if tampered with and continue assessing the need for fencing
Rock selaginella (*Selaginella rupestris*)	SELARUP-2021-A	Active	None identified	-	Continue assessing the need for follow-up measures
	SELARUP-2021-B	Active	None identified	-	Continue assessing the need for follow-up measures
Slender penstemon *(P. gracilis*)	PENSGRA-2020-A	Active	Continued watering	2022: not watered due to wet spring 2020: watered	Continue watering if deemed necessary
	PENSGRA-2020-B	Active	Continued watering.	2022: not watered due to wet spring	Continue watering if deemed necessary
	PENSGRA-2021-C	Active	Initiate watering in drought conditions, if needed.	2022: not watered due to wet spring	Initiate watering in drought conditions, if needed
Sprengel's sedge (*C. sprengelii*)	CARESPR-2020-1A	Active	Initiate watering in drought conditions, if needed.	2022: not watered due to wet spring	Initiate watering in drought conditions, if needed
	CARESPR-2020-1B	Active	Determine if fencing is needed to prevent	2022: no laydown observed. Intervention not required. 2020: sticks were installed into the ground to deter animals from laying on plants	Continue to assess if fencing is required. Initiate watering in drought conditions, if needed

Species	Site Name	Status	Follow-up Measures	Current Status	Follow-up Measures to address in 2023
			animals from laying on the plants.		
	CARESPR-2020-C	Active	Initiate watering in drought conditions, if needed.	2022: not watered due to wet spring	Initiate watering in drought conditions, if needed

3.3.1 Year-end Monitoring

Year-end monitoring involved an evaluation of survivorship, maturity, reproduction, and recruitment (Table 3.3-3). These metrics are being used to evaluate population viability at recipient sites and to track establishment of the translocated plants and resulting recruitment. The year-end monitoring is critical to ensure that issues with viability or establishment can be identified and addressed as they arise.

Table 3.3-3. Summary of Year-end Monitoring Results for 2022

Species	Site Name	Survivorship		Maturity		Reproduction		Recruitment
		Survival in Relation to Total	Percent Survival	Flowering in Relation to Total	Percent Flowering	Seed Production in Relation to Total	Percent Seeding	Number of recruits observed
Canada mountain-ricegrass	PIPTCAN-2020-A	1/5	20%	1/5	20%	1/5	20%	0
	PIPTCAN-2020-B	3/5	60%	3/5	60%	3/5	60%	0
Davis' locoweed	OXTYCAM3-2020-B	49/101	49%	17/101	17%	17/101	17%	4
	OXTYCAM3-2020-C	123/199	62%	22/199	11%	22/199	11%	0
	OXYTCAM3-2022-D	29/43	67%	-	-	-	-	-
Dryland sedge	CAREXER-2020-D	100/105	95%	100/105	95%	100/105	95%	-
	CAREXER-2020-E	48/50	96%	47/50	94%	47/50	94%	-
Prairie buttercup	RANURHO-2021-A	17/17	100%	-	-	-	-	3
	RANURHO-2021-B	3/4	75%	1/4	25%	-	-	1
	RANURHO-2022-C	9/9*	100%	1/9	11%	1/9	11%	0
Slender penstemon	PENSGRA-2020-A	25/25	100%	25/25	100%	25/25	100%	-
	PENSGRA-2020-B	16/25	64%	11/25	44%	11/25	44%	-
	PENSGRA-2021-C	21/21	100%	21/21	100%	21/21	100%	-
Rock selaginella	SELARUP-2021-A	56/56*	100%	56/56	100%	56/56	100%	-

Species	Site Name	Survivorship		Maturity		Reproduction		Recruitment
		Survival in Relation to Total	Percent Survival	Flowering in Relation to Total	Percent Flowering	Seed Production in Relation to Total	Percent Seeding	Number of recruits observed
Torrey's sedge	CARETOR-2021-A	7/8	87%	1/8	12%	1/8	12%	-
Sprengel's sedge	CARESPR-2020-A	2/2	100%	0/2	0%	0/2	0%	-

*Clumps of individuals

3.3.2 Canada mountain-ricegrass (*Piptatheropsis canadensis)*

In 2022, ten clumps of Canada mountain-ricegrass were monitored at two sites (site IDs: PIPTCAN-2020-A and PIPTCAN-2020-B; Plates 3.3-1 and 3.3-2). At site ID: PIPTCAN-2020-A, five clumps containing Canada mountain-ricegrass that had been salvaged and translocated in 2020 were monitored on August 17, 2022. Out of the five clumps, only one appeared to have survived, exhibiting both inflorescences and seeds. On July 31, 2022, another five clumps were monitored at PIPTCAN-2020-B and three individuals were alive, with inflorescences present and seed observed.

Plate 3.3-1. Sample of Canada mountain-ricegrass that was monitored

Plate 3.3-2. Sample of Canada mountain-ricegrass seed heads from a monitored plant

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

3.3.3.1 Site OXYTCAM3-2020-C

On September 2, 2022, 199 individuals (141 seedlings and 58 adults) out of 543 Davis' locoweed translocated in 2020 and 2021 were monitored in 2022. Out of the 199 monitored, 123 survived (61.8%; Plates 3.3-3 and 3.3-4) and 22 of the survivors were observed to have seed heads. Five out of 74 survived seedlings (6.8%) and 17 out of 49 survived adults (35%) had seed heads. Herbivory by small animals was observed and several plots exhibited relatively dense mats of clover growing between the transplants (3.3-5). In most instances, clover was removed during monitoring activities.

Plate 3.3-3. Sample of adult Davis' locoweed protected by net fencing installed at site ID: OXYTCAM3-2020-C

Plate 3.3-4. Sample of seedlings monitored at site ID: OXYTCAM3-2020-C

Plate 3.3-5. Clover growing in between translocated Davis' locoweed at site ID: OXYTCAM3-2020-C

3.3.3.2 Site OXYTCAM3-2020-B

On September 2, 2022, 101 Davis' locoweed (cohort 1 – 2020 planting) were monitored. Out of the 101 monitored, 49 survived (48.5%) and 27 of the survivors were observed to have seed heads (55%). Four new recruits were also observed. Conditions were dry at the time of monitoring, and the presence of cattle (dung and trampling) was also observed in the area.

Interim monitoring for cohort 2 (June 2022 planting) was also conducted. The Davis' locoweed planted in the area with greater canopy cover appeared to be in good condition, with seed heads observed (Plate 3.3-6). Certain individuals in the sandier site were observed to be alive; however, ungulate tracks through the plot had disturbed the substrate and may have buried other individuals (Plate 3.3-7).

Plate 3.3-6. Sample of Davis' locoweed at site OXYTCAM3-2020-B

Plate 3.3-7. Sample of Davis' locoweed recruit at site OXYTCAM3-2020-B

3.3.3.3 Site OXYTCAM3-2022-D

On September 2, 2022, interim monitoring of the 43 translocated individuals (June 14, 2022, planting) at site OXYTCAM3-2022-D was conducted. Out of 43 individuals monitored, only 29 were observed to have survived (63%) (Plate 3.3-8). Some plants appeared desiccated (Plate 3.3-9); however, final monitoring will be completed in 2023 for a more thorough assessment.

Plate 3.3-8. Sample of Davis' locoweed at site OXYTCAM3-2022-D

Plate 3.3-9. Sample Davis' locoweed individual showing desiccation (site: OXYTCAM3-2022-D)

3.3.4 Dryland sedge (*Carex xerantica*)

Dryland sedge at CAREXER-2020-D and CAREXER-2020-E were monitored on July 31 and August 2, 2022. At site CAREXER-2020-D, 100 out of 105 (95%) individuals were observed to be present (Plates 3.3-10 and 3.3-11). All plants that were monitored contained seed heads, which could be representative of their reproductive viability. At site CAREXER-2020-E, 48 out of 50 (96%) individuals were observed to be present. All plants that were monitored possessed seed heads except for one individual that had been grazed.

Plate 3.3-10. Example of dryland sedge monitored with seed heads (seed heads can be seen near top of measuring tape)

Plate 3.3-11. Example of dryland sedge monitored (tag located at the base of the plant).

3.3.5 Prairie buttercup (*Ranunculus rhomboideus*)

On July 29, 2022, the prairie buttercups that were salvaged from Watson Slough were monitored (interim). All nine clumps that were translocated at the new site off of the Upper Cache Road survived, with one individual bearing seeds.

At site RANURHO-2021-A, all individuals appeared to be alive and in good condition during interim monitoring on June 10, 2022 (Plate 3.3-12). Year-end monitoring results on September 5, 2022 confirmed all 17 individuals to have survived (Plate 3.3-13) with three additional recruits observed (Plate 3.3-14). The cages and collars were effective in protecting the plants from herbivory. Some of the cages, however, had been flattened slightly, but the seedlings were undamaged. The cages may require some maintenance in the future as the plants grow larger.

Plate 3.3-12. Sample of prairie buttercup during interim monitoring on June 10, 2022 (site ID: RANURHO-2021-A)

Plate 3.3-13. Sample of prairie buttercup during final monitoring on September 5, 2022 (site ID: RANURHO-2021-A)

Plate 3.3-14. Sample of prairie buttercup recruit (circled in red) during final monitoring on September 5, 2022 (site ID: RANURHO-2021-A)

At site RANURHO-2021-B, two of the three adult plants translocated earlier in 2022 (June 17), had survived when monitored on September 5, 2022 (Plate 3.3-15). However, a few of the protective collars that had been installed to deter herbivory had been removed. The protective collars that had been removed were re-installed.

Plate 3.3-15. Sample of prairie buttercup during final monitoring on September 5, 2022 (site ID: RANURHO-2021-B)

3.3.6 Slender penstemon (*Penstemon gracilis*)

Slender penstemon at PENSGRA-2020-A and PENSGRA-2020-B were monitored on July 31 and August 2, 2022 (Plates 3.3-16 and 3.3-17). Slender penstemon at PENSGRA-2021-C were monitored on September 5, 2022. All 25 individuals planted at PENSGRA-2020-A in 2020 were assessed and found to have survived (100%) and produced flower and seeds (100%). Of the 25 individuals planted at PENSGRA-2020-B, 16 survived (64%) and 11 of the survivors produced flowers and seeds (69%).

Plate 3.3-16. Example of slender penstemon monitored with seed heads

Plate 3.3-17. Example of slender penstemon monitored with seed heads

At site PENSGRA-2021-C, interim monitoring on August 7, 2022 found cohort 2 to be doing well and showing multiple seed heads (Plate 3.3-18). Final monitoring results on September 5, 2022 showed very few plants from cohort 1 surviving. Out of 38 spots monitored where penstemon were planted, only two spots had surviving individuals (one adult with seed heads and three florets) (Plate 3.3-19). The low survival rate was expected due to high stress experienced by salvaged plants and the dry conditions at the time of planting. Cohort 2, however, had a high survival rate such that all 21 individuals had survived and were observed to be producing seeds. Cohort 2 was nursery-grown and translocated in a shadier portion of the upper slope that contained stone-free aeolian soils, which may have helped retain moisture, thereby contributing to the survival of these plants.

Plate 3.3-18. Example of an adult slender penstemon (cohort 2) with multiple seed heads (photo credit: Ryan Durand)

Plate 3.3-19. Example of slender penstemon florets (cohort 1)

3.3.7 Rock selaginella (*Selaginella rupestris*)

Most of the rock selaginella that had been interplanted with slender penstemon at site PENSGRA-2021-C appeared to have survived translocation. Out of 56 clumps of selaginella observed, all 56 were alive. However, those from cohort 2 (grown from cuttings) appeared to be in much better health, as can be seen by the green foliage (Plate 3.3-20). Desiccated foliage (grey and yellowish-green) was mostly observed on the selaginella from cohort 1 (Plate 3.3-21).

Plate 3.3-20. Example of rock selaginella (cohort 2)

Plate 3.3-21. Example of rock selaginella (cohort 1)

3.3.8 Torrey's sedge (*Carex torreyii*)

At site CARETOR-2021-A, seven out of eight seedlings had survived and one had produced seed heads (Plate 3.3-22). The vegetation in the area had been disturbed and flattened by large ungulates (Plate 3.3-23).

Plate 3.3-22. Disturbed and flattened grass at site CARETOR-2021-A

Plate 3.3-23. Example of adult Torrey's Sedge translocated on June 17, 2022, at site CARETOR-2021-A

3.3.9 Sprengel's sedge (*Carex sprengelii*)

Sprengel's sedge at CARESPR-2020-A and CARESPR-2020-B were monitored on September 5 (Plate 3.3-24). Both individuals planted at CARESPR-2020-A survived (100%), but no seed heads were observed this year. All three of the individuals planted at CARESPR-2020-B in 2020 also survived but had no observable seed heads at the time of monitoring. Two out of the four individuals planted in 2021 at CARESPR-2020-B survived, and one individual produced seed heads.

Plate 3.3-24. Example of adult Sprengel's sedge translocated in 2020 at site CARESPR-2020-B

3.4 YEAR IN REVIEW

This section summarizes what was achieved in 2022 from goals established at the end of year 2021. The goals and efforts taken for 2022 are summarized in table 3.4-1.

Table 3.4-1. Summary of goals achieved in 2022

2022 Goals	Achievement Status	Details
Find additional propagule collection and/or recipient sites for Canada mountain-ricegrass and rock selaginella.	✓	Four multi-species recipient site plots were identified to include rock selaginella. Two of the four multi-species recipient site plots were also identified to include mountain-ricegrass. Two site plots were identified specifically for mountain-rice grass (Appendix A).
Augment existing recipient sites for Davis' locoweed, Torrey's sedge, Sprengel's sedge, and prairie buttercup.	✓	436 Davis' locoweed, three Torrey's sedge, and 20 prairie buttercups were translocated in 2022. One prairie buttercup, three Sprengel's sedge and two Torrey's sedges were given to Sister's Nursery for out-planting in 2023.

2022 Goals	Achievement Status	Details
Establish additional single-species sites where suitable habitats exist.	✓	Two site plots were identified specifically for each of the following species: mountain-rice grass, Sprengel's sedge, and prairie buttercup. In addition, one site was identified specifically for Torrey's sedge (Appendix A).
Distribute sites as widely as possible to disperse the translocated plants across a larger number of recipient sites to build resilience into the program against the impacts of stochastic events (e.g., floods, fires, landslides) on the overall program objectives.	✓	Three new sites, RANURHO-2022-C, OXYTCAM3-2022-D, and OXYTCAM3-2022-E were used in 2022 for translocation (see Figures 3.3-1 and 3.3-2).
New recipient sites will be evaluated with a stronger focus on the accessibility of resources, particularly water, as earlier translocation efforts have demonstrated that water availability can be a limiting factor at many sites.	Goal has been modified	Although accessibility to water will remain an important factor, it has been recognized as being habitat dependent. Since most of the target plants are found on dry shrub-grassland slopes far up from the river, compromises have been made, so that if all or most of the other criteria have been met the site may still be considered a potential.
Understand facets of population dynamics of select target species through statistical analysis.	In Progress	
Improve the detectability of species using alternate markings that are more visible throughout the entire growing season	✓	Red tags were utilized for marking plants in 2022 to improve detectability. Red tags provided much more contrast with the planting substrate than the silver, orange, and yellow tags that blended in with cobbles, dead grass, and leaf litter.
Apply mitigative measures, including protective fencing or cages, to prevent damage from herbivory and the control of invasive plants.	✓	The use of cages and collars to protect against herbivory in previous years was found to be very effective. Protective collars were used again around newly established prairie buttercups in 2022. These mitigative measures also improved detectability of plantings.

2022 Goals	Achievement Status	Details
Identify opportunities for improvement within an adaptive management framework.	✓	Ongoing maintenance to previously installed cages and collars and being extra mindful of translocation timing are some of the opportunities identified in 2022. See section 3.6: Plan Forward for further details.

3.5 Plan Forward

Knowledge gained from the 2022 program will inform improvements to project methods and management in 2023 to increase the probability of translocation success.

Future propagule collection efforts will focus primarily on acquiring seed for Torrey's sedge, since both *in-situ* and *ex-situ* collection efforts in 2022 were unsuccessful.

Propagation efforts will focus on 1) generating new plants from the Canada mountain-ricegrass seeds at both NATS and Twin Sisters native plant nurseries; 2) enhancing further proliferation of rock selaginella cuttings in the nursery; and 3) generating a seed bank and new stock for species with lower germination rates (i.e., Torrey's sedge).

Translocation efforts will continue to focus on distributing plants across a larger number of recipient sites. This will build resilience into the program against the impacts of stochastic events (e.g., floods, fires, landslides) on the overall program objectives. In addition, translocation will occur in the spring, when moist conditions are more readily available, for those species that naturally occur in dryland habitats to facilitate establishment and survivability. Future efforts will continue to focus on improving detectability of species through measures such as coloured tags and flagging that is discernible throughout the various seasons. Additional measures may include collars around individual plants with low detectability (i.e., Canada mountain-ricegrass and prairie buttercup.

The selection of an appropriate analytical and statistical paradigm to evaluate the key factors such as survival, maturity, and reproduction is in progress and will depend on a number of factors, including the number of sites deemed appropriate for translocation (and, therefore, the number of replicates) and the number of seeds/propagules/seedlings available for transplant and monitoring. As all phases of the program work concurrently, opportunities for improvement will be identified within an adaptive management framework throughout the remaining lifespan of the program.

The translocation of all species that specialize in drier habitats will be prioritized in the spring or during a wetter season, if forecasted, to improve survivability and establishment. Due to the very dry fall season in 2022, translocation did not occur on dry south-facing slopes. The dry environmental conditions may also have contributed to the abundance of grasshoppers observed on site. Planting during cool and moist conditions may enhance the survival and establishment of the plants and provide enough soil moisture to support the plants' initial growth. As well, these conditions could minimize the effects of insect herbivory if food sources (plants) are healthy and abundant.

REFERENCES

B.C. CDC. 2021. *Recent Data Changes*. Available online: https://www2.gov.bc.ca/gov/content /environment/plants-animals-ecosystems/conservation-data-centre/explore-cdcdata/ conservation-data-centre-updates.

B.C. CDC. 2020. *Species and Ecosystems Explorer*. Retrieved from: http://a100.gov.bc.ca/pub/eswp/.

Bush, N. 2022. *The role of microsites and life stage in determining translocation success of a globally vulnerable plant variety, Oxytropis campestris* var. *davisii* [Unpublished master's thesis, University of British Columbia].Civi. Corp Pty Limited 2021. Available online: https://solocator.com.

Dalrymple, S.E., E. Banks, G.B. Stewart, and A.S. Pullin. 2012. A meta-analysis of threatened plant reintroductions from across the globe. In Plant reintroduction in a changing climate (pp. 31- 50). Island Press, Washington, DC.

Eagle Cap Consulting Ltd. 2021. *2020 Interim report preconstruction rare plant surveys*. Site C Clean Energy Project.

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

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

Natureserve. 2023. *Oxytropis campestris* var. *davisii.* https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.150677/Oxytropis_campestris_var_davisii. Accessed 20 February 2023

Powell, L.R., Berg, A.A., Johnson, D.L., and Warland, J. 2007. Relationships of pest grasshopper populations in Alberta, Canada to soil moisture and climate variables. *Agricultural and Forest Meteorology*, 144, 73-84.

Tredennick, A.T., Hooten, M.B., and Adler, P.B. 2017. Do we need demographic data to forecast plant population dynamics? *Methods in Ecology and Evolution*, 8, 541-551.

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

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

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

Date: November 28, 2022

To: Natasha Bush (EcoLogic)

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

Subject: Site C ERPT Program: Potential Recipient Site Selection Methods & Results

Introduction

An important component of the Site C Experimental Rare Plant Translocation (ERPT) program is the selection of suitable recipient sites for planting of propagules collected from the project activity zone. Program planning in the spring of 2022 identified a need for eight recipient sites to accommodate the propagules collected (or planned for collection). This memo outlines the methods and results of the recipient site selection work performed in 2022.

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

Methods

Prefield Review

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

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

Seven of the nine taxa currently in the ERPT program were selected by the program manager as 2022 target species in need of additional recipient sites for translocation:

- *Carex sprengelii* (Sprengel's sedge)
- *Carex torreyi* (Torrey's sedge)
- *Carex xerantica* (dryland sedge)
- *Oxytropis campestris* var. *davisii* (Davis' locoweed)
- *Piptatheropsis canadensis* (Canada mountain-ricegrass)
- *Ranunculus rhomboideus (prairie buttercup)*
- *Selaginella rupestris* (rock selaginella)

The project botanical team met in March 2022 to review the target species list and define desired recipient site characteristics. Each desired site characteristic was also assigned a weighting to reflect its relative importance to successful propagule establishment. This allowed for the potential recipient sites to be ranked for suitability following the field visits.

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

- contain suitable high-quality habitat for the specific rare plant taxon
- be located in the Peace River region of BC
- be located on land owned by BC Hydro or on Crown land
- not be located on lands requiring access through a locked gate or other owner permission
- not be located in the Site C Project Activity Zone (PAZ)
- not be located below the reservoir preliminary Erosion Impact Line (EIL - a precautionary estimate of the amount of erosion that could occur over a 100 year period)
- be accessible by road or boat during the entire growing season
- have a low likelihood of future disturbance
- have a low percentage of non-native plants
- have good cell service
- be more than one kilometre from known occurrences of the same taxon
- not contain known occurrences of other rare plant taxa
- be close to a source of water

A literature review was conducted for each of the nine species currently in the ERPT program to evaluate any new information relevant to the translocation work. This included checks of recent BC Conservation Data Centre (BCCDC) information to uncover any new element occurrences or changes to rare status, and a Google Scholar search for literature on the nine species published since 2021. The review supplemented literature searches conducted in previous years for the translocation project. Queries were also run on the project rare plant database to uncover apparent habitat associations for the seven 2022 target species based on updated field data.

The habitat needs for the seven target taxa were then reviewed and grouped into four types, in order to aid in the visual evaluation of aerial imagery:

1. river or large stream, with level, open, non-active cobble bar; shading open to partial; sparsely vegetated; sandy, well drained soil

2. moist, shrubby, level to moderate slope, shading open to full, aspect variable, densely vegetated, may dry out later in season, relatively rich clay/silt soil

3. mesic to dry, open, south-facing hillcrest or gentle slope; relatively dense low-shrub grassland vegetation with a green-coloured appearance

4. dry, steep, open south-facing hillcrest/hillside in close proximity to a gravel pit; relatively sparse low shrub, xeric grassland vegetation with a tan-coloured appearance

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

- aerial imagery of the BC Peace River region;
- property ownership provided by BC Hydro;
- known element occurrences of the priority taxa;
- potential recipient sites documented in previous years;
- the Site C Project Activity Zone; and
- the preliminary Erosion Impact Line.

Field Verification

Once recipient areas had been marked in the GIS, selected sites were inventoried in the field to determine suitability. Suitable Potential Recipient Sites (PRS) were evaluated and documented, with the data entered into a digital form for later analysis. Data elements collected included all those typically required by the BCCDC to document rare vascular plant element occurrences, as well as ratings for each of the thirteen desired site characteristics.

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

Potential Recipient Sites were selected partially based on distance to other planting sites, with the aim of distributing them over a wide geographical extent. In some instances, a site was found to contain suitable habitat for several ERPT program species in close proximity, and multi-species PRS plots were completed. While this does provide the option to plant multiple species at the same site, with the consequent increased risk of a single disturbance event impacting multiple species, the limited number of suitable sites available for some of the program species necessitated using one site for several species in some cases. In addition, several of the program species occur together in wild populations.

Results

Prefield Review

The literature search uncovered three recent references containing information potentially relevant to the translocation of the ERPT program species.

- *Prescribed burning has limited effects on the population dynamics of rare plants (Novak et al. 2022)*
- *The timing of snowmelt and amount of winter precipitation have limited influence on flowering phenology in a tallgrass prairie (Chandler and Travers 2021)*
- *Ecological Sites and Successional Plant Community Types of the Peace River Parkland Subregion: Second Approximation (Willoughby, Stone, and Rosendal 2021)*

The queries run on the Site C rare plant database to identify habitat associations for the seven 2022 target species returned five helpful correlations that may have not been otherwise noted. These refine the correlations uncovered during previous years' prefield reviews and are:

- For *Carex sprengelii*: all occurrences where slope was recorded (n=4) were located on flat or relatively low-slope microsites (5° slope or less)
- For *Oxytropis campestris* var. *davisii*: 0-5° slope for all occurrences where slope was recorded (26 occurrences)
- For *Penstemon gracilis*: most occurrences (16 of 21) are on steeper slopes (15–45°) that are south facing (all aspects are S, SW, or SE where aspect is recorded)
- For *Piptatheropsis canadensis*: all five Project area occurrences are found on level microsites, except for one where a slope of 3° was recorded
- For *Selaginella rupestris*: all occurrences are on steep slopes (20–45°) where slope is recorded (6 of 10 occurrences); aspect is recorded as south facing and crown closure is listed as "open" or "partial" for all occurrences where those fields were recorded (8 of 10 occurrences)

A total of 33 planting areas that appeared to have a high likelihood of meeting the requirements for recipient sites were selected from the examination of the GIS layers. The most weight was given to the *appropriate habitat types* and *ease of legal access* criteria. Some planting areas appeared to contain habitat specific to only one rare taxon, and other areas were thought to contain habitat for multiple rare taxa. Not all potential planting areas in the BC Peace Region were considered; rather the review focussed on areas that appeared to be easily accessible by road from Fort St. John, and on areas that were thought to be easily accessible by boat on the Peace River. Therefore, if additional potential recipient sites are required in the future, the as-yet unreviewed portions of the BC Peace region remain for consideration.

A unique PRS point was then generated for each planting area microsite thought to have suitable habitat for translocation of one of the seven 2022 target species. These points were intended to speed the field verification work by directing the surveyors' effort on the ground towards microsites of the best quality habitat. There was no expectation that every PRS point would be field checked, and the exact location for each actual PRS plot was to be decided in the field after a cursory area survey.

The majority of the PRS points used for the 2022 recipient site evaluation work had been generated previously, in the prefield reviews completed in 2019, 2020, and 2021 for the project. Therefore only a few new PRS points were required for the seven 2022 target taxa: four new points each were generated for *Carex torreyi* and *Selaginella rupestris*, three points each for *Piptatheropsis canadensis* and *Ranunculus rhomboideus,* and one new point for *Carex sprengelii*. No new PRS points were created for *Oxytropis campestris* var. *davisii*.

Field Verification

The team of two botanists performed the field verification work between June 9 and 13, on July 28 and 29, and on August 22, 2022. In preparation, the 33 selected planting areas were grouped according to the general access route to allow for efficient survey days. Of the 33 planting areas delineated, 12 received either complete or partial field checks in 2022 (Table 1). All areas were reached by road from Fort St. John, with the closest area located approximately nine kilometres away, and the farthest area approximately 87 km from the town.

The 21 planting areas not field checked in 2022 consist of nine that are still considered to be of possible use if additional potential recipient sites are required in the future, and 15 that were field checked previously and have already had plots completed or have been set aside for future consideration.

Table 1: ERPT Potential Planting Areas Considered in 2022

Planting Area ID	Field Checked?	Field Check Date(s)	Details
4	yes	2019-06-05, 2020-06-07, 2021-06-13, 2022-08-22	Plots completed in 2019, 2020; Removed from Consideration in 2022
14	yes	2019-06-02, 2020-06-05, 2022-06-11	Set Aside for Future Consideration
15	yes	2019-06-02, 2022-06-10	Plots completed 2022
16	no		Possible for Future Evaluation
17	yes	2019-08-10, 2020-07-30, 2022-06-09, 2022-07-28	Plots completed 2019, 2022
22	yes	2019-06-04, 2020-06-12, 2021-06-15	Plots Completed in 2019, 2020 & 2021
23	yes	2020-08-06	Set Aside for Future Consideration
28	yes	2020-06-05, 2021-08-05, 2022-08-02	Plots Completed in 2020, 2022
29	yes	2021-06-10	Set Aside for Future Consideration
30	yes	2019-06-07, 2020-06-04, 2021-06-11, 2022-06-10	Plot completed 2022
31	yes	2019-06-07	Set Aside for Future Consideration

Planting Area ID	Field Checked?	Field Check Date(s)	Details
32	yes	2021-06-10 & -11, 2021-08-05, 2022-08-07	Set Aside for Future Consideration
34	yes	2020-06-05, 2021-06-11, 2022-06-12	Plots Completed in 2020, 2021, 2022
35	no		Possible for Future Evaluation
36	no		Possible for Future Evaluation
37	no		Possible for Future Evaluation
38	no		Possible for Future Evaluation
39	yes	2020-06-07	Set Aside for Future Consideration
40	yes	2020-06-07, 2021-06-13, 2022-07-28	Plots Completed in 2020, 2022
41	yes	2020-10-09	Set Aside for Future Consideration
42	yes	2020-08-03	Set Aside for Future Consideration
43	yes	2020-08-03	Set Aside for Future Consideration
44	yes	2020-06-07	Plot Completed in 2020
45	yes	2020-06-07	Set Aside for Future Consideration
48	yes	2020-06-04, 2022-07-29	Set Aside for Future Consideration
49	yes	2020-06-09, 2021-06-13, 2022-07-29	Plots Completed in 2022
50	no		Possible for Future Evaluation
52	yes	2020-08-02	Set Aside for Future Consideration
53	no		Possible for Future Evaluation
54	no		Possible for Future Evaluation
55	no		Possible for Future Evaluation
57	yes	2020-10-08	Plot Completed in 2020
58	yes	2022-06-11, 2022-07-28	Plots Completed in 2022

The 12 field checks produced the following results:

- one planting area was removed from consideration (too many rare plant occurrences already present);
- three planting areas were set aside for future consideration; and
- eight planting areas were considered to be worth investigating further.

A survey of each of the eight "best choice" planting areas was performed, and a total of eleven PRS plots were completed (Table 2). Supplemental planting locations were also marked in suitable habitat near the PRS plots, where appropriate, to provide options for the planting crew.

It should be noted that during the course of the field verification surveys, twenty new rare plant sites were discovered: eleven patches of *Drymocallis arguta* (tall wood beauty), three patches of *Carex xerantica* (dry-land sedge), two patches of *Penstemon gracilis* (slender penstemon), and one patch each of *Carex torreyi, Lomatium foeniculaceum* var. *foeniculaceum* (fennel-leaved desert-parsley), *Piptatheropsis canadensis,* and *Ranunculus rhomboideus.*

Table 2: Potential Recipient Site Plots 2022

PRS Site ID	*Taxon*	Habitat	Survey Date	Area (sq m)
PRS-CARESPR-011	*Carex sprengelii*	Moist woods bordering swamp	2022-06-10	200
PRS-CARESPR-021	*Carex sprengelii*	Wooded moist gully	2022-06-09	250
PRS-CARETOR-025	*Carex torreyi*	Shrub-grassland interface	2022-06-10	200
PRS-PIPTCAN-005	*Piptatheropsis canadensis*	Shrub-grassland interface	2022-07-28	500
PRS-PIPTCAN-008	*Piptatheropsis canadensis*	Shrub-grassland interface	2022-08-02	30
PRS-RANURHO-011	*Ranunculus rhomboideus*	Moist woods bordering swamp	2022-06-10	500
PRS-RANURHO-015	*Ranunculus rhomboideus*	Shrub-grassland hillside	2022-06-12	1,250
PRS-2022-001	*Carex torreyi, Piptatheropsis canadensis, Ranunculus rhomboideus, Selaginella rupestris*	Shrub-grassland hillside	2022-06-09, 2022-07-28	7,500
PRS-2022-003	*Carex sprengelii, Carex torreyi, Piptatheropsis canadensis, Ranunculus rhomboideus, Selaginella rupestris*	Shrub-grassland hillside	2022-06-11	100,000
PRS-2022-004	*Carex sprengelii, Carex torreyi, Piptatheropsis canadensis, Ranunculus rhomboideus, Selaginella rupestris*	Shrub-grassland hillside	2022-06-11	1,000
PRS-2022-005	*Carex xerantica, Penstemon gracilis, Selaginella rupestris*	Shrub-grassland hillside	2022-07-29	1,500

Discussion

The goal of the work was to locate one or two suitable recipient sites for the current year's target taxa based on the 13 criteria listed in the Methods section above. During the course of the field verification, it became clear that the first 10 criteria were relatively easy to meet (that is, accessible planting areas outside of the Site C PAZ and EIL, on Crown land near the Peace River, which contain appropriate rare plant habitat, low levels of both non-native plants and disturbance, and that have good cellular coverage).

However, the final three criteria proved much more challenging (planting areas greater than one kilometre from known sites of the same taxon, not already occupied by other rare plant species, and close to a source of water). While the prefield review specifically avoided known rare plant sites in choosing potential planting areas to evaluate, it was anticipated that new rare plant occurrences would be discovered since the goal was to target high-quality rare plant habitats. Thus, twenty new rare plant sites were documented by the survey team during the field verification process. The surveyors attempted to avoid these new sites when placing PRS plots and marking supplemental planting locations, but this was not always possible: at seven of the recommended planting sites, PRS plots had to be placed in the vicinity of other naturally-occurring rare plant populations. However, this compromise was accepted as reasonable considering that naturally-occurring multi-species rare plant sites are frequently found in the BC Peace region. In one instance, based on the additional natural rare plant patches discovered in 2022 at one of the previously-recommended planting areas, it was determined that the entire planting area should be removed from consideration for use in the ERPT program.

The final compromise for PRS plot placement, as anticipated, was that few of the sites could be said to have a source of water, since most PRS locations are on relatively dry shrub-grassland slopes generally found well above the Peace River and only rarely near year-round streams or springs. Of the eleven plots completed in 2022, only two had a water source, as they were able to be placed in moist woods bordering a swamp.

Therefore, given the above caveats, all eight planting areas where PRS plots were completed in 2022 do meet the majority of the requirements of an ideal recipient site. Five of the planting areas contain a variety of habitats and are suitable for multiple species translocation. The remaining planting areas were specifically selected for a single taxon.

The areas suitable for multiple species translocation are all on either Crown parcels or BC Hydro-owned parcels, located between Hudson's Hope and the Alberta border. Eight multi-species plots were completed, for *Carex sprengelii, Carex torreyi, Piptatheropsis canadensis, Ranunculus rhomboideus,* and *Selaginella rupestris.* One area was also considered suitable for *Penstemon gracilis,* a taxon not specifically in need of additional planting sites for 2022 but which is still actively being planted out.

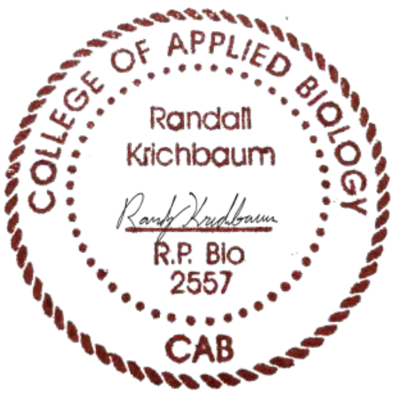
Single-species PRS plots were placed in three separate planting areas on Crown land parcels between the junction of Upper Cache Road & Highway 29 and the Alberta border. Plots for *Carex sprengelii, Carex torreyi,* and *Piptatheropsis canadensis* were completed.

Closure

Reviewed and approved:

Randy Krichbaum M.Sc., R.P. Bio., P. Biol.
Senior Ecologist
Eagle Cap Consulting Ltd.

<Original signed and sealed November 28, 2022 at Calgary, Alberta>



References

Chandler, Emma K, and Steven E Travers. 2021. “The Timing of Snowmelt and Amount of Winter Precipitation Have Limited Influence on Flowering Phenology in a Tallgrass Prairie.” *Botany*, October. doi:10.1139/cjb-2021-0102.

Novak, Logan, Joshua P. Scholl, Gretel Kiefer, and Amy M. Iler. 2022. “Prescribed Burning Has Limited Effects on the Population Dynamics of Rare Plants.” *Conservation Science and Practice* 4 (10). doi:10.1111/csp2.12792.

Willoughby, M G, C Stone, and A Rosendal. 2021. *Ecological Sites and Successional Plant Community Types of the Peace River Parkland Subregion: Second Approximation*. Edmonton, Alberta: Government of Alberta.

APPENDIX B. DATA CAPTURE FORM – TRANSLOCATION

Experimental Rare Plant Translocation Program

ECOLOGIC	**TRANSECT / PLOT / INDIVIDUAL** **Data Capture Form**	SITE + T/P	[S-_________] +
		Data Sheet Tracking Number	

Data Recorder:		*Team:*	

TRANSECT / PLOT Level Information		**TRANSECT or PLOT**	*specify*	**ID:**		
Species Name	**Recipient Site Name**	**UTMZone**	**Easting**	**Northing**	**Elev. (m)**	**Plot Solocator Photos**
dd	dd					

Outplanting Conditions			**Nursery**	dd	
Date(yymmdd)	**Weather Cond**	**Ambient Temp (*C)**	**Date Removed**	**Plug Size (mm)**	**Growth Media**

TRANSECT or PLOT		**MAP**	Y/ N	**subPLOT Information**		
Dimensions (m x m)	**Shape & Orientation**	**Loc. of Map**		**subPlot ID**	**Dimensions (m x m)**	**subPL Photos**
		dd		dd		

General Comments

PLANT OBVS	*Example*																											
TAG NUMBER	94																											
Plant Presence	bsent																											
Plant Condition	dead																											
Inflorescences (#)	4																											
Seeds (#heads /pods)	1																											
Implem / Monitor	mon																											
Photos	meth																											
Height (cm)	3																											
Surf.Area cm2	200																											
%CV of Surf. Area	40																											
Soil Mositure	ories																											
Soil Temperature	deg C																											
Mulch Type	osses																											
Mulch Depth	2																											
MicroCatch Created	s / no																											
Damage1 Type	down																											
Damage1 Extent	down																											
Damage2 Type	down																											
Damage2 Extent	down																											
Damage3Type	down																											
Damage3 Extent	down																											
Planter (name)	Bush																											

Species	**Recip. Site**	**Nursery**	**Loc. of Map**	**subPlotID**	**Plant Presence**	**Plant Cond.**	**Inflorescences (#)**	**Seeds (#heads /pods)**
list	list	list	list	instructions	list	list	instructions	instructions

Experimental Rare Plant Translocation Program

Surf.Area cm2	%CV of Surf. Area	Mulch Type	Damage Type	Damage Extent
instructions	instructions	list	list	list

ECOLOGIC

MAP / SITE DIAGRAM

SITE + T/P	[S-__________] +
Data Sheet Tracking Number	

Map Recorder:		*Team:*	

TRANSECT / PLOT Level Information	**TRANSECT or PLOT**	*specify T or P*	**ID:**

Species Name	**Recipient Site Name**	**Slope (deg)**	**Aspect (T)**
dd	dd		

General Comments	**Draw Slope Direct.**	**North Arrow**

Draw site diagram here. Clearly illustrate locations of specific tag numbers.

Appendix 10. Cavity Nesting Mitigation and Monitoring Program 2022 Annual Report

Ausenco Engineering Canada Inc.
18th Floor, 4515 Central Boulevard
Burnaby, BC, Canada V5H 0C6
T: +1 604.669.0424
F: +1.604.669.0430
www.ausenco.com

Memorandum

Attention	Brock Simons, BC Hydro
From:	Ausenco Sustainability Inc.
Subject:	Cavity-Nesting Mitigation and Monitoring Program – 2022 Annual Report
Date	November 23, 2022
Document Ref:	989619-08

1 Introduction

BC Hydro assessed the potential effects of the Site C Clean Energy Project on Wildlife Resources in the Site C Environmental Impact Statement (EIS) using key species groups (BC Hydro 2013). Cavity-nesting bird species were assessed in the EIS as part of the migratory birds (passerines [songbirds], northern flicker, and waterfowl) and raptors (hawks and owls) groups (BC Hydro 2016). In 2017, a mitigation and monitoring plan for cavity-nesting birds was developed with input from the Vegetation and Wildlife Technical Committee, which is comprised of representatives of the Canadian Wildlife Service, the BC Ministry of Environment and Climate Change Strategy and the BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development.

The purpose of the Cavity-Nesting Mitigation and Monitoring Program is to mitigate habitat loss for cavity-nesting species associated with Site C reservoir vegetation clearing, and to monitor the effectiveness of that mitigation (BC Hydro 2018). Mitigating the impacts of habitat loss for cavity nesting birds is focused on areas that will be retained (i.e., not cleared and not flooded) and currently have a low density of suitable trees for cavity-nesting species (i.e., structural stage 4 [pole-sapling] or 5 [young forest][1] habitats that have few large-diameter trees or snags). Mitigation of habitat loss will be achieved using different measures depending on the duration of the effects they are intended to mitigate (i.e., short-, medium-, or long-term). Nest box installation for cavity-nesting species provides short-term mitigation, the results of which are the focus of this memo.

1 Structural Stage 4 (pole-sapling forest): Trees >10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually >10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually <40 years for normal forest succession; up to 100+ years for dense (5000–15 000+ stems per hectare) stagnant stands. Structural Stage 5 (young forest): Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions; from RIC (1998).

2 Methods

2.1 Nest Box Construction

Cavity-nesting birds differ in their habitat requirements and selection of cavities. Therefore, a variety of nest box designs were constructed to mitigate impacts on nesting habitat for cavity-nesting birds due to activities associated with the Site C Clean Energy Project (**Photo 1**). Thirteen different nest box designs were constructed to accommodate 21 species of cavity-nesting birds, with some box designs intended to support multiple species (BC Hydro 2018).

Photo 1 Nest Box Designs Built for the Cavity-Nesting Mitigation and Monitoring Program

2.2 Nest Box Installation

The selection of sites followed specifications described in the Cavity Nesting Species Mitigation and Monitoring Program (BC Hydro 2018). The selection of habitat and placement of nest boxes was guided based on information from James (1984) and terrestrial ecosystem mapping data collected in 2016 along the periphery of the planned reservoir. Boxes were placed on lands owned or leased by BC Hydro or on Crown land, in areas outside of planned clearing boundaries, above the high-water mark, and in areas of suitable but suboptimal habitat (i.e., areas of suitable age class but with a low number of cavity trees).

Box installation was specifically focussed on lower suitability habitat with a low proportion of potential cavity-nest trees (i.e., structural stages 4 to 5), but with the greatest potential to develop into more suitable habitat over the short term. **Photo 2** presents an example of an installed nest box design ‘A’, intended for black-capped chickadee (*Poecile atricapillus*), boreal chickadee (*P. hudsonicus*), red-breasted nuthatch (*Sitta canadensis*), white-breasted nuthatch (*S. carolinensis*), house wren (*Troglodytes aedon*), and brown creeper (*Certhia americana*).

Additional information based on literature and expert knowledge was also considered for the installation of nest boxes:

- Proximity to a food source for all species (e.g., wetlands, water sources)
- Bird distribution and abundance information from Site C baseline studies in the area
- Known habitat associations
- Appropriate nest heights (**Table 1**)
- Density of nest boxes within an area (i.e., spacing between nest boxes) (**Table 1**).

Photo 2 Nest box design 'A'

Table 1 Installation Specifications for Nest Boxes Targeting Particular Bird Species

Species Group	Common Name	Scientific Name	Minimum Spacing Between Boxes (m)	Nest Box Height (m)
Passerines	black-capped chickadee	*Poecile atricapillus*	150-200	1.5 - 4.5
	boreal chickadee	*Poecile hudsonicus*	150-200	1.5 - 3
	brown creeper	*Certhia americana*	150	1.0 - 10
	red-breasted nuthatch	*Sitta canadensis*	50	1.5 - 4.5
	white-breasted nuthatch	*Sitta carolinensis*	300	1.5 - 6
	tree swallow	*Tachycineta bicolor*	10-30	1.5 - 1.8
	violet-green swallow	*Tachycineta thalassina*	10-30	2.75 - 4.5
	house wren	*Troglodytes aedon*	30	1.5 - 3
	mountain bluebird	*Sialia currucoides*	90	1.2 – 1.8
Waterfowl	Barrow's goldeneye	*Bucephala islandica*	150-200	1.8 - 6
	Bufflehead	*Bucephala albeola*	50-150	1.5 - 3
	common goldeneye	*Bucephala clangula*	1,000	1.8 - 9
	common merganser	*Mergus merganser*	100	2.4 - 5.2
	hooded merganser	*Lophodytes cucullatus*	30	1.8 - 7.6
Raptors and Owls	barred owl	*Strix varia*	1,000	4.5 - 9
	boreal owl	*Aegolius funereus*	150	≥3
	northern saw-whet owl	*Aegolius acadicus*	400-500	≥3
	northern pygmy-owl	*Glaucidium gnoma*	400-500	≥3
	northern hawk-owl	*Surnia ulula*	500-700	≥3
	American kestrel	*Falco sparverius*	500-800	3.5 – 6

2.3 Nest Box Monitoring and Maintenance

Nest box monitoring will continue biennially through the Site C Clean Energy Project construction and the first ten years of operations (**Appendix A**). Boxes installed in 2017 were monitored in 2020 (Hemmera 2020) and again in 2022 and will be monitored every two years after that through the first 10 years of Project operations. Boxes installed in 2019 and 2020 were monitored in 2021 and will be monitored again in 2023.

Originally, 96 boxes were scheduled to be monitored in 2022 (**Appendix A**). Thirty-two boxes had either been temporarily deactivated or were located within active work areas in 2022, so those boxes were removed from the list of boxes to be visited. All the boxes scheduled to be monitored in 2022 had been installed in 2017.

Monitoring in 2022 was conducted by a qualified environmental professional in a manner that minimizes disturbance to active nests. Using the breeding period information provided in **Appendix B**, nest box visits were timed to coincide with nest stages in which the likelihood of detecting use is greatest (i.e., late incubation to early nestling stages). Visits timed to coincide with nests at a stage with older nestlings are more likely to effectively determine use because parents at that time are more likely to be feeding nestlings more frequently. However, due to variation in brood timing within and among species, attempting to time surveys to coincide with the presence of older nestlings would increase the chance of arriving too late for direct observations of breeding activity for some nests. Therefore, a conservative estimate of the nesting window was applied to maximize the likelihood of observing active use and determining the species using each box.

During the monitoring work, surveyors approached the box discreetly, watching and listening for activity. When adults were attending a box, surveyors observed from a distance, recorded species, and attempted to determine stage (if nestlings were present, food delivery and fecal sac removal confirmed stage). If no use was evident from nest box observation, surveyors approached the nest box structure (tree or otherwise) and tapped lightly on it to elicit a response (Dudley and Saab 2003). If no bird appeared at the cavity entrance, a pole-mounted camera was used to examine the nest box contents. When nesting activity was documented but no adult birds were observed at the box, egg and nest characteristics (e.g., nesting material type, egg colour, shape, and size) were used to identify, where possible, the species or genus occupying the box. For species with similar eggs and nests, it is only possible to identify to genus (e.g., goldeneye species [*Bucephala* spp.]).

During each nest box visit surveyors recorded the following data electronically:

- Date and time
- Coordinates
- Surveyors
- Weather conditions
- Nest box ID
- Detection methods
- Adult behaviour
- Audible nestlings
- Food delivery
- Pole camera examination
- Whether the box is being used
- Species detected
- Notes informing environmental context, such as disturbance in the area.

Nest boxes have a 10 to 15-year lifespan with regular maintenance. Nest boxes in need of repair (e.g., damaged or fallen boxes, loose lids or covers) were flagged during the monitoring season in 2022 and repaired during the monitoring period if feasible (e.g., not occupied, salvageable). Maintenance and repair included replacing nesting material if necessary and performing any replacement or repair of damaged boxes.

Some nest boxes have been deactivated to prevent them from being used if there was potential for other BC Hydro activities (e.g., clearing) disturbing nesting birds. Boxes were deactivated by first ensuring that the box was vacant and then installing a piece of wood to block the entrance hole.

3 Results

3.1 Nest Box Installation

Between 2017 and 2020, 268 nest boxes were installed on trees and structures on BC Hydro-owned and managed lands, and on private lands where permission was granted (**Table 2**, **Figure 1**). Twenty-one boxes have been installed near the lower reservoir, 78 near the eastern reservoir, 38 near the middle reservoir and 131 near the western reservoir.

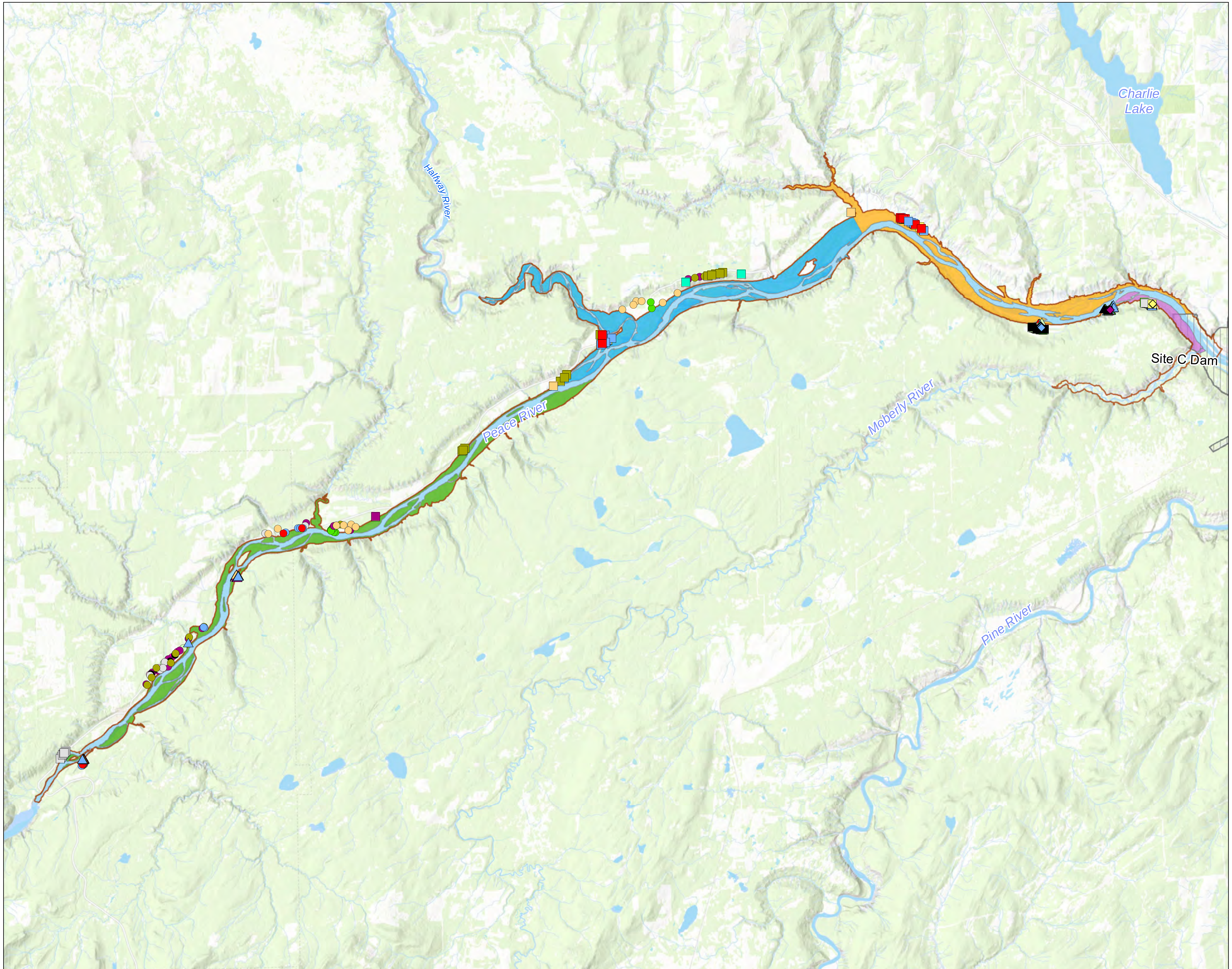
A total of 96 nest boxes were installed in 2017 on the north side of the Peace River. An additional 171 nest boxes were installed from 2019 to 2020; 83 were installed in 2019 on the south side of the Peace River, and the remaining 88 were installed in spring 2020 on the north and south sides of the Peace River. The locations of the 2020 nest boxes were selected based on areas not covered in previous installations (2017 and 2019) and complementing the habitat and species assemblage within the proposed reservoir following the same criteria for habitat selection (see **Section 2.2**). Five boxes that had been damaged or removed were reinstalled in 2021.

Ten boxes of five different box types were installed in 2022 (**Photo 2**) on the south side of the river, including three E1, one G, one E2, three B3 and two F, for a total of 277 boxes installed in all years. **Table 2** summarizes the target species, habitat type and number of boxes of each design installed to date.

Table 2 Target Species, Habitat Preferences, and Total Number Nest Boxes Installed in 2017, 2019, 2020 and 2022

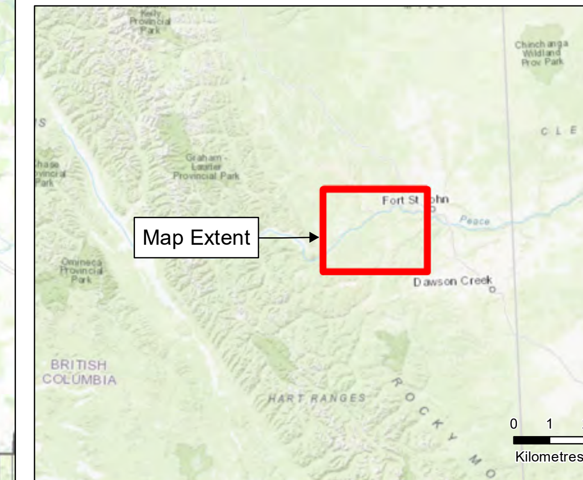
Species Group	Habitat Preference	Box Type	Species Supported	Number of Boxes Installed to Date
Passerine	• Use a variety of habitat types, from dry to wet forests and in most structural stages • Brown creeper and nuthatches prefer more mature forested habitats • Swallows use wetland and cultivated field habitat • Mountain bluebirds require open field habitat	A / BC / B1	black-capped chickadee boreal chickadee red-breasted nuthatch white-breasted nuthatch house wren brown creeper	44
		A2 / B2	mountain bluebird tree swallow violet-green swallow	57
Waterfowl	• Need an unobstructed flight path from suitable forage habitat to nesting features	E1	bufflehead	11
		F	Barrow's goldeneye common goldeneye hooded merganser	50
		D / G	common merganser	19
Raptors and Owls	• Typically found in mesic to moist forests • smaller species found in younger forests • American kestrel requires open field habitat	E2	boreal owl northern saw-whet owl	28
		E3	American kestrel	17
		C	northern pygmy- owl	26
		B3	northern hawk-owl	23
		H	barred owl	2
			Total	**277**

Note: 264 boxes were proposed to be installed in total (BC Hydro 2018)



Site C Clean Energy Project
Peace River, BC

Nest Box Locations



Legend

- Proposed Dam Site
- 5 Year Beach Line
- Eastern Reservoir
- Lower Reservoir
- Middle Reservoir
- Western Reservoir

Nest Boxes - Year Installed

Type	2017	2019	2020	2022
A	●	▲	■	
A2	●	▲	■	
B1	●	▲	■	
B2	●	▲		
B3	●	▲	■	◆
BC	●	▲	■	
C	●	▲	■	
D			■	
E1	●		■	◆
E2	●	▲	■	◆
E3	●	▲	■	
F	●	▲	■	◆
G	●	▲	■	◆
H		▲	■	

Notes

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

Sources

- Basemap: ESRI World Topographic Base

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Kilometres

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Page Size: 11" x 17"

989619-08	Production Date: Nov 21, 2022	Figure 1

Ausenco BC hydro

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3.2 Monitoring and Maintenance of Nest Boxes Installed in Previous Years

Of the 64 boxes targeted for monitoring from May 31 to June 2, 2022, two were not available and 62 were potentially available for use. One nest box scheduled for monitoring in 2022 could not be found and was presumably lost during vegetation clearing after a change in clearing boundaries or during inclement weather. A second box had been destroyed by a falling tree. Six additional boxes that had previously been deactivated (**Photo 2**) were visited to check their condition, although they were not on the list of boxes targeted for monitoring in 2022.

Repairs were made to one box, and old wasp nests (**Photo 3**) were removed from three boxes. New nest material was added to 34 boxes. One additional box (C-20) that had not been scheduled for monitoring in 2022 was checked as it was adjacent to a box that was on the list for 2022 monitoring. The status of each box at the time of monitoring is presented in **Appendix C**.

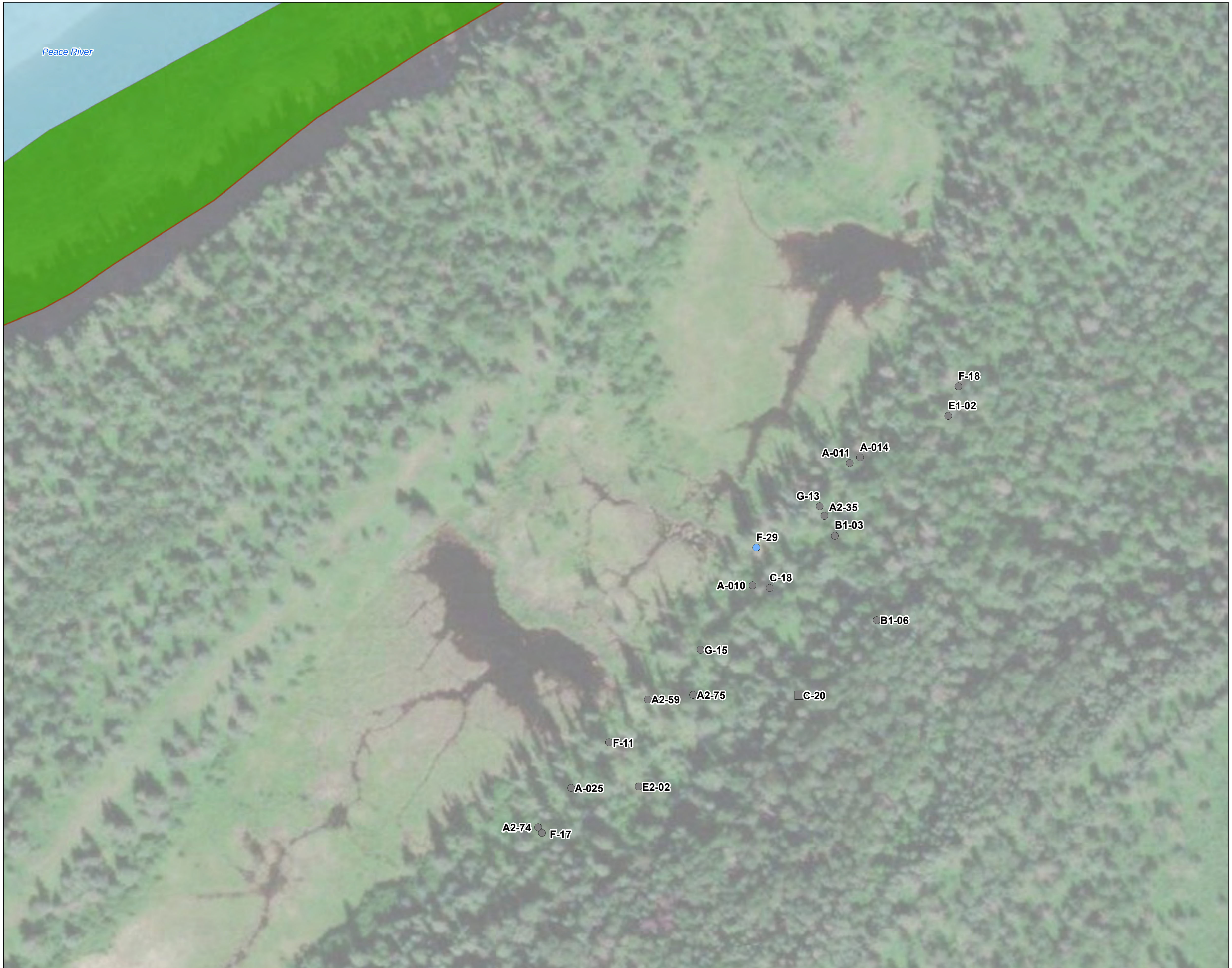
Photo 3 Deactivated Nest Box

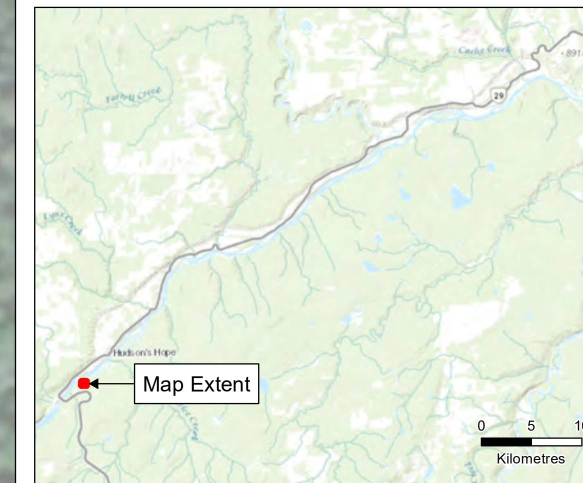
Photo 4 Wasp Nest Inside Nest Box

Twenty-six boxes showed signs of current or previous bird use such as nesting material, feathers, eggs or birds present. Two boxes contained active nests. An adult American kestrel (*Falco sparverius*) with five eggs was found in box E3-16 (**Figure 2**, **Photo 5**). Box F-29 contained an adult bufflehead (*Bucephala albeola*) with nine eggs (**Figure 3**, **Photo 6,**). Flying squirrels (*Glaucomys sabrinus*) were discovered using two boxes (**Photo 7**). Other signs of rodent use, such as droppings, tooth marks (**Photo 8**), or food caches, were observed at seven additional boxes during monitoring.

Site C Clean Energy Project
Peace River, BC

Locations of Nest Boxes with Eggs #1





Legend

- 5 Year Beach Line
- Western Reservoir
- Waterbody

Nest Boxes with Eggs - Species

- Bufflehead (*Bucephala albeola*)

Other Nest Boxes - Year Installed

- 2017
- 2020

Notes

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

Sources

- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

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Metres

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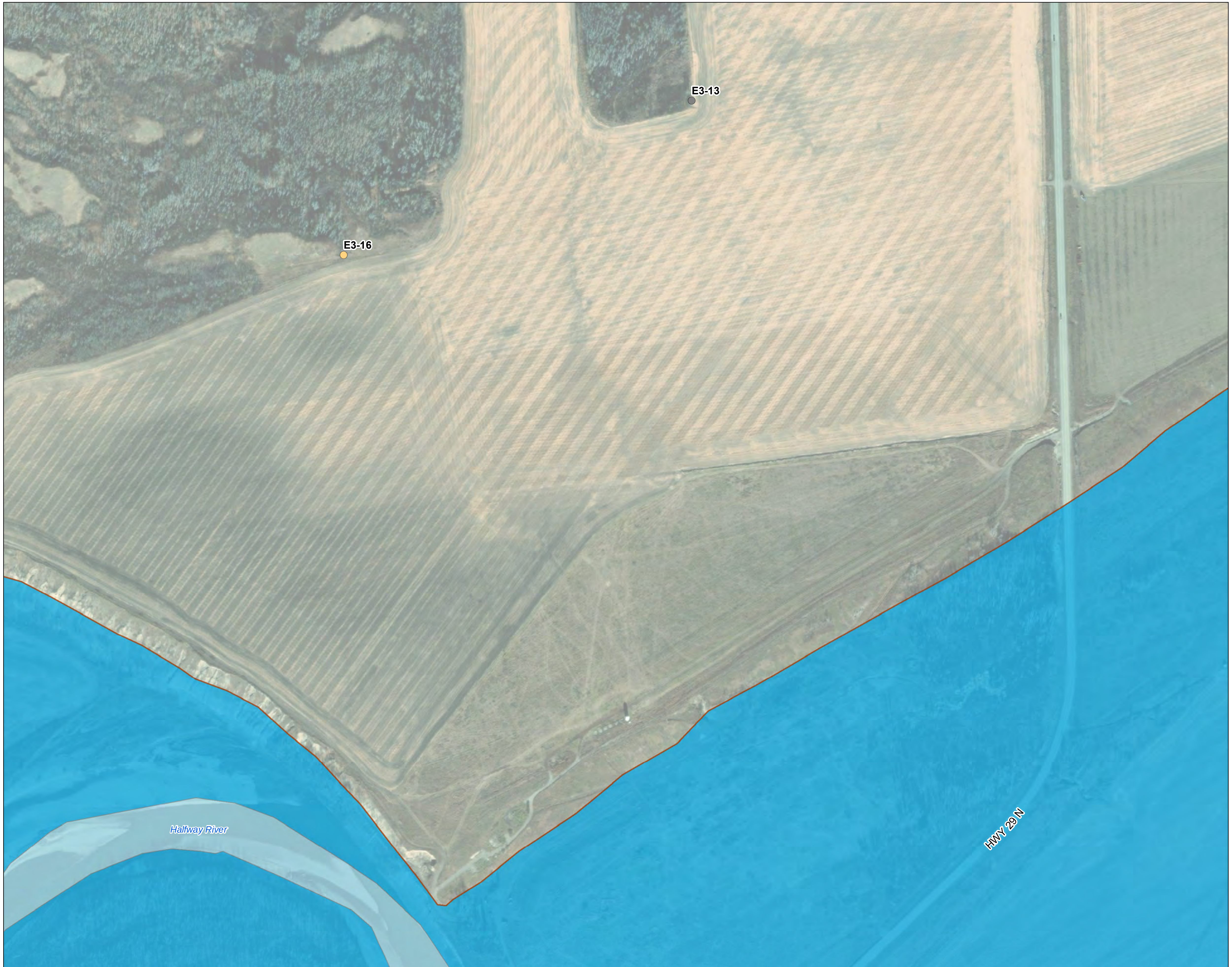
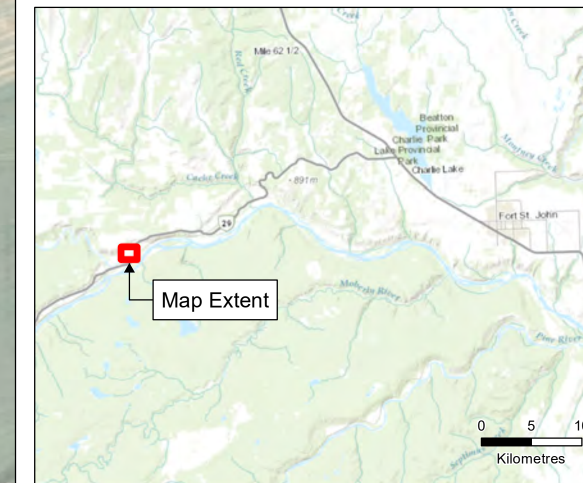
989619-08	Production Date: Nov 9, 2022	Figure 2

Ausenco BChydro

Site C Clean Energy Project
Peace River, BC

Locations of Nest Boxes with Eggs #2





Legend

- 5 Year Beach Line
- Middle Reservoir
- Watercourse
- Waterbody

Nest Boxes with Eggs - Species

- American kestrel (*Falco sparverius*)

Other Nest Boxes - Year Installed

- 2017

Notes

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

Sources

- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

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Metres

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Page Size: 11" x 17"

989619-08	Production Date: Nov 9, 2022	Figure 3

Ausenco BChydro

Photo 5 American Kestrel Nest

Photo 6 Bufflehead Nest

Photo 7 Flying Squirrel

Photo 8 Squirrel Chewing Damage Around Entrance

4 Discussion

Of the 64 nest boxes scheduled for monitoring in 2022, one could not be located and one was destroyed, leaving 62 boxes potentially available for use. Twenty-six of 62 (42%) had at least some signs of nesting, although in some cases it was unclear if the nesting material observed in the box was from birds or from rodents. Two of the 62 boxes (3%) were occupied by birds and another two by flying squirrels at the time of the monitoring.

The occupancy rate in 2022 (42%) is similar to that documented in 2021. A larger subset of nest boxes (171) was monitored in 2021 and 35% of available boxes showed signs of use that year (Hemmera 2022). This occupancy percentage is similar to other studies of artificial nests conducted on multiple species (Milligan and Dickinson 2016).

The 2022 kestrel nest was discovered in an E3 box, designed for kestrels, while the bufflehead nested in an F box designed for other waterfowl species. The F boxes have an oval opening 3.5 inches by 4.5 inches, larger than the 3-inch diameter round opening in the E1 boxes designed specifically for bufflehead. The F boxes are also 10 inches deeper than the bufflehead boxes. These observations continue to provide evidence that although the boxes are suited to the species for which they were designed, they provide nesting opportunities for other species as well.

5 Closure

We sincerely appreciate the opportunity to have assisted you with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

Report prepared by:
Ausenco

ORIGINAL SIGNED

Lorraine Andrusiak M.Sc., R.P.Bio.
Senior Terrestrial Biologist

Report prepared by:
Ausenco

ORIGINAL SIGNED

Felix Martinez-Nunez M.Sc., R.P.Bio.
Wildlife Biologist

6 References

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Prepared for BC Hydro by Keystone Wildlife Research Ltd. Available at https://www.ceaa-acee.gc.ca/050/evaluations/document/85328?culture=en-CA.

BC Hydro. 2016. Site C Clean Energy Project Vegetation and Wildlife Mitigation and Monitoring Cavity Nesting Species Summary.

BC Hydro. 2018. Site C Clean Energy Project Vegetation and Wildlife Cavity Nesting Species Mitigation and Monitoring Program.

Dudley, J., and V.A. Saab. 2003. A Field Protocol to Monitor Cavity-nesting Birds Res. Pap. RMRS-RP-44. United States Department of Agriculture, Forest Service, Rocky Mountain Research Station. Available at http://www.fs.fed.us/rm/pubs/rmrs_rp044.pdf.

Hemmera Envirochem Inc. (Hemmera). 2020. Cavity Nesting Mitigation and Monitoring Program - 2020 Annual Report: Memorandum Prepared for BC Hydro, Burnaby, BC.

Hemmera Envirochem Inc. (Hemmera). 2022. Cavity Nesting Mitigation and Monitoring Program – 2021 Annual Report. Memorandum prepared for BC Hydro, Burnaby, BC.

James, R.D. 1984. Habitat Management Guidelines for Cavity-nesting Birds in Ontario. Royal Ontario Museum. Available at http://www.ontla.on.ca/library/repository/mon/6000/10299742.pdf.

Milligan, M.C., and J.L. Dickinson. 2016. Habitat Quality and Nest-box Occupancy by Five Species of Oak Woodland Birds. The Auk 133(3):429–438. Available at https://bioone.org/journals/the-auk/volume-133/issue-3/AUK-15-187.1/Habitat-quality-and-nest-box-occupancy-by-five-species-of/10.1642/AUK-15-187.1.full#i0004-8038-133-3-429-t01.

Resources Inventory Committee (RIC). 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Ecosystems Working Group, Terrestrial Ecosystems Task Force, Resources Inventory Committee; Resources Inventory Committee (RIC), Victoria, BC.

Appendix A
Monitoring and Maintenance Schedule

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
A-002	A	2017		X		X		X	
A-010	A	2017		X		X		X	
A-011	A	2017		X		X		X	
A-014	A	2017		X		X		X	
A-017	A	2017		X		X		X	
A-020	A	2017		X		X		X	
A-021	A	2017		X		X		X	
A-025	A	2017		X		X		X	
A2-35	A2	2017		X		X		X	
A2-36	A2	2017		X		X		X	
A2-37	A2	2017		X		X		X	
A2-44*	A2	2017		X		X		X	
A2-45	A2	2017		X		X		X	
A2-51	A2	2017		X		X		X	
A2-55	A2	2017		X		X		X	
A2-58*	A2	2017		X		X		X	
A2-59	A2	2017		X		X		X	
A2-62*	A2	2017		X		X		X	
A2-66*	A2	2017		X		X		X	
A2-72*	A2	2017		X		X		X	
A2-74	A2	2017		X		X		X	
A2-75	A2	2017		X		X		X	
A2-76	A2	2017		X		X		X	
A2-79	A2	2017		X		X		X	
B1-01	B1	2017		X		X		X	
B1-02	B1	2017		X		X		X	
B1-03	B1	2017		X		X		X	
B1-06	B1	2017		X		X		X	
B2-03	B2	2017		X		X		X	
B2-06	B2	2017		X		X		X	
B3-02	B3	2017		X		X		X	
B3-03	B3	2017		X		X		X	
B3-05	B3	2017		X		X		X	
B3-06	B3	2017		X		X		X	
B3-07	B3	2017		X		X		X	
B3-10*	B3	2017		X		X		X	
B3-11	B3	2017		X		X		X	
B3-12	B3	2017		X		X		X	
B3-13	B3	2017		X		X		X	
B3-14	B3	2017		X		X		X	

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
B3-16*	B3	2017		X		X		X	
B3-17	B3	2017		X		X		X	
B3-20	B3	2017		X		X		X	
BC-01	BC	2017		X		X		X	
BC-02	BC	2017		X		X		X	
BC-03	BC	2017		X		X		X	
BC-05	BC	2017		X		X		X	
C-01	C	2017		X		X		X	
C-02*	C	2017		X		X		X	
C-03	C	2017		X		X		X	
C-08	C	2017		X		X		X	
C-12	C	2017		X		X		X	
C-13	C	2017		X		X		X	
C-15*	C	2017		X		X		X	
C-18	C	2017		X		X		X	
C-22	C	2017		X		X		X	
E1-02	E1	2017		X		X		X	
E1-05*	E1	2017		X		X		X	
E2-01	E2	2017		X		X		X	
E2-02	E2	2017		X		X		X	
E2-03*	E2	2017		X		X		X	
E2-06	E2	2017		X		X		X	
E2-10	E2	2017		X		X		X	
E2-13	E2	2017		X		X		X	
E2-17	E2	2017		X		X		X	
E2-20*	E2	2017		X		X		X	
E2-21	E2	2017		X		X		X	
E2-27*	E2	2017		X		X		X	
E2-28	E2	2017		X		X		X	
E3-01	E3	2017		X		X		X	
E3-02	E3	2017		X		X		X	
E3-03	E3	2017		X		X		X	
E3-04	E3	2017		X		X		X	
E3-05	E3	2017		X		X		X	
E3-07*	E3	2017		X		X		X	
E3-09*	E3	2017		X		X		X	
E3-11*	E3	2017		X		X		X	
E3-12*	E3	2017		X		X		X	
E3-13	E3	2017		X		X		X	
E3-14*	E3	2017		X		X		X	

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
E3-15*	E3	2017		X		X		X	
E3-16	E3	2017		X		X		X	
F-03*	F	2017		X		X		X	
F-07*	F	2017		X		X		X	
F-08*	F	2017		X		X		X	
F-11	F	2017		X		X		X	
F-17	F	2017		X		X		X	
F-18	F	2017		X		X		X	
F-29	F	2017		X		X		X	
F-31	F	2017		X		X		X	
F-32*	F	2017		X		X		X	
F-42*	F	2017		X		X		X	
G-07*	G	2017		X		X		X	
G-08*	G	2017		X		X		X	
G-13	G	2017		X		X		X	
G-15	G	2017		X		X		X	
A-004	A	2019	X		X		X		X
A-006	A	2019	X		X		X		X
A-007	A	2019	X		X		X		X
A-013	A	2019	X		X		X		X
A-015	A	2019	X		X		X		X
A-016	A	2019	X		X		X		X
A-022	A	2019	X		X		X		X
A-024	A	2019	X		X		X		X
A-026	A	2019	X		X		X		X
A2-27	A2	2019	X		X		X		X
A2-28	A2	2019	X		X		X		X
A2-29	A2	2019	X		X		X		X
A2-30	A2	2019	X		X		X		X
A2-32	A2	2019	X		X		X		X
A2-33	A2	2019	X		X		X		X
A2-34	A2	2019	X*		X		X		X
A2-38	A2	2019	X		X		X		X
A2-39	A2	2019	X		X		X		X
A2-42	A2	2019	X		X		X		X
A2-46	A2	2019	X		X		X		X
A2-47	A2	2019	X		X		X		X
A2-53	A2	2019	X*		X		X		X
A2-56	A2	2019	X		X		X		X
A2-57	A2	2019	X*		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
A2-63	A2	2019	X*		X		X		X
A2-64	A2	2019	X*		X		X		X
A2-67	A2	2019	X		X		X		X
A2-68	A2	2019	X		X		X		X
A2-69	A2	2019	X		X		X		X
A2-80	A2	2019	X		X		X		X
B1-04	B1	2019	X		X		X		X
B1-05	B1	2019	X		X		X		X
B1-06b	B1	2019	X		X		X		X
B2-01	B2	2019	X		X		X		X
B2-02	B2	2019	X		X		X		X
B2-04	B2	2019	X		X		X		X
B2-05	B2	2019	X		X		X		X
B3-01	B3	2019	X		X		X		X
B3-04	B3	2019	X		X		X		X
B3-08	B3	2019	X		X		X		X
B3-15	B3	2019	X		X		X		X
B3-18	B3	2019	X		X		X		X
BC-04	BC	2019	X		X		X		X
C-21	C	2019	X		X		X		X
E2-11	E2	2019	X		X		X		X
E2-18	E2	2019	X		X		X		X
E2-26	E2	2019	X		X		X		X
F-02	F	2019	X		X		X		X
F-04	F	2019	X		X		X		X
F-05	F	2019	X		X		X		X
F-06	F	2019	X		X		X		X
F-10	F	2019	X		X		X		X
F-14	F	2019	X		X		X		X
F-15	F	2019	X		X		X		X
F-16	F	2019	X		X		X		X
F-19	F	2019	X		X		X		X
F-22	F	2019	X		X		X		X
F-23	F	2019	X		X		X		X
F-24	F	2019	X		X		X		X
F-25	F	2019	X		X		X		X
F-28	F	2019	X		X		X		X
F-30	F	2019	X		X		X		X
F-37	F	2019	X		X		X		X
F-39	F	2019	X		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
F-40	F	2019	X		X		X		X
F-47	F	2019	X		X		X		X
G-05	G	2019	X		X		X		X
OWL-2	H	2020	X		X		X		X
OWL-3	H	2020	X		X		X		X
A-001	A	2020	X		X		X		X
A-003	A	2020	X		X		X		X
A-005	A	2020	X*		X		X		X
A-009	A	2020	X		X		X		X
A-012	A	2020	X		X		X		X
A-018	A	2020	X		X		X		X
A2-31	A2	2020	X		X		X		X
A2-41	A2	2020	X		X		X		X
A2-48	A2	2020	X		X		X		X
A2-49	A2	2020	X		X		X		X
A2-50	A2	2020	X		X		X		X
A2-52	A2	2020	X		X		X		X
A2-61	A2	2020	X		X		X		X
A2-70	A2	2020	X		X		X		X
A2-81	A2	2020	X		X		X		X
B1-00	B1	2020	X		X		X		X
B3-09	B3	2020	X		X		X		X
B3-19	B3	2020	X		X		X		X
BC-01S	BC	2020	X		X		X		X
BC-02b	BC	2020	X*		X		X		X
BC-03b	BC	2020	X		X		X		X
BC-04b	BC	2020	X		X		X		X
BC-NN	BC	2020	X		X		X		X
C-04	C	2020	X		X		X		X
C-05	C	2020	X		X		X		X
C-06	C	2020	X		X		X		X
C-09	C	2020	X		X		X		X
C-10	C	2020	X		X		X		X
C-11	C	2020	X		X		X		X
C-14	C	2020	X		X		X		X
C-16	C	2020	X		X		X		X
C-17	C	2020	X		X		X		X
C-19	C	2020	X		X		X		X
C-20	C	2020	X		X		X		X
C-23	C	2020	X		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
C-X1	C	2020	X		X		X		X
C-X2	C	2020	X		X		X		X
C-X3	C	2020	X		X		X		X
D-01	D	2020	X		X		X		X
D-02	D	2020	X		X		X		X
D-03	D	2020	X		X		X		X
E1-01	E1	2020	X		X		X		X
E1-03	E1	2020	X		X		X		X
E1-04	E1	2020	X		X		X		X
E1-07	E1	2020	X		X		X		X
E1-09	E1	2020	X		X		X		X
E2-04	E2	2020	X		X		X		X
E2-05	E2	2020	X		X		X		X
E2-07	E2	2020	X		X		X		X
E2-08	E2	2020	X		X		X		X
E2-12	E2	2020	X		X		X		X
E2-14	E2	2020	X		X		X		X
E2-15	E2	2020	X		X		X		X
E2-16	E2	2020	X		X		X		X
E2-19	E2	2020	X		X		X		X
E2-22	E2	2020	X		X		X		X
E2-23	E2	2020	X		X		X		X
E2-25	E2	2020	X		X		X		X
E2-27b	E2	2020	X		X		X		X
E3-01b	E3	2020	X		X		X		X
E3-08	E3	2020	X		X		X		X
F-01	F	2020	X		X		X		X
F-13	F	2020	X		X		X		X
F-21	F	2020	X		X		X		X
F-26	F	2020	X		X		X		X
F-27	F	2020	X		X		X		X
F-33	F	2020	X		X		X		X
F-34	F	2020	X*		X		X		X
F-35	F	2020	X		X		X		X
F-36	F	2020	X		X		X		X
F-38	F	2020	X		X		X		X
F-41	F	2020	X		X		X		X
F-43	F	2020	X		X		X		X
F-45	F	2020	X		X		X		X
F-46	F	2020	X		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
F-48	F	2020	X		X		X		X
F-49	F	2020	X		X		X		X
G-01	G	2020	X		X		X		X
G-02	G	2020	X		X		X		X
G-04	G	2020	X		X		X		X
G-06	G	2020	X		X		X		X
G-09	G	2020	X		X		X		X
G-10	G	2020	X		X		X		X
G-12	G	2020	X		X		X		X
G-14	G	2020	X		X		X		X

Notes:

X indicates the scheduled year for monitoring and maintenance; no boxes were installed in 2019.

* indicates boxes which could not be found in 2021, which were either missed during monitoring or destroyed during inclement weather. These boxes will be searched for again in 2023 to confirm their status.

Appendix B
Breeding Periods for Survey Timing

Species Group	Focal Species	Breeding Window Date Range[1, 2]	Late Incubation to Early Nestling Stages Date Range[2, 3]
Passerines	black-capped chickadee	Early March to early August	Mid-March to mid-July
	boreal chickadee	Mid-May to mid-July	Mid-May to mid-July
	brown creeper	Early April to late July	Early May to mid-June
	red-breasted nuthatch	Early April to late July	Mid-May to mid-June
	white-breasted nuthatch	Mid-April to early July	
	tree swallow	Mid-April to mid-September	Mid-May to mid-August
	violet-green swallow	Early April to late August	Early May to mid-July
	house wren	Mid-April to late August	Early May to mid-August
	mountain bluebird	Late March to early August	Mid-May to late July
Waterfowl	Barrow's goldeneye	Mid-March to late August	Early May to mid-July
	bufflehead	Mid-April to late August	Early June to mid-July
	common goldeneye	Early April to late August	Early May to mid-July
	common merganser	Early March to early September	Mid-April to late June
	hooded merganser	Late March to early October	Early May to early July
Raptors and Owls	barred owl	Mid-March to mid-August	Mid-April to late May
	boreal owl	Early April to mid-July	
	northern saw-whet owl	Early March to mid-August	Early April to mid-June
	northern pygmy owl	Mid-April to late August	Mid-May to mid-June
	northern hawk-owl	Mid-April to early August	
	American kestrel	Early April to late August	Early April to mid-July

Notes:
[1] the range of dates from egg-laying to fledging in BC for each focal species.
[2] information is based on Campbell et al. 1990a, 1990b, 1997.
[3] the range of dates when nests in BC are likely to be in the late incubation or early nestling stages.

Appendix C
2021 Monitoring and Maintenance Results

2022 Monitoring Date	Nest Box ID	Nest Box Type	Survey Methods	Current Use	Bird Species Using Box	Box Status	Maintenance Completed	Comments
June 1	A-002	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	Old nest
May 31	A-010	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	
May 31	A-011	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	
May 31	A-014	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 1	A-017	A	Visual inspection	No	None	Operational	Visually inspected	Rodent gnawing
June 1	A-020	A	Visual inspection	No	None	Deactivated	Visually inspected	Old nest
June 1	A-021	A	Visual inspection	No	None	Operational	Visually inspected	
May 31	A-025	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	
May 31	A2-35	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	Old nest
June 2	A2-36	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 2	A2-37	A	Visual inspection	No	None	Operational	Visually inspected	Stick nest inside
June 2	A2-45	A	Visual inspection	No	None	Operational	Visually inspected	
June 2	A2-51	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 2	A2-55	A	Visual inspection	No	None	Operational	Visually inspected; nest material added	
May 31	A2-59	A	Visual inspection	No	None	Operational	Visually inspected	
May 31	A2-74	A	Visual inspection	No	None	Operational	Visually inspected	
May 31	A2-75	A	Visual inspection	No	None	Operational	Visually inspected	
June 2	A2-76	A	Visual inspection	No	None	Operational	Visually inspected	Old nest
June 2	A2-79	A	Visual inspection	No	None	Operational	Visually inspected	Old nest
May 31	B1-01	B	Visual inspection	No	None	Operational	Visually inspected	Old nest
June 1	B1-02	B	Visual inspection	No	None	Operational	Visually inspected	
May 31	B1-03	B	Visual inspection	No	None	Operational	Visually inspected	
May 31	B1-06	B	Pole camera examination	No	None	Operational	Visually inspected	Old nest
June 1	B2-03	B	Visual inspection	No	None	Operational	Visually inspected; nest material added	Old nest
June 1	B2-06	B	Visual inspection	No	None	Operational	Visually inspected	Old nest
May 31	B3-02	B	Visual inspection	No	None	Operational	Visually inspected	Old nest
June 1	B3-03	B	Visual inspection	No	None	Operational	Visually inspected	Old nest

2022 Monitoring Date	Nest Box ID	Nest Box Type	Survey Methods	Current Use	Bird Species Using Box	Box Status	Maintenance Completed	Comments
June 1	B3-05	B	Visual inspection	No	None	Deactivated	Visually inspected	
June 2	B3-06	B	Visual inspection	No	None	Operational	Visually inspected	Flying squirrel inside
June 1	B3-07	B	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 2	B3-11	B	Visual inspection	No	None	Operational	Visually inspected	
June 1	B3-12	B	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 1	B3-13	B	Visual inspection	No	None	Deactivated	Visually inspected	Old nest
May 31	B3-14	B	Visual inspection	No	None	Operational	Visually inspected; nest material added	Old nest
June 2	B3-17	B	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 1	B3-20	B	Visual inspection	No	None	Operational	Visually inspected; nest material added	
May 31	BC-01	BC	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 1	BC-02	BC	Visual inspection	No	None	Operational	Visually inspected	
June 1	BC-03	BC	Visual inspection	No	None	Operational	Visually inspected	
June 1	BC-05	BC	Visual inspection	No	None	Operational	Visually inspected	
June 2	C-01	C	Visual inspection	No	None	Deactivated	Visually inspected	
June 1	C-03	C	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 1	C-08	C	Visual inspection	No	None	Deactivated	Visually inspected	
June 1	C-12	C	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 1	C-13	C	Visual inspection	No	None	Operational	Visually inspected; nest material added	
May 31	C-18	C	Visual inspection	No	None	Operational	Visually inspected	Old nest
May 31	C-20	C	Pole camera examination	No	None	Operational	Visually inspected; nest material added	
May 31	C-22	C	Visual inspection	No	None	Operational	Visually inspected; nest material added	Possible previous use
May 31	E1-02	E	Visual inspection	No	None	Not found	N/A	
May 31	E2-01	E	Visual inspection	No	None	Operational	Visually inspected	Old nest
May 31	E2-02	E	Pole camera examination	No	None	Operational	Visually inspected; nest material added	
June 1	E2-06	E	Visual inspection	No	None	Operational	Visually inspected	Old nest

2022 Monitoring Date	Nest Box ID	Nest Box Type	Survey Methods	Current Use	Bird Species Using Box	Box Status	Maintenance Completed	Comments
June 1	E2-10	E	Visual inspection	No	None	Operational	Visually inspected; nest material added	Old nest
May 31	E2-13	E	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 1	E2-17	E	Visual inspection	No	None	Operational	Visually inspected; removed wasp nest; nest material added	Wasp nest
June 1	E2-21	E	Visual inspection	No	None	Operational	Visually inspected; removed wasp nest; nest material added	Wasp nest
June 2	E2-28	E	Visual inspection	No	None	Operational	Visually inspected	Old nest
June 2	E3-01	E	Visual inspection	No	None	Operational	Visually inspected	
June 2	E3-02	E	Visual inspection	No	None	Operational	Visually inspected; nest material added	
June 2	E3-03	E	Visual inspection	No	None	Operational	Visually inspected	Old nest
June 2	E3-04	E	Visual inspection	No	None	Operational	Visually inspected; nest material added	Signs of rodent use
June 2	E3-05	E	Visual inspection	No	None	Operational	Visually inspected	Flying squirrel inside
June 2	E3-13	E	Visual inspection	No	None	Operational	Visually inspected; nest material added	Old kestrel nest
June 2	E3-16	E	Visual inspection	Yes	American Kestrel	In use	Visually inspected	Adult and 5 eggs
May 31	F-11	F	Visual inspection	No	None	Operational	Visually inspected; nest material added	Old nest, possibly kestrel
May 31	F-17	F	Pole camera examination	No	None	Operational	Visually inspected; nest material added	Old nest, down feathers
May 31	F-18	F	Visual inspection	No	None	Operational	Visually inspected; nest material added	
May 31	F-29	F	Visual inspection	Yes	Bufflehead	In use	Visually inspected	Adult and 9 eggs
June 1	F-31	F	Visual inspection	No	None	Deactivated	Visually inspected	
May 31	G-13	G	Visual inspection	No	None	Destroyed by tree	N/A	
May 31	G-15	G	Visual inspection	No	None	Operational	Visually inspected; repaired box bottom; nest material added	

Appendix D
Summary of Nest Box Use – All Years

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
A-001	A	2020			No			
A-002	A	2017	Yes	Unknown			Yes	Unknown
A-003	A	2020			No			
A-004	A	2019			No			
A-006	A	2019			No			
A-007	A	2019			No			
A-009	A	2020			No			
A-010	A	2017	No				No	
A-011	A	2017	No				No	
A-012	A	2020			No			
A-013	A	2019			No			
A-014	A	2017	No				No	
A-015	A	2019			No			
A-016	A	2019			No			
A-017	A	2017	No				No	
A-018	A	2020			No			
A-020	A	2017	Yes	Unknown			Yes	Unknown
A-021	A	2017	Yes	Unknown			No	
A-022	A	2019			No			
A-024	A	2019			No			
A-025	A	2017	No				No	
A-026	A	2019			No			
A2-27	A2	2019			Yes	House wren		
A2-28	A2	2019			No			
A2-29	A2	2019			No			
A2-30	A2	2019			No			
A2-31	A2	2020			No			
A2-32	A2	2019			Yes	House wren		
A2-33	A2	2019			No			

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
A2-35	A2	2017	No				Yes	Unknown
A2-36	A2	2017	Yes	Unknown			No	
A2-37	A2	2017	No				Yes	Unknown
A2-38	A2	2019			No			
A2-39	A2	2019			No			
A2-41	A2	2020			Yes	House wren		
A2-42	A2	2019			No			
A2-44	A2	2017	Yes	Unknown				
A2-45	A2	2017	No				No	
A2-46	A2	2019			Yes	House wren		
A2-47	A2	2019			N/A			
A2-48	A2	2020			Yes	House wren		
A2-49	A2	2020			Yes	House wren		
A2-50	A2	2020			Yes	House wren		
A2-51	A2	2017	No				No	
A2-52	A2	2020			Yes	House wren		
A2-55	A2	2017	No				No	
A2-56	A2	2019			No			
A2-58	A2	2017	No					
A2-59	A2	2017	No				No	
A2-61	A2	2020			Yes	House wren		
A2-62	A2	2017	No					
A2-66	A2	2017	Gone					
A2-67	A2	2019			No			
A2-68	A2	2019			No			
A2-69	A2	2019			No			
A2-70	A2	2020			No			
A2-71	A2	2020			Yes			
A2-72	A2	2017	Gone					

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
A2-74	A2	2017	No				No	
A2-75	A2	2017	No				No	
A2-76	A2	2017	No				Yes	Unknown
A2-79	A2	2017	No				Yes	Unknown
A2-80	A2	2019			N/A			
A2-81	A2	2020			Yes	House wren		
B1-00	B1	2020			No			
B1-01	B1	2017	Gone				Yes	Unknown
B1-02	B1	2017	Yes	Unknown			No	
B1-03	B1	2017	No				No	
B1-04	B1	2019			No			
B1-05	B1	2019			No			
B1-06	B1	2017	No				Yes	Unknown
B2-01	B2	2019			No			
B2-02	B2	2019			No			
B2-03	B2	2017	No				Yes	Unknown
B2-04	B2	2019			No			
B2-05	B2	2019			No			
B2-06	B2	2017	Yes	Unknown			Yes	Unknown
B3-01	B3	2019			Yes	Unknown		
B3-02	B3	2017	Yes	Unknown			Yes	Unknown
B3-03	B3	2017	Yes	Unknown			Yes	Unknown
B3-04	B3	2019			No			
B3-05	B3	2017					Deactivated	
B3-06	B3	2017	No				No	
B3-07	B3	2017	No				No	
B3-07	B3	2019			No			
B3-08	B3	2019			No			
B3-09	B3	2020			Yes	Unknown		

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
B3-10	B3	2017	Yes	Unknown				
B3-11	B3	2017	No				No	
B3-12	B3	2017	No				No	
B3-13	B3	2017	Yes	Unknown			Deactivated	
B3-14	B3	2017	No				Yes	Unknown
B3-15	B3	2019			No			
B3-16	B3	2017	Gone					
B3-17	B3	2017	No				No	
B3-18	B3	2019			No			
B3-19	B3	2020			Yes	Unknown		
B3-20	B3	2017	No				No	
BC-01	BC	2017	No				No	
BC-01s	BC	2020			No			
BC-02	BC	2017					No	
BC-03	BC	2017					No	
BC-03b	BC	2020			No			
BC-04b	BC	2020			No			
BC-05	BC	2017					No	
BC-2	BC	2017	No					
BC-3	BC	2017	No					
BC-5	BC	2017	No					
BC-NN	BC	2020			No			
C-01	C	2017	No				Deactivated	
C-02	C	2017	No					
C-03	C	2017	No				No	
C-04	C	2020			No			
C-05	C	2020			No			
C-06	C	2020			No			
C-08	C	2017	No				Deactivated	

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
C-09	C	2020			No			
C-10	C	2020			Yes	House wren		
C-11	C	2020			No			
C-12	C	2017	No				No	
C-13	C	2017	No				No	
C-14	C	2020			Yes	Unknown		
C-15	C	2017	Gone					
C-16	C	2020			No			
C-17	C	2020			No			
C-18	C	2017	No				Yes	Unknown
C-19	C	2020			No			
C-20	C	2017					No	
	C	2020			No			
C-21	C	2019			No			
C-22	C	2017	No				Yes	Unknown
C-23	C	2020			No			
C-X1	C	2020			No			
C-X2	C	2020			No			
C-X3	C	2020	Repaired					
D-01	D	2020			Yes	Unknown		
D-02	D	2020			Yes	Unknown		
D-03	D	2020			Yes	American kestrel		
E1-01	E1	2020			No			
E1-02	E1	2017	No				Not found	
E1-03	E1	2020			No			
E1-04	E1	2020			No			
E1-05	E1	2017	No					
E1-07	E1	2020			Yes	Unknown		
E1-09	E1	2020			Yes	American kestrel		

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
E2-01	E2	2017	No				Yes	Unknown
E2-02	E2	2017	No				No	
E2-03	E2	2017	No					
E2-04	E2	2020			No			
E2-05	E2	2017	Yes	House wren				
	E2	2020			Yes	Unknown		
E2-06	E2	2017					Yes	Unknown
E2-07	E2	2020			No			
E2-08	E2	2020			Yes	Unknown		
E2-10	E2	2017	No				Yes	Unknown
E2-11	E2	2019			No			
E2-12	E2	2020			No			
E2-13	E2	2017	No				No	
E2-14	E2	2020			No			
E2-15	E2	2020			No			
E2-16	E2	2020			Yes	Unknown		
E2-17	E2	2017	No				No	
E2-18	E2	2019			No			
E2-19	E2	2020			No			
E2-20	E2	2017	Yes	Unknown				
E2-21	E2	2017	No				No	
E2-22	E2	2020			Yes	Unknown		
E2-23	E2	2020			Yes	Unknown		
E2-25	E2	2020			Yes	Unknown		
E2-26	E2	2019			No			
E2-27	E2	2017	Gone					
E2-27b	E2	2020			Yes	Unknown		
E2-28	E2	2017	Yes	Unknown			Yes	Unknown
E3-01	E3	2017	No				No	

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
E3-01b	E3	2020			No			
E3-02	E3	2017	No				No	
E3-03	E3	2017	Yes	Unknown			Yes	Unknown
E3-04	E3	2017	No				No	
E3-05	E3	2017	No				No	
E3-07	E3	2017	Gone					
E3-08	E3	2020			Deactivated			
E3-09	E3	2017	Gone					
E3-11	E3	2017	Yes	Unknown				
E3-12	E3	2017	Gone					
E3-13	E3	2017	Yes	American kestrel			Yes	Unknown
E3-14	E3	2017	Yes	American kestrel				
E3-15	E3	2017	No					
E3-16	E3	2017	Yes	Unknown			Yes	American kestrel
F-01	F	2020			Yes	Unknown		
F-02	F	2019			Yes	Unknown		
F-03	F	2017	Salvaged					
F-04	F	2019			No			
F-05	F	2019			Not found			
F-06	F	2019			No			
F-07	F	2017	Deactivated					
F-08	F	2017	Deactivated					
F-10	F	2019			Yes	Unknown		
F-11	F	2017	Yes	Unknown			Yes	American kestrel
F-13	F	2020			Yes	Unknown		
F-14	F	2020			No			
F-15	F	2019			No			
F-16	F	2019			No			
F-17	F	2017	No				Yes	Unknown

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
F-18	F	2017	No				No	
F-19	F	2019			No			
F-21	F	2020			Yes	Unknown		
F-22	F	2019			No			
F-23	F	2019			No			
F-24	F	2019			Yes	Unknown		
F-25	F	2019			No			
F-26	F	2020			Yes	Unknown duck		
F-27	F	2020			No			
F-28	F	2019			No			
F-29	F	2017	No				Yes	Bufflehead
F-30	F	2019			No			
F-31	F	2017	Yes	Unknown			Deactivated	
F-32	F	2017	Deactivated					
F-33	F	2020			No			
F-35	F	2020			No			
F-36	F	2020			No			
F-37	F	2019			No			
F-38	F	2020			No			
F-39	F	2019			Yes	Unknown		
F-40	F	2019			Yes	Unknown		
F-41	F	2020			Yes	Unknown		
F-42	F	2017	Gone					
F-43	F	2020			Yes	Unknown		
F-45	F	2020			No			
F-46	F	2020			Yes	Unknown		
F-47	F	2019			No			
F-48	F	2020			Yes	House wren		
F-49	F	2020			Yes	Goldeneye		

Nest Box ID	Nest Box Type	Year installed	2020		2021		2022	
			Used?*	Species	Used?	Species	Used?	Species
G-01	G	2020			No			
G-02	G	2020			No			
G-04	G	2020			Yes	Duck species		
G-05	G	2019			Yes	Unknown		
G-06	G	2020			Yes	Unknown		
G-07	G	2017	Deactivated					
G-08	G	2017	Salvaged					
G-09	G	2020			Yes	Unknown		
G-10	G	2020			Yes	Unknown		
G-12	G	2020			Yes	Unknown		
G-13	G	2017	No				Destroyed	
G-14	G	2020			Yes	Unknown		
G-15	G	2017	No				No	
OWL-2	H	2020			No			
OWL-3	H	2020			Yes	Passerine species		

*"used" = box shows signs of being used by birds, such as the presence of feathers, feces, nest material, eggshells, eggs or live birds.

Appendix 11. Bald Eagle Nest Surveys 2022 Annual Report

Ausenco Engineering Canada Inc.
18th Floor, 4515 Central Boulevard
Burnaby, BC, Canada V5H 0C6
T: +1 604.669.0424
F: +1.604.669.0430
www.ausenco.com

Memorandum

Attention	Brock Simons, Terrestrial Biodiversity Specialist, Site C Clean Energy Project
From:	Jason Brogan, M.Sc., R.P.Bio., Ausenco Sustainability Inc.
Subject:	Bald Eagle Nest Surveys – Summary 2022
Date	November 21, 2022
Document Ref:	989619-05

1 Introduction

This memo summarizes the findings of bald eagle (*Haliaeetus leucocephalus*) nest surveys conducted in May and June 2022. The purpose of the surveys was to document the status of known and newly constructed bald eagle nests along the Peace River, at wetlands near the Site C transmission line, and at artificial (mitigation) nesting structures. The 2022 work is a continuation of the surveys that were completed in 2016 through 2021 (Hemmera 2016, 2018a, 2018b, 2019, 2021, 2022) and during baseline studies for the Site C Clean Energy Project (Keystone 2009).

Bald eagle nest surveys were conducted with two objectives:

1. Determine the status (active/not active) and productivity of known and newly constructed bald eagle nests in the study area (Peace River Valley from Hudson's Hope to the Alberta Border, as well as at natural wetlands adjacent to the Site C transmission line right-of-way); and
2. Provide the data to BC Hydro to inform Site C construction mitigation.

Data collected during this survey provide information on the spatial distribution, timing, and productivity of bald eagle nests in the study area.

2 Methods

Surveys of bald eagle nests were conducted by helicopter on May 12 and 27, and June 10, 2022, with a two-person crew consisting of a crew lead and a technician, following methods outlined by the Resources Inventory Committee (RIC 2001). The study area is composed of the Peace River Valley from Hudson's Hope to the Alberta Border, as well as natural wetlands adjacent to the Site C transmission line right-of-way.

Previously identified nest locations from past aerial surveys (Hemmera 2022) were visited. In addition to known nests, a search was conducted simultaneously for new nests, which were then added to the database with unique identification designations starting with 22- for the 2022 surveys. Bald eagle nests reported by other crews working for BC Hydro were also visited. Nests that were known to be destroyed since 2021 (e.g., nest disintegrated, host tree failed naturally, or host tree was felled) were not visited in 2022, but searches were conducted in those areas for newly constructed nests.

The observations recorded at each known or new bald eagle nest (or stick nests constructed by other species) were the nest status (“active”, “inactive”, “not detected”, “tree gone”, “unknown”), the species associated with each nest, and the number of nestlings.

Status was determined by the presence of attending adults or evidence of nestlings. Productivity was estimated by counting the number of nestlings in each nest with the assumption that most nestlings reach fledging (Buehler 2021). Annual productivity was calculated as the sum of estimated productivity from active nests divided by the number of active nests. The following assumptions were used to determine nest status and productivity:

Active nests included those with evidence of adults attending the nest during any one of the field surveys;

- The number of chicks fledged is
  - o The number of chicks in a nest at the last observation reflects the number fledged, except nests with three chicks which were only assumed to fledge two chicks (Gerrard and Bortolotti 1988, as cited in Buehler 2021); or
  - o The number of chicks in a nest that was inactive on subsequent visit(s) based on observer’s comments, considering age of chick and date observed.
- No second clutches.

Nestlings grow quickly in the first days and weeks after hatching, resulting in large size differences between each sibling (Bortolotti 1986a). A third hatched chick is at a great disadvantage and will likely starve due to being out-competed by its larger siblings (Gerrard and Bortolotti 1988, as cited in Buehler 2021). In two-chick broods, both chicks generally survive (e.g., only two chicks from 37 two-chick broods in Saskatchewan died [(Bortolotti 1986b)]). Therefore, when calculating nest productivity, if two or three chicks were observed in a nest during the final survey round, it was assumed that two chicks survived and fledged.

Second clutches are not observed in natural bald eagle populations (Buehler 2021), likely due to the long duration of breeding, as speculated by Newton (2010). Exceptions are known when eggs or nestlings are artificially removed as part of captive breeding programs (Morrison and Walton 1980; Wood and Collopy 1993), or eggs are lost early in the season (Steenhof and Newton 2007). No second clutches have been observed in the study area to date.

As this is an interim report, only simple summary statistics (i.e., nests active, estimated fledged chicks per active nest) were calculated. Survey results were provided to BC Hydro in Excel (.csv) and spatial (.kml) format, including applicable comments and coordinates for each nest.

3 Survey Results

There were 37 potential nests in trees and 29 artificial nesting platforms monitored in 2022 (**Appendix A**). Of the 37 potential tree nests, 19 were active and 18 were inactive (**Table 1**). Of the available surveyed nests, 51% were active (or occupied). There was a total of 22 assumed fledged chicks observed, with chick numbers ranging from one to two chicks per nest. The estimated fledge success in 2022 was 1.16 fledged chicks per active nest.

One nest (2211) was observed active in late May 2022 but could not be observed to confirm status in the June survey due to high winds and proximity to power lines (**Appendix B**). The chicks found in this nest in May were of an advanced age (large with black feathers). Given that all the chicks observed at other nests in late May were observed again in June, and thus fledged, the two chicks in nest 2211 were also deemed fledged. Canada geese (*Branta canadensis*) were found in two nests, nests 1110 and 2212. No bald eagle nesting activity was observed at the 29 artificial nesting platforms.

Bald eagle nest monitoring has been conducted since 2016, with adequate data collected since 2017 to estimate productivity (**Table 1**). The average number of active nests from 2017 to 2022 was 26.7 ± 5.0 standard deviation (SD). The average annual total chicks from 2017 to 2022 was 35.8 ± 8.4 SD. The average number of young fledged per active nest from 2017 to 2022 was 1.35 ± 0.26 SD (**Table 1**).

Table 1 Bald Eagle Nest Status and Productivity 2016 - 2022

Nest Status	2016	2017	2018	2019	2020*	2021	2022
Tree Nests							
Active	NEI	34	28	29	25	25	19
Inactive	8	7	15	19	16	17	18
Percent Active	-	**83**	**65**	**60**	**61**	**60**	**51**
Not Detected/Tree Gone	-	18	4	6	11	15	0
Unknown	52	-	1	0	0	0	0
Total Nests Surveyed	**60**	**59**	**48**	**54**	**52**	**57**	**37**
Estimated productivity (total chicks)	**NEI**	**39**	**34**	**42**	**46**	**32**	**22**
Estimated young fledged per active nest (fledging success rate)	**NEI**	**1.15**	**1.21**	**1.45**	**1.84**	**1.28**	**1.16**
Artificial Nesting Structures							
Active	-	-	-	0	0	0	0
Inactive	-	-	-	3	3	29	29
Total Structures Surveyed	-	-	-	**3**	**3**	**29**	**29**
Estimated productivity (total chicks)	-	-	-	**0**	**0**	**0**	**0**
Estimated young fledged per active nest (fledging success rate)	-	-	-	**0**	**0**	**0**	**0**

Note: NEI = not enough information
"-" indicates no data
* Estimates of productivity (fledged per active nest) in 2020 were based on only two surveys rather than three and some early active nests may have been missed. Therefore, active nests may be underestimated and, consequently, young fledged per active nest may be overestimated

4 Discussion

This is the sixth year of collecting sufficient data to calculate annual productivity of the bald eagles residing in the study area (2017 to 2022). Data collected in 2022 represent the lowest numbers of chicks and young fledged per active nest estimated over the course of the program. The greatest number of chicks observed was 46 in 2020, which has declined by over half to 22 in 2022. 2020 was also the year with the greatest fledge success of 1.84 chicks per active nest compared to 1.16 fledged chicks per active nest in 2022. The number of active nests was greatest in 2017 with 34 active nests observed, but in 2022 only 19 active nests were observed.

Productivity of raptors is influenced by many factors, including environmental conditions, disease and available nesting habitat. Spring is the time when bald eagles are laying eggs or raising young and is also the time when the species is most vulnerable to environmental factors. The 2022 spring in British Columbia was colder and wetter than experienced in recent history (Gordon 2022; Dornain 2022). Low spring temperatures and wet springs have been correlated with reduced chick production, active nests and fledge success (Bangerter et al. 2021; Gende et al. 1997). In 2022 there was also a spike in bald eagle deaths across the province with evidence that avian flu may be the culprit (Hwa Song 2022; Smalley 2022). Project construction may also be influencing bald eagle productivity, as progressive reservoir clearing prior to inundation has reduced the availability of suitable nesting habitat.

In 2022, bald eagle nest productivity was low with 1.16 fledged chicks per active nest, but comparable to other nearby bald eagle populations. Studies conducted in 1995 and 1997 at the Williston Reservoir, approximately 188 km upstream of the Site C dam, averaged 0.78 fledged chicks per active nest, which is lower than observed in our study (Merkens et al. 1997; Booth et al. 1999). On Kodiak Island, Alaska, bald eagle fledging success was 0.81 in 2002 (Zwiefelhofer 2007).

This year is one of the final years before reservoir filling, which is planned to occur as soon as fall 2023, and large areas of forest have been cleared, altering nesting habitat. Once the reservoir is filled, landscape changes such as a reduction in the distance from water to nesting habitat will occur, and bald eagle productivity and artificial nest use will be re-evaluated.

Surveys using the methods described here will continue annually through the construction phase of the Project and through the first 10 years of operations, as per the commitments in the Site C Bald Eagle Mitigation and Monitoring Program (BC Hydro 2015).

5 Closure

This Work was performed in accordance with BCO95055 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and BC Hydro (Client), dated 21 June 2016 (Contract). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this Work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this report are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

6 References

Bangerter, A.B., E.R. Heiser, J.D. Carlisle, and R.A. Miller. 2021. Local Weather Explains Annual Variation in Northern Goshawk Reproduction in the Northern Great Basin, USA. The Journal of Raptor Research 55(4):471–484.

Booth, B., M. Merkens, and M.D. Wood. 1999. Productivity of Ospreys and Bald Eagles in the Williston and Dinaosaur Reservoirs, North-central British Coumbia, 1995. Peace-Williston Fish & Wildlife Compensation Program Report No. 125. Available at https://www.env.gov.bc.ca/wildlife/wsi/reports/4848_WSI_4848_RPT_1995_REPORT_NO_125.PDF.

Bortolotti, G.R. 1986a. Evolution of Growth Rates in Eagles: Sibling Competition vs. Energy Considerations. Ecology 67(1):182–194.

Bortolotti, G.R. 1986b. Influence of Sibling Competition on Nestling Sex Ratios of Sexually Dimorphic Birds. Journal of Plant Ecology 127(4):495–507.

Buehler, D.A. 2021. Bald Eagle (Haliaeetus leucocephalus). In P.G. Rodewald, Editor. Birds of the World. Cornell Laboratory of Ornithology, Ithaca, NY, USA. Available at https://doi.org/10.2173/bow.baleag.01.

Dornain, K. 2022. Peace Region Farmers Frustrated by Rising Input Costs, Difficult Planting Season. CJDC-TV News. Available at https://www.cjdctv.com/peace-region-farmers-frustrated-by-rising-input-costs-difficult-planting-season-1.5919755.

Gende, S.M., M.F. Wilson, and M. Jacobsen. 1997. Reproductive Success of Bald Eagles (Haliaeetus leucocephalus) and its Association with Habitat or Landscape Features and Weather in Southeast Alaska. Canadian Journal of Zoology 75(10):1595–1604.

Gordon, K. 2022. Why has B.C.'s Spring Been so Cold and Wet? Global News. Available at https://globalnews.ca/news/8849192/why-has-bc-spring-cold-wet/.

Hemmera Envirochem Inc. (Hemmera). 2016. Bald Eagle Nest Surveys: Memorandum to Anre McIntosh BC Hydro. 20 December 2016.

Hemmera Envirochem Inc. (Hemmera). 2018a. Bald Eagle Nest Surveys - Summary for 2017.

Hemmera Envirochem Inc. (Hemmera). 2018b. Bald Eagle Nest Surveys - Summary for 2018: Site C Wildlife Monitoring BCO 95055. Memorandum to Brock Simons BC Hydro. 7 December 2018.

Hemmera Envirochem Inc. (Hemmera). 2019. Bald Eagle Surveys - Summary 2019: Site C Wildlife Monitoring BCO 95055. Memorandum to Brock Simons BC Hydro. 15 October 2019.

Hemmera Envirochem Inc. (Hemmera). 2021. Bald Eagle Nest Surveys - Summary 2020: Site C Wildlife Monitoring BCO 95055. Memorandum to Brock Simons BC Hydro. 16 March 2021.

Hemmera Envirochem Inc. (Hemmera). 2022. Bald Eagle Nest Surveys - Summary 2021: Site C Wildlife Monitroing BCO 95055. Memorandum to Brock Simons BC Hydro. 9 March 2022.

Jung, Christina (Hwa Song). 2022. Province Investigating Spike in Bald Eagle Deaths in B.C. CBC News. Available at https://www.cbc.ca/news/canada/british-columbia/bald-eagle-avian-flu-1.6509806.

Keystone Wildlife Research Ltd. (Keystone). 2009. Peace River Site C Hydro Project Stage 2 Baseline Vegetation and Wildlife Report. Prepared for BC Hydro Site C Project, Surrey, BC.

Merkens, M., B. Booth, and W.D. Wood. 1997. Osprey and Bald Eagle Productivity And Habitat Use in the Williston Reservoir Watershed, North-Central BC, 1997. Peace-Williston Fish & Wildlife Compensation Program Report No. 202. Available at http://a100.gov.bc.ca/pub/siwe/details.do?id=4848.

Morrison, M.L., and B.J. Walton. 1980. The Laying of Replacement Clutches by Falconiformes and Strigiformes in North America. Raptor Research and Management Techniques 14(7):85.

Newton, I. 2010. Population Ecology of Raptors. T & AD Poyser, London, UK.

Resources Inventory Committee (RIC). 2001. Inventory Methods for Raptors. Standards for Components of British Columbia's Biodiversity No. 11. Version 2.0. Prepared for the Terrestrial Ecosystems Task Force Resources Inventory Committee. Ministry of Sustainable Resource Management, Environment Inventory Branch, Victoria, BC. Available at https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/rapt_ml_v2.pdf.

Smalley, M. 2022. Avian Flu Confirmed in Bald Eagle Found Near 100 Mile House: Wild Birds across B.C. Testing Positive for H5N1 Virus. Vancouver Island Free Daily. Available at https://www.vancouverislandfreedaily.com/news/avian-flu-confirmed-in-bald-eagle-found-near-100-mile-house/.

Steenhof, K., and I. Newton. 2007. Assessing nesting success and productivity. Raptor Research and Management Techniques:181–192.

Wood, P.B., and M.W. Collopy. 1993. Effects of Egg Removal on Bald Eagle Productivity in Northern Florida. Journal of Wildlife Management 57(1):1.

Zwiefelhofer, D. 2007. Comparison of Bald Eagle (Haliaeetus leucocephalus) Nesting and Productivity at Kodiak National Wildlife Refuge, Alaska, 1963–2002. The Journal of Raptor Research 41(1):1–9.

Appendix A
Nest Survey Results 2022

Nest_ID	Latitude	Longitude	First Detected	2022 Activity	Nest Substrate
22	56.13563	-120.640732	pre-2014	Inactive	Tree
29	56.107913	-120.099152	pre-2014	Active	Tree
38	56.105158	-120.441541	pre-2014	Active	Tree
100	56.157959	-120.751805	pre-2014	Active	Tree
104	56.194969	-120.800772	pre-2014	Inactive	Tree
146	56.005196	-121.959974	pre-2014	Active	Tree
203	55.997013	-121.721242	pre-2014	Inactive	Tree
222	56.093503	-120.349667	pre-2014	Active	Tree
225	56.003474	-121.677346	pre-2014	Inactive	Tree
607	56.118299	-120.54547	2017	Inactive	Tree
608	56.147848	-120.708719	2017	Inactive	Tree
610	56.057325	-121.115654	2017	Active	Tree
611	56.002778	-121.679799	2017	Inactive	Tree
802	56.195208	-120.847432	2019	Active	Tree
803	56.112141	-120.529482	2019	Inactive	Tree
804	56.138087	-120.019688	2019	Active	Tree
805	56.064382	-121.095033	2019	Inactive	Tree
806	56.136127	-120.642822	2019	Inactive	Tree
1001	56.190211	-120.890286	2021	Active	Tree
1100	55.99477	-121.65667	2021	Inactive	Tree
1102	56.10305	-120.25499	2021	Inactive	Tree
1103	56.19153	-121.51116	2021	Inactive	Tree
1105	56.24904	-121.14629	2021	Inactive	Tree
1106	56.00555	-121.67447	2021	Active	Tree
1110	56.22109	-121.059517	2021	Active	Tree
2201	56.011502	-121.923083	2022	Active	Tree
2202	56.028036	-121.899608	2022	Inactive	Tree
2203	56.119679	-121.666751	2022	Active	Tree
2204	56.132945	-121.620312	2022	Active	Tree
2205	56.165529	-121.565091	2022	Inactive	Tree
2206	56.177167	-121.522078	2022	Active	Tree
2207	56.225671	-121.3979	2022	Active	Tree
2208	56.140699	-120.7123	2022	Active	Tree
2209	56.113856	-120.48277	2022	Inactive	Tree
2210	56.098417	-120.184053	2022	Active	Tree
2211	55.97833	-121.99086	2022	Active	Tree
2212	56.221567	-121.069282	2022	Inactive	Tree

Nest_ID	Latitude	Longitude	First Detected	2022 Activity	Nest Substrate
Eagle_134_West	56.24284171	-121.325927	2021	Inactive	Platform
Eagle_14.1	56.22482582	-120.9380538	2021	Inactive	Platform
Eagle_142	56.24337297	-121.3944903	2021	Inactive	Platform
Eagle_144	56.2352197	-121.4039796	2021	Inactive	Platform
Eagle_147	56.23080701	-121.4137136	2021	Inactive	Platform
Eagle_151	56.23170841	-121.4351008	2021	Inactive	Platform
Eagle_153	56.22785045	-121.4505666	2021	Inactive	Platform
Eagle_153_East	56.22949139	-121.4424183	2021	Inactive	Platform
Eagle_167	56.2504824	-121.5058218	2021	Inactive	Platform
Eagle_182C	56.18959271	-121.5161017	2021	Inactive	Platform
Eagle_216B	56.18719662	-121.5246218	2021	Inactive	Platform
Eagle_217	56.18436136	-121.5340437	2021	Inactive	Platform
Eagle_246	56.11959613	-121.700627	2021	Inactive	Platform
Eagle_247 east	56.11782301	-121.7097745	2021	Inactive	Platform
Eagle_249_East	56.1180545	-121.7208007	2021	Inactive	Platform
Eagle_254_West	56.12483942	-121.7551792	2021	Inactive	Platform
Eagle_257N	56.12191123	-121.7687378	2021	Inactive	Platform
Eagle_258_East	56.12062749	-121.7769985	2021	Inactive	Platform
Eagle_326	56.0707243	-121.8540666	2021	Inactive	Platform
Eagle_41.1A	56.21323424	-121.0643504	2021	Inactive	Platform
Eagle_41.1B	56.2141132	-121.075756	2021	Inactive	Platform
Eagle_48	56.23015272	-121.0930696	2021	Inactive	Platform
Eagle_49.1B	56.21772486	-121.1053797	2021	Inactive	Platform
Eagle_49.2B	56.21559669	-121.0943731	2021	Inactive	Platform
Eagle_75	56.2545448	-121.1846652	2021	Inactive	Platform
Eagle_75.1	56.25008933	-121.1768376	2021	Inactive	Platform
p32	56.240476	-121.129658	2018	Inactive	Platform
p39	56.234984	-120.955227	2018	Inactive	Platform
p47	56.232966	-121.100321	2018	Inactive	Platform

Appendix B

Active Bald Eagle Nests
and Assumed Productivity 2022

Nest ID	12 May 2022 Comments	27 May 2022 Comments	10 June 2022 Comments	Total Chicks Fledged
29	Incubating	Adult perched along river but nest empty	2 adults, possibly an egg	0
38	2 chicks + adult	Adult and 1 grey-feathered chick	adult and chick	1
100	at least 1 chick + adult	Adult and 1 grey-feathered chick	adult and large black feathered chick	1
146	Adult on nest	2 grey-feathered chicks with adult perched nearby	1 black-feathered and 1 grey-feathered chick	2
222	2 chicks	2 dark-feathered chicks	1 adult, 2 big dark brown chicks	2
610	2 chicks + adult	Empty. These chicks were quite mature on previous survey (large and black-feathered) but no eagles present on this survey.	Empty nest but good condition	2
802	Adult on nest	Adult and 1 chick	1 grey feathered chick and adult nearby	1
804	at least 1 chick + adult	2 chicks and adult in nest. Additional adult perched nearby along river.	2 chicks	2
1001	2 chicks + adult	Adult and 2 chicks	2 black feathered chicks	2
1106	Adult on nest	Adult with 1 grey-feathered chick. Lots of fish in the nest. Another adult perched nearby.	Adult and 2 grey-feathered chicks	2
2211	Not surveyed/detected	First time detected - usually don’t survey west of Peace Canyon Bridge. 2 large black-feathered chicks present.	Did not approach as it was windy and powerlines nearby - safety concern.	2
2201	Adult on nest. Another adult perched nearby	1 grey-feathered chick with adult perched in nest tree	Adult and 1 greyish black chick	1
2202	Did not see birds on nest though it seemed new and adult was perched across river	Adult perched on nest rim but no eggs or chicks	Empty	0
2203	Adult on nest	No BAEA seen in area	Inactive	0
2204	Adult on nest	1 grey-feathered chick with adult perched in nest tree	Adult and 1 grey-feathered chick	1
2206	2 chicks + adult nearby	Inactive	Inactive	0
2207	at least 1 chick adult feeding	1 grey-feathered chick with adult perched in nest tree. This nest is adjacent to side channel along low part of river - not up on bench.	Adult and 1 grey feathered chick	1
2208	at least 1 chick + adult	Adult and 1 chick. 2nd adult flew in.	adult and 1 black feathered chick	1
2210	2 chicks + adult (other adult flying across R)	1 grey-feathered chick. No adults present. Smaller nest above in same tree.	1 chick molting, adult nearby	1
			Total Chicks	**22**

Appendix 12. Ground Nesting Raptor Monitoring 2022 Annual Report

Site C Clean Energy Project
Ground-Nesting Raptor Monitoring
2022 Annual Report

PRESENTED TO

BC Hydro and Power Authority

DECEMBER 22, 2022
ISSUED FOR USE
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Saulteau EBA Environmental Services Joint Venture.
Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

Site C Clean Energy Project Ground-Nesting Raptor Monitoring 2022 Annual Report

FILE: 704-ENW.PENW03042-02.GNRM22
December 22, 2022

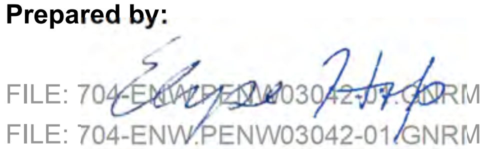
PRESENTED TO

Site C Clean Energy Project
BC Hydro and Power Authority
P.O. Box 49260
Vancouver, BC V7X 1V5

PRESENTED BY

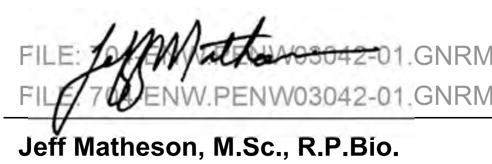
Saulteau EBA Environmental Services Joint Venture
1000-885 Dunsmuir Street
Vancouver, BC V6E 3X2
P 604.685.0275

Prepared by:



Elyse Hofs, B.Sc., B.I.T.
Junior Environmental Scientist

Reviewed by:



Jeff Matheson, M.Sc., R.P.Bio.
Senior Biologist

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EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors (i.e., Short-eared Owl [*Asio flammeus*] and Northern Harrier [*Circus hudsonius*]) in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2022. The surveys were part of BC Hydro's Ground-Nesting Raptor Follow-up Monitoring Program. This report describes the methods used to conduct the surveys and provides a summary of the results.

The 2022 ground-nesting raptor surveys were conducted using two methods: (1) Field surveys were conducted along transects and at standwatch stations to detect Northern Harrier and Short-eared Owl, and (2) Autonomous Recording Units (ARUs) were established at select standwatch stations with the purpose of detecting Short-eared Owl through human-listening.

The ground-nesting raptor field surveys were completed within three cleared portions of the Site C construction headpond: Cache Creek, Bear Flats, and along the Peace River between the Halfway River and Moberly River. The surveys were conducted either through transects or through stationary standwatches. Ground-nesting raptor surveys were completed at each transect and standwatch station up to six times over May and June 2022 (three daytime visits and three evening surveys at select sites). The cleared portions near Bear Flats and Cache Creek were accessed on foot and the areas along the Peace River were accessed by boat.

ARUs were deployed at seven stations throughout the survey area that were assessed as having the highest habitat potential for Short-eared Owl. These seven stations were located along transects or at standwatch stations in the Bear Flats and Peace River survey areas at locations that had experienced between two to four growing seasons since clearing. The ARUs were retrieved after a month of recording and three audio recordings taken near sunset were randomly selected from separate nights at each station and analyzed and interpreted for Short-eared Owl through human listening.

No Short-eared Owls were detected during the field surveys or through human listening of the ARU recordings. Northern Harriers were observed ten times throughout the May and June surveys. The majority of the Northern Harrier activity was observed within the Bear Flats/Cache Creek survey areas. No behaviours suggestive of Northern Harrier nesting were observed. Surveys in 2023 will continue in cleared areas within the construction headpond.

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1.0 INTRODUCTION

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2022. The surveys were part of BC Hydro's Ground-Nesting Raptor Follow-up Monitoring Program (BC Hydro 2016). Ground-nesting raptor surveys have occurred annually since 2016. This report describes the methods used to conduct the surveys and provides a summary of the results from 2022.

The Ground-Nesting Raptor Follow-up Monitoring Program is specifically focused on two ground-nesting raptor species: Short-eared Owl (*Asio flammeus)* and Northern Harrier (*Circus hudsonius)* (Table 1).

Table 1: Species Covered in the Ground-Nesting Raptor Follow-up Monitoring Program

Common Name	Scientific Name	BC List	COSEWIC [1] Status	SARA [2] Status
Short-eared Owl	*Asio flammeus*	Blue	Threatened	Schedule 1 – Special Concern
Northern Harrier	*Circus hudsonius*	Yellow	-	-

[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada.
[2] SARA – *Species at Risk Act*.

The objectives of the ground-nesting raptor monitoring program are to determine the following:

- The number of Northern Harrier and Short-eared Owl nesting in areas cleared within the construction headpond prior to reservoir filling;
- The effects of seasonal construction headpond flooding on Northern Harrier and Short-eared Owl nests; and
- The use of open fields within mitigation properties by Northern Harrier and Short-eared Owl as nesting habitat.

2.0 EXISTING DATA

Baseline surveys for Northern Harrier were conducted in 2010 (Hilton *et al.* 2013). One Northern Harrier was observed within the proposed reservoir footprint and 15 were observed outside the Peace River valley. An additional 50 Northern Harrier were recorded incidentally between 2006 and 2016 (Hilton et al., 2016). The majority of these observations were associated with agricultural fields and upland habitats removed from the Peace River. No nests of Northern Harrier were identified during the baseline studies. For the ground-nesting raptor follow-up monitoring conducted annually since 2016, Northern Harrier have been observed hunting within and adjacent to the proposed reservoir and one nest was found within the proposed reservoir footprint though not within an area cleared for reservoir preparation.

Baseline surveys for Short-eared Owl were conducted in 2006, 2010, and 2012 (Hilton et al., 2016). Short-eared Owls were not detected during targeted surveys in 2006, although one was observed incidentally during another survey. Twelve Short-eared Owls were detected during surveys in 2010, with one detection indicating evidence of breeding (begging calls). No Short-eared Owls were observed in 2012. One of the 12 Short-eared Owl observations during the three years of baseline surveys was within the Peace River valley; all other observations were outside the valley in neighbouring plateau areas. For the ground-nesting raptor follow-up monitoring conducted annually since 2016, no Short-eared Owls have been observed in or adjacent to cleared portions of the reservoir or elsewhere in the Peace River valley.

3.0 METHODS

The 2022 ground-nesting raptor surveys were conducted using two methods:

1. Field surveys were conducted along transects and at standwatch stations to detect Northern Harrier and Short-eared Owl; and

2. Autonomous Recording Units (ARUs) were deployed at select standwatch stations as a pilot study to determine if acoustic recordings could be used to detect Short-eared Owl in late-evening hours when sites cannot be surveyed by human observers.

Surveys were conducted in cleared portions of the construction headpond between the dam site and the Halfway River. Surveys of the mitigation properties were conducted in 2016 and 2017. Use of the mitigation properties in their current conditions (i.e., in the absence of any land-use changes or habitat modification) by ground-nesting raptors has been well documented and further surveys would likely not provide new information. Surveys of the mitigation properties were therefore not conducted in 2022. Surveys of these areas will be performed again when the reservoir has been inundated or when there are substantial land use changes or habitat modifications in the mitigation properties, whichever occur first.

3.1 Field Surveys

Surveys were conducted at 36 standwatch stations within the three areas outlined in Table 2 and on Figures 1 through 8 (see Appendix B for a full list of the standwatch stations surveyed in 2022 and the survey history of each station from 2016 – 2022):

- The Bear Flats area had a single transect with five standwatch stations located along its length (Figure 2).

- The Cache Creek area consisted of a single standwatch station (Figure 3).

- The Peace River area was the largest survey area, with five transects (for a total of 25 standwatch stations) between the Moberly River and Cache Creek and five standwatch stations located between Cache Creek and the Halfway River (Figures 3 to 8). No new survey stations were established within the Peace River area this year.

Within these three areas, ground-nesting raptors were surveyed up to six times over May and June 2022 to capture earlier, middle, and later stages of their breeding season. The surveys were conducted using a combination of transects and stationary standwatches. The cleared Bear Flats and Cache Creek areas were accessed by foot and the cleared Peace River areas were accessed by boat. Surveys were completed by two teams of two observers. Each team was composed of a biologist with raptor survey experience and an assistant (Appendix C).

The single remaining station located within the previously surveyed Highway 29 area, H29SW06, was located within an active gravel pit and was not accessible for the 2022 surveys. This was the only station surveyed in 2021 that was not surveyed in 2022.

Table 2: 2022 Survey Areas with Dates and Times

Survey Location	First Visit	Second Visit (Evening)	Third Visit	Fourth Visit (Evening)	Fifth Visit	Sixth Visit (Evening)
Bear Flats	May 19, 2022 08:35 – 11:07	May 19, 2022 20:25 – 21:15 (Only surveyed BFSW01 and BFSW02)	June 6, 2022 04:41 – 07:13	June 6, 2022 20:30 – 21:25 (Only surveyed BFSW01 and BFSW02)	June 20, 2022 10:11 – 12:53	June 24, 2022 20:14 – 21:11 (Only surveyed BFSW01 and BFSW02)
Cache Creek	May 19, 2022 13:13 – 13:33	May 19, 2022 21:24 – 21:44	June 6, 2022 08:50 – 09:10	June 6, 2022 21:38– 21:58	June 21, 2022 11:47 – 12:07	June 24, 2022 21:42 – 22:02
Peace River	May 17, 2022 08:00 – 16:15 & May 18, 2022 07:45 – 16:30	No evening surveys conducted	May 31, 2022 07:04 – 14:00 & June 1, 2022 09:32 – 09:52 & June 2, 2022 09:48 – 11:20	No evening surveys conducted	June 18, 2022 06:49 – 14:20 & June 19, 2022 10:50– 11:12 & June 21, 2022 09:22 – 10:51	No evening surveys conducted

Northern Harrier are diurnal, and research suggests they are generally active between 05:30 and 21:30 (Smith et al. 2011). Short-eared Owl are a crepuscular species and optimal survey timing is in the evening just prior to civil twilight (Wiggins at al. 2006). While most surveys were conducted during daytime hours, three evening surveys were conducted at three select sites to increase the likelihood of detecting any Short-eared Owl present (the “evening” visit columns in Table 2). The evening surveys were limited to areas that could be safely accessed by truck due to the logistical and safety considerations that come with conducting surveys in cleared portions of the reservoir that require boat access. Evening surveys would require boating in very low light or dark conditions after surveys are complete, which would not be considered a safe work practice by BC Hydro.

3.1.1 Transect Survey Protocol

The transect surveys were conducted by walking at a speed of 0.5 – 2 km/hr while looking and listening for birds. Surveyors stopped whenever required to confirm identification and record data. The walking transects were located only in cleared portions of the reservoir. Surveyors selected walking paths that provided visual coverage of the entire portion of suitable habitat in each area. During the transect, surveyors stopped at each established standwatch station to complete a standwatch survey. From each standwatch station the surveyors had a view from the previous standwatch station to the next station in the transect. Adding these standwatches into the transect surveys allowed surveyors to observe areas for longer periods to increase the potential to observe bird activity and nesting behaviour for the purpose of locating ground-nesting raptor nests. Standwatches were conducted by observing from a stationary position for approximately 20 minutes.

Surveys were not completed during periods of high wind (greater than Beaufort 3; 12 – 19 km/hr), rain or fog, when bird activity and detectability are likely to be low. The order that the stations were visited was different on each of the survey days so that time of day varied between visits.

For all raptor observations, species, sex, age, activity, distance and compass direction were recorded. Other species were recorded as incidental observations (Appendix A). Since ground-nesting raptor nests can easily be destroyed by human traffic, surveyors were instructed to observe for behaviour suggesting a nest was nearby (e.g., one or both of the pair returning to the same location with nesting materials or food, a pair of Northern Harriers exchanging prey or nesting materials through aerial passes, or a male Short-eared Owl defending a nest with distraction displays) rather than conduct intensive foot searches to locate a nest.

3.1.2 Standwatch Survey Protocol Without Transects

Standwatch surveys in the absence of associated transects were conducted in cleared portions of the reservoir that (1) could not be visited by foot due to impassible terrain, and/or (2) could not be linked with other standwatch stations to form a transect. Standwatches were conducted by observing from a stationary position for approximately 20 minutes.

Surveys were not completed during periods of high wind (greater than Beaufort 3, 12 – 19 km/hr), rain or fog. The order that the stations were visited were different on each of the survey days.

Ground-nesting raptor observations were collected following the same protocol as described in Section 2.1.1 for transect surveys.

3.2 Autonomous Recording Unit Surveys

An ARU is a standalone audio recording device that can be deployed and left for a period of time to record vocalizations or other sounds. The audio recordings are analyzed and interpreted once the recording units have been retrieved. ARUs are a commonly used tool to survey birds (Shonfield and Bayne 2017). The benefit of using ARUs for bird surveys is that the units can be deployed during daylight hours in areas that cannot be easily or safely accessed in the evening/night (i.e. along the Peace River) when species such as Short-eared Owl are active, allowing for monitoring in areas that would otherwise be difficult to survey.

Short-eared Owl are not especially vocal (Wiggins et al. 2020) and surveys for this species are best conducted using visual ground surveys. However, ARUs could be a useful supplement to visual surveys if Short-eared Owl vocalizations can be reliably detected by a human listener in recordings. This would allow for listening of recordings at locations that could not otherwise be surveyed in evening hours.

To informally test the utility of ARUs for detecting Short-eared Owls and determine if ARUs could be a useful addition to supplement the ongoing visual ground surveys at Site C, an experimental trial was conducted from 2020 to 2022. ARUs were deployed at select standwatch stations with the intent that Short-eared Owl would be detected by visual survey and recordings could then be reviewed to identify Short-eared Owl vocalizations. Ideally, ARUs would be deployed at locations where Short-eared Owls are known to occur; however, previous surveys have not identified any Short-eared Owl in or adjacent to the reservoir area.

ARUs (Song Meter SM4 from Wildlife Acoustics Inc.) were deployed at seven stations that were assessed as having the highest habitat potential for Short-eared Owl. These seven stations were located along transects or at standwatch stations in the Bear Flats and Peace River survey areas in locations that had experienced between two to four growing seasons since clearing (Table 3). These sites were abundant in low vegetation, grasses, shrubby regrowth, and had abundant coarse woody debris. A description of the habitat at each ARU survey station can be found in Section 3.1.

Table 3. 2022 ARU Survey Station Locations

ARU Survey Station	Location Reference	UTM Zone	UTM Easting	UTM Northing
PRSW04	Along Peace River Transect #1	10V	624853	6233390
PRSW06	Along Peace River Transect #2	10V	626238	6232838
PRSW15	Along Peace River Transect #3	10V	622112	6232810
PRSW17	Along Peace River Transect #4	10V	619113	6232097
PRSW26	Along Peace River Transect #5	10V	612173	6236510
BFSW02	Along the Bear Flats transect.	10V	611565	6237462
PRSW31	Peace River Standwatch Station	10V	600090	6233286

The ARUs were installed from May 17 to 19, 2022 and were collected from June 18 to 21, 2022. The ARUs were installed based on the deployment protocol of Lankau (2015). Each unit was mounted on a wooden stake or affixed to a tree approximately 1 m from the ground. The ARUs were set to record for 10 minutes every half hour each evening for the duration of deployment. The evening recordings were collected between 20:00 to 00:10 (i.e., midnight). The ARUs recorded 2-channel stereo, compressed W4V-8 files at 24 KHz.

To increase the probability of Short-eared Owl detection, recordings that could be selected for human listening were restricted to those taken as close to sunset (approximately 21:55 in June) as possible, when Short-eared Owls are likely to be most active. Three 10-minute recordings, taken at either 21:30 or 22:00, were randomly selected from each station for human listening, for a total of 18 recordings. The three recordings were selected from different nights during the ARU deployment period. If a selected recording had persistent wind or rain, a new recording was randomly selected to avoid periods of low Short-eared Owl activity or decreased ability to detect sounds. The compressed W4V files were converted to uncompressed WAV files using the Kaleidoscope software (version 5.3.8) by Wildlife Acoustics. The uncompressed WAV files were then imported into Audacity (version 2.4.2) for human listening. The trained human listener played back each recording and was instructed to record Short-eared Owl calls, including barks, screams, bill snaps and male courtship hoots detected in 1-minute intervals; replay any section needed to accurately track and count Short-eared Owl detections; and estimate perceived distance to each individual (near, mid and far). Human listening was conducted by the same trained human listener for all recordings.

4.0 RESULTS

4.1 Habitat at Survey Areas

Habitat information for each survey station was noted during surveys to determine the quality of the cleared area as hunting and nesting habitat for ground-nesting raptors. Table 4, below, describes the habitat at each survey station. Photographs of the habitat at each station are presented on Figures 2 to 8.

Table 4: Habitat at Peace River Standwatch Stations and Transects during the 2022 Surveys

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
Bear Flats Survey Area – Transect Only			
Bear Flats Transect ▪ BFSW01 ▪ BFSW02 ▪ BFSW03 ▪ BFSW04 ▪ BFSW05	Winter 2018/2019	3	The cleared area was experiencing vegetation regrowth with high percent cover (> 90%) of grasses, forbs and shrubs. Shrubs were approximately 1 m high. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.
Cache Creek Survey Area – Standwatch Only			
CCSW07	Partial clearing in Winter 2016/2017 Partial clearing in Winter 2018/2019	5 3	Reestablished vegetation is dominated by grasses and patches of low shrubs approximately 1.0 m in height. The area is oriented south towards Cache Creek, bounded by Highway 29 to the north and surrounded by deciduous riparian forests.
Peace River Survey Area – Transect and Standwatch			
Peace River Transect #1 ▪ PRSW02 ▪ PRSW03 ▪ PRSW04	Winter 2017/2018	4	A cleared and mulched bench in the river channel with thick herbaceous and shrubby regrowth covering 90% of the cleared area. Some grassy, open areas are still present. The dominant shrubs are prickly rose, Saskatoon berry and wolf willow. Some balsam poplar saplings are > 2.0 m tall, but most shrubs are around 1.0 m tall. It is bounded on the northern and southern sides by intact strips of open riparian forest between the cleared area and the Peace River.
Peace River Transect #2 ▪ PRSW05 ▪ PRSW06 ▪ PRSW07 ▪ PRSW08	Winter 2017/2018	4	A cleared stretch of coniferous forest on a north-facing slope with abundant grass, herb and shrub regrowth covering 90% of the area. The balsam poplar saplings are around 2.0 m tall, but the majority of the shrubs are around 1.0 m tall. The transect is bounded to the south by the Peace River, and to the north and west by coniferous forest.
Peace River Transect #3 ▪ PRSW11 ▪ PRSW12 ▪ PRSW13 ▪ PRSW14 ▪ PRSW15	Winter 2018/2019 (Except PRSW15 which was cleared 2019 / 2020)	3 2	A large cleared and mulched area encompassing Tea Island. Vegetation cover along the transect is high (>90%). The old back channels that braid through this area are dominated by forbs and grasses, and the upland areas are revegetating with forbs, grasses and shrubs. The balsam poplar saplings are around 2.0 m tall, but the majority of the shrubs are around 1.0 m tall. It is bounded by dry south-facing slopes to the north and an intact strip of riparian forest along the Peace River to the south.

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
Peace River Transect #4 ▪ PRSW16 ▪ PRSW17 ▪ PRSW18 ▪ PRSW19 ▪ PRSW20 ▪ PRSW21 ▪ PRSW22 ▪ PRSW23	Winter 2019/2020	2	The flat floodplain areas and the southern slopes were cleared and mulched. Some exposed soils, and abundant small and large woody debris remain. Vegetation regrowth is moderate and consists of grasses, herbs and short shrubs (<1 m tall) covering approximately 75% of the area. It is bounded to the north by the Peace River, and to the south by coniferous forest. Riparian buffers were left around the perimeters of the clearcut areas.
Peace River Transect #5 ▪ PRSW24 ▪ PRSW25 ▪ PRSW26 ▪ PRSW27 ▪ PRSW28	Winter 2019/2020	2	This area had been cleared and mulched. Some exposed soils, and abundant small and large woody debris still remain. Vegetation regrowth is moderate and consists of grasses, herbs and mostly short shrubs (<0.5 m tall) covering approximately 70% of the area. Dominant shrub species are prickly rose and soopolallie. It is bounded to the north by the Peace River, and to the south by coniferous forest. Riparian buffers were left around the perimeters of the clearcut areas.
PRSW31	Winter 2019/2020	2	The area had been cleared and mulched. Approximately 75% of the area is experiencing vegetation regrowth, and consists of grasses, herbs and low shrubs under 0.5 m in height. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW32	Winter 2019/2020	2	The area had been cleared and mulched. Approximately 75% of the area is experiencing vegetation regrowth, and consists of grasses, herbs and low shrubs under 0.5 m in height. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW33	Winter 2019/2020	2	The area had been cleared and mulched. Approximately 75% of the area is experiencing vegetation regrowth and consists of grasses, herbs and low shrubs under 1.0 m in height. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW34	Winter 2019/2020	2	A small, cleared area surrounded by mainly deciduous trees. Approximately 75% of the cleared and grubbed area is experiencing vegetation regrowth and consists mostly of grasses, herbs and low shrubs. It is bounded to the east and south by the Peace River and to the north by floodplains, and Highway 29.
PRSW35	Winter 2019/2020	2	A small, cleared area surrounded by mainly deciduous trees. Approximately 75% of the cleared and grubbed area is experiencing vegetation regrowth and consists mostly of grasses, herbs and low shrubs less than 1.0 m tall. It is bounded to the east and south by the Peace River and to the north by floodplains, and Highway 29.

4.2 Transect Results

Seven Northern Harriers were observed along transects within the Bear Flats and Peace River survey areas (Table 5). During the May 19 surveys along the Bear Flats transect, four Northern Harriers were observed during daytime surveys and one Northern Harrier were observed during evening surveys. It is likely that these were repeat observations of one or a few individuals present within the Bear Flats area at that time. On May 31, one Northern Harrier was observed along Peace River Transect #1, and on June 20, one Northern Harrier was observed along the Bear Flats Transect. No nests or behaviour suggesting the presence of nests were observed along any of the transects surveyed. Short-eared Owl was not observed along any of the transects.

4.3 Standwatch Results

Three Northern Harriers were observed at standwatch only stations (Table 5). One Northern Harrier was observed at the Cache Creek standwatch station on May 19, one was observed at PRSW32 on June 2, and one was observed at PRSW35 on June 1. No nests or behaviour suggesting the presence of nests were observed at any of the standwatch only stations. Short-eared Owl was not observed at any of the standwatch only stations.

4.4 Incidental Observations

There were no incidental Northern Harrier or Short-eared Owl observed during any of the three visits.

4.5 ARU Survey Results

Three 10-minute recordings from each of the six stations were analyzed through human listening, for a total of 18 recordings. No Short-eared Owls were detected through human listening.

Table 5: Northern Harrier Observations during the May/June 2022 Field Surveys.

Transect / Standwatch	Station	Date	Time	Count	Activity	Sex	Age Class	Observation Location			Comments[1]
								UTM Z	UTM E	UTM N	
Bear Flats Transect	BFSW01	19-May-22	8:48	1	Soaring	Unknown	Adult	10V	611070	6237977	One NOHA observed 500 m away at 260 degrees. Flew along the Peace River then south over the slopes behind Bear Flats
Bear Flats Transect	BFSW02	19-May-22	9:24	1	Soaring	Unknown	Adult	10V	611565	6237462	One NOHA observed 50 m away at 240 degrees. Flew over the flats near the Peace River. May be same individual observed at BFSW01.
Bear Flats Transect	BFSW03	19-May-22	9:50	1	Hunting	Unknown	Adult	10V	612033	6237303	One NOHA observed 200 m away at 200 degrees. Flying along the flats by the Peace River. May be same individual observed at BFSW01.
Bear Flats Transect	BFSW04	19-May-22	10:31	1	Soaring	Unknown	Adult	10V	612479	6237070	One NOHA observed 100 m away at 60 degrees. First observed flying high above Bear Flats alongside a Golden Eagle.
Bear Flats Transect	BFSW02	19-May-22	20:15	1	Soaring	Unknown	Adult	10V	611252	6237842	One NOHA observed 250 m away at 200 degrees. Observed this individual on an evening survey between BFSW01 and BFSW02.
Cache Creek Standwatch	CCSW07	19-May-22	21:35	1	Soaring	Male	Adult	10V	608790	6237457	One NOHA observed 25 m away at 100 degrees. Soaring over Cache Creek towards Bear Flats during an evening survey.
Peace River Transect #1	PRSW03	31-May-22	10:14	1	Flying	Male	Adult	10V	624352	6233286	One NOHA observed 50 m away at 20 degrees. Flew low over the clearcut and along the Peace River downstream of survey location.
Peace River Standwatch	PRSW32	2-Jun-22	9:48	1	Flying	Male	Adult	10V	602252	6233346	One NOHA observed 100 m away at 280 degrees. Flying low over the clearcut, perhaps hunting.
Peace River Standwatch	PRSW35	1-Jun-22	9:32	1	Soaring	Male	Adult	10V	609370	6236803	One NOHA observed 100 m away at 120 degrees.
Bear Flats Transect	BFSW01	20-Jun-22	10:11	1	Soaring	Unknown	Unknown	10V	611062	6238025	One NOHA observed 500 m away at 196 degrees. Soaring, and then was chased by Brewer's Blackbirds down by the Peace River.

[1] NOHA = Northern Harrier

5.0 DISCUSSION

The first substantial clearing of the headpond area occurred in fall/winter 2016/2017 and continued incrementally each through winter 2020. Vegetation regrowth in cleared areas remains moderate (less than 75% coverage, and shrubs below 0.5 m in height) until the third growing season. Prior to the third growing season, suitable ground-nesting raptor breeding habitat in cleared areas appears to be absent or of very low quality. Cleared areas in their third growing season and onward have high coverage of grasses, forbs and taller shrubs and appear to provide suitable breeding habitat for ground-nesting raptors.

The 2022 ground-nesting raptor surveys detected Northern Harrier in and adjacent to the Project footprint. Northern Harriers were observed ten times throughout the May and June surveys. The majority of the Northern Harrier activity was observed within the Bear Flats/Cache Creek survey areas. No behaviours suggestive of nesting were observed.

No Short-eared Owls were detected during the 2022 ground-nesting raptor surveys, which is consistent with the previous years' findings. No Short-eared Owls have been observed in or adjacent to the Project footprint since surveys began in 2016. The experimental use of ARUs to detect Short-eared Owl using audio recordings continues to be inconclusive since no Short-eared Owl were detected in 2020, 2021 or 2022. The ARU trial will be conducted again in 2023.

Areas surveyed within the headpond area in 2016 through 2022 will be surveyed again in 2023 in addition to any newly cleared areas within the headpond. Surveys in the headpond will continue until the reservoir has been filled.

6.0 REFERENCES

BC Hydro. 2016. Ground Nesting Raptor Follow-up Monitoring Program Plan. Prepared for BC Hydro's Site C Clean Energy Project.

Hilton, S., L. Simpson, and L. Andrusiak. 2013. Part 6 Raptors. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC.

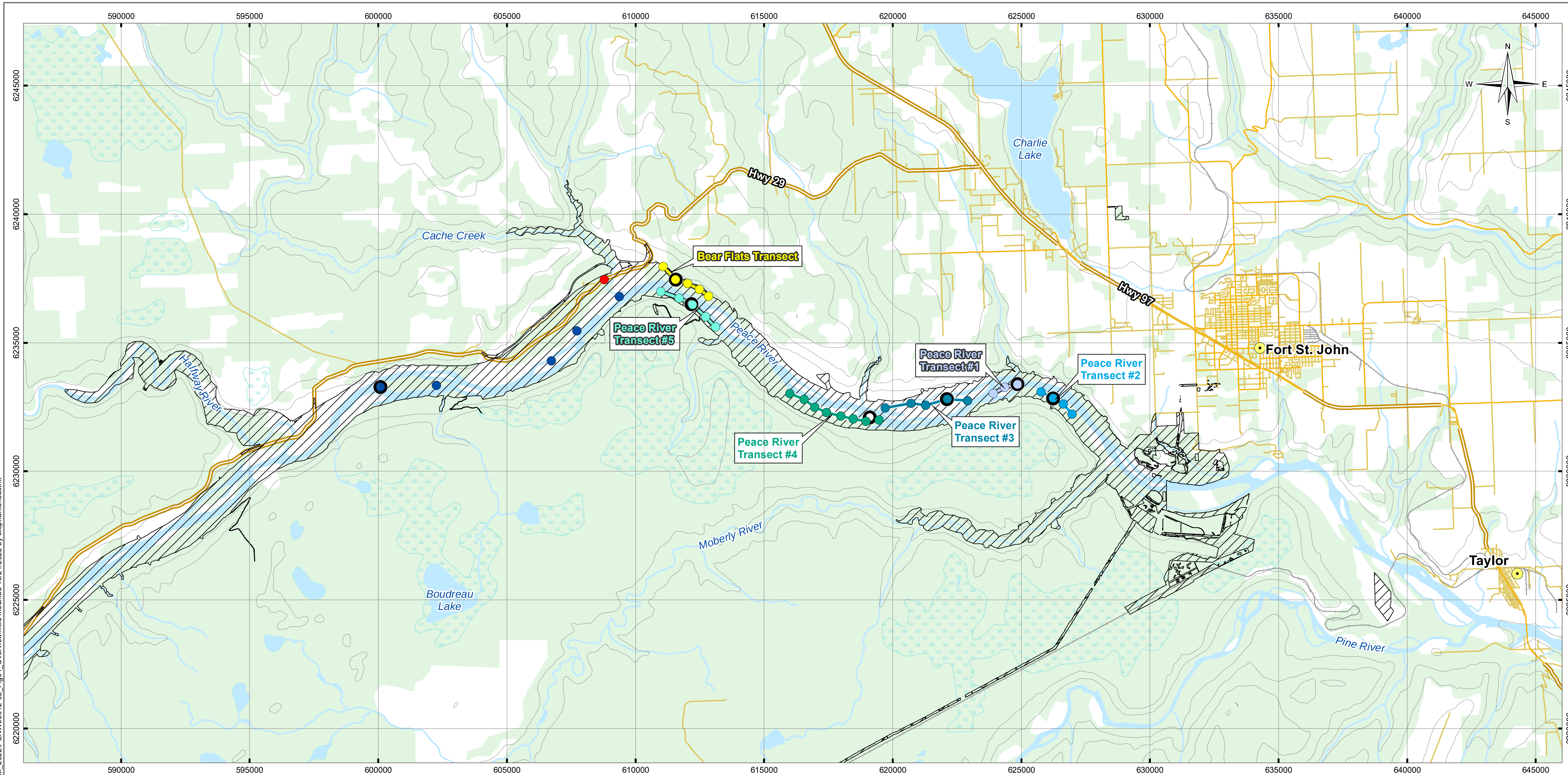
Lankau, H.E., MacPhail, A., Knaggs, M. and Bayne, E. 2015. Acoustic recording analysis protocol. BioAcoustic Unit, University of Alberta and Alberta Biodiversity Monitoring Institute. Edmonton, Alberta.

Resources Inventory Committee. 2001. Inventory Methods for Raptors. Standards for Components of British Columbia's Biodiversity No. 11. BC Ministry of Sustainable Resource Management, Environment Inventory Branch, Victoria, BC.

Shonfield, J. and E.M. Bayne. 2017. Autonomous recording units in avian ecological research: current use and future applications. Avian Conserv. Ecol. 12(1).

Siddle, C. 2010. Birds of North Peace River (Fort St. John and Vicinity), British Columbia, 1975-1999: Part 1 (Introduction and Non-passerines: waterfowl through woodpeckers). Wildlife Afield 7(1):12–123.

FIGURES



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LEGEND

Project Footprint
ARU Station

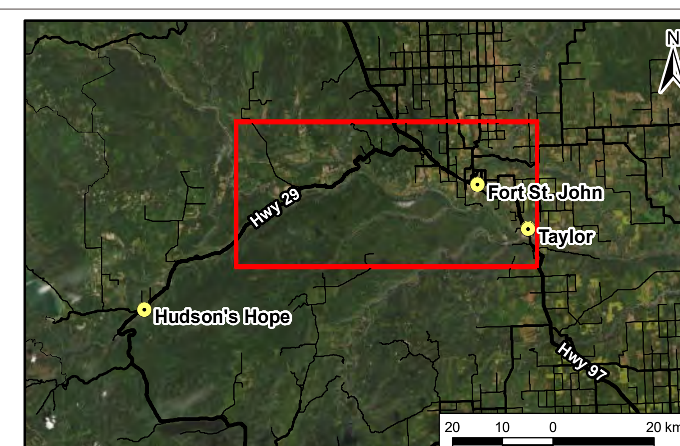
Standwatch Station
- Cache Creek
- Peace River

Transect Standwatch Station
- Bear Flats
- Peace River #1
- Peace River #2
- Peace River #3
- Peace River #4
- Peace River #5

Transect
- Bear Flats
- Peace River #1
- Peace River #2
- Peace River #3
- Peace River #4
- Peace River #5

- Populated Place
- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Railway
- Residential Area

- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Wooded Area



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STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2022 ANNUAL REPORT

Project Overview

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC Hydro Power smart

Scale: 1:150,000
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Kilometres

FILE NO.
PENW03042-02_Fig01_Overview.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	EH	0

DATE
December 22, 2022

PROJECT NO.
ENW.PENW03042-02

TETRA TECH

Figure 1

LEGEND

- Northern Harrier Observation
- ARU Station
- Bear Flats Transect Standwatch Station
- Bear Flats Transect
- Project Footprint
- Highway
- Watercourse
- Waterbody

NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2016).

STATUS
ISSUED FOR USE

SITE C
GROUND-NESTING RAPTOR MONITORING
2022 ANNUAL REPORT

Bear Flats Transect Stations

PROJECTION: UTM Zone 10	DATUM: NAD83
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OFFICE: Tt-VANC	DWN: SL; CKD: BB; APVD: EH; REV: 0
DATE: December 22, 2022	PROJECT NO.: ENW.PENW03042-02

CLIENT: BC Hydro Power smart

TETRA TECH

Figure 2

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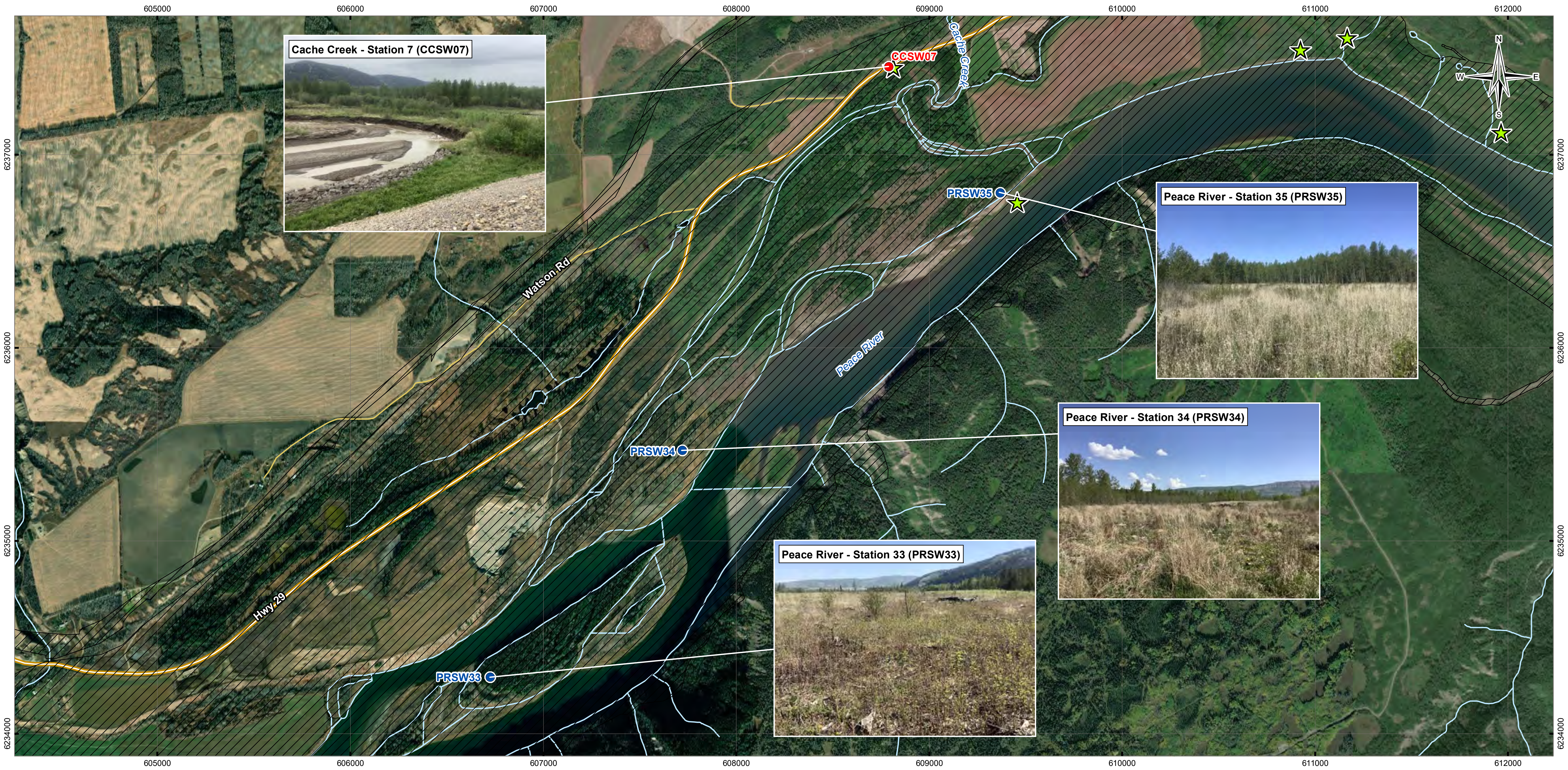
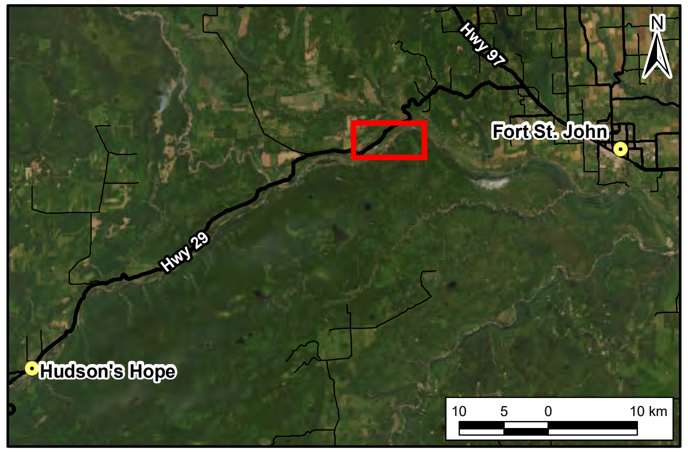


LEGEND

- Northern Harrier Observation
- Cache Creek Standwatch Station
- Peace River Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



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Imagery from ESRI; Maxar (2016/2018).

STATUS
ISSUED FOR USE

SITE C
GROUND-NESTING RAPTOR MONITORING
2022 ANNUAL REPORT

Cache Creek and Peace River Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC Hydro Power smart

Scale: 1:20,000
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Metres

FILE NO.
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OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	EH	0

DATE	PROJECT NO.
December 22, 2022	ENW.PENW03042-02

TETRA TECH

Figure 3

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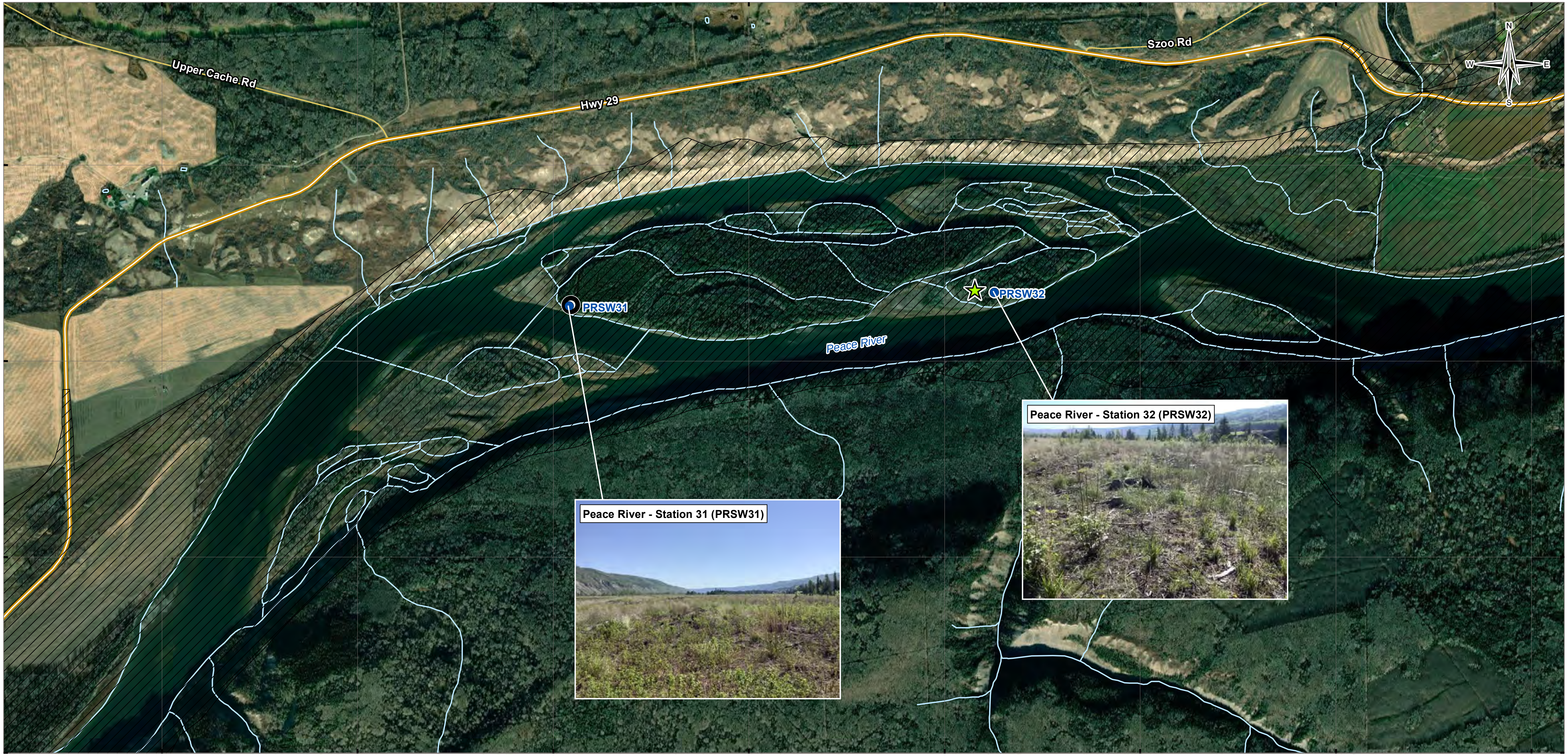
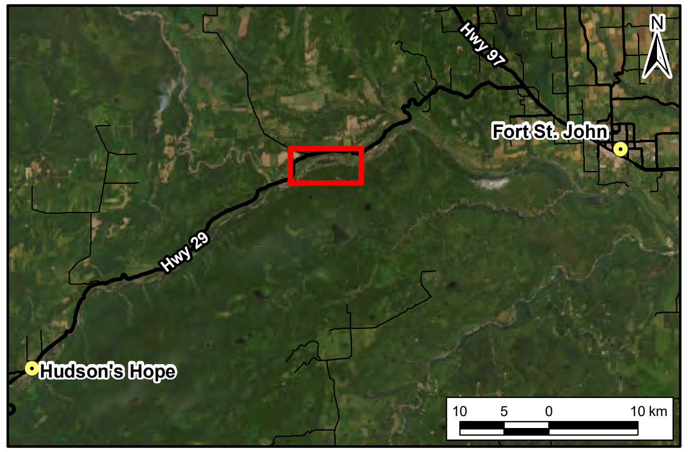


LEGEND

- Northern Harrier Observation
- ARU Station
- Peace River Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



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Imagery from ESRI; Maxar (2018).

STATUS
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SITE C GROUND-NESTING RAPTOR MONITORING 2022 ANNUAL REPORT

Peace River Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC Hydro Power smart

Scale: 1:20,000
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Metres

FILE NO.
PENW03042-02_Fig04_PeaceR.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	EH	0

DATE	PROJECT NO.
December 22, 2022	ENW.PENW03042-02

Figure 4

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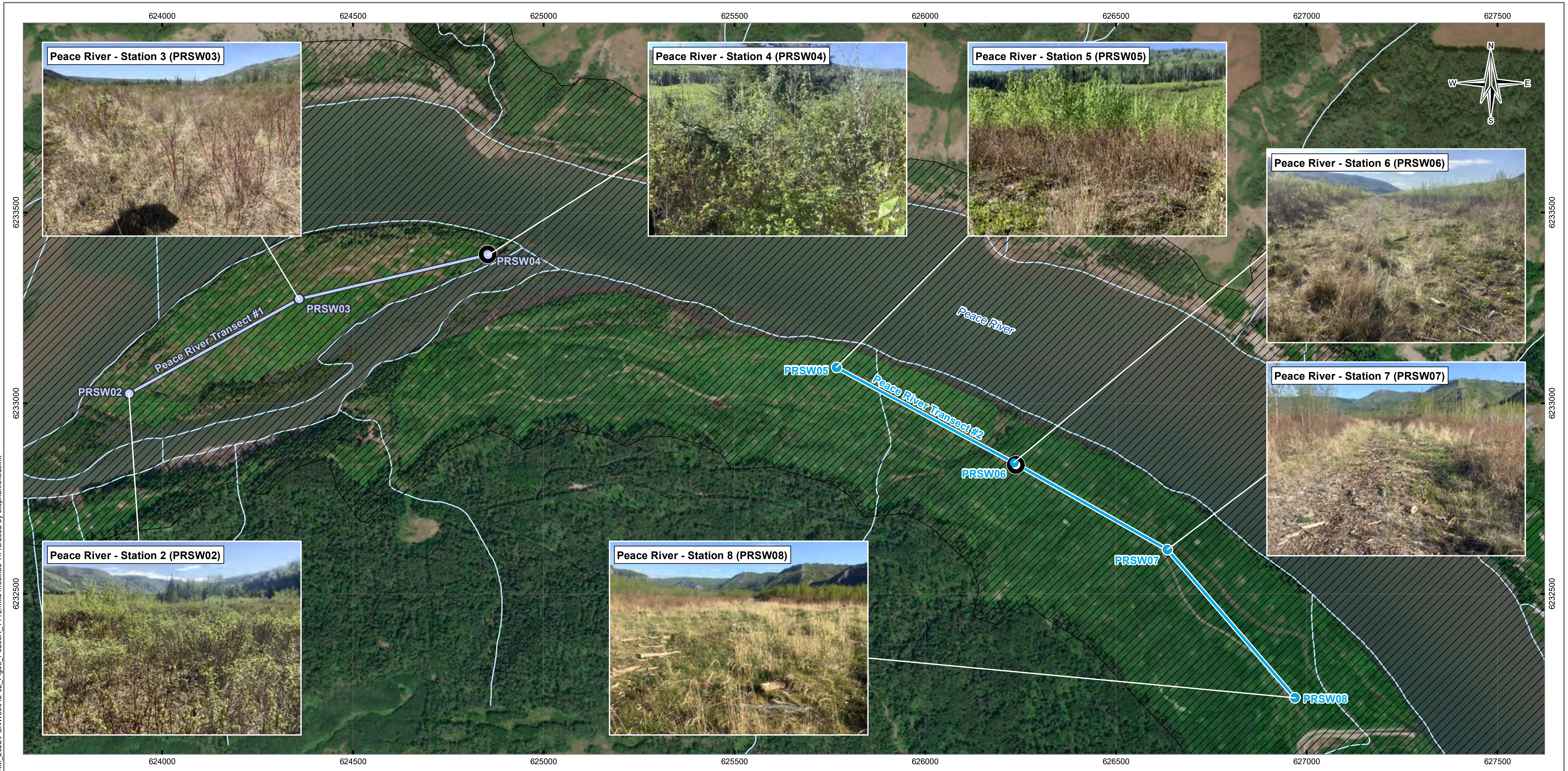
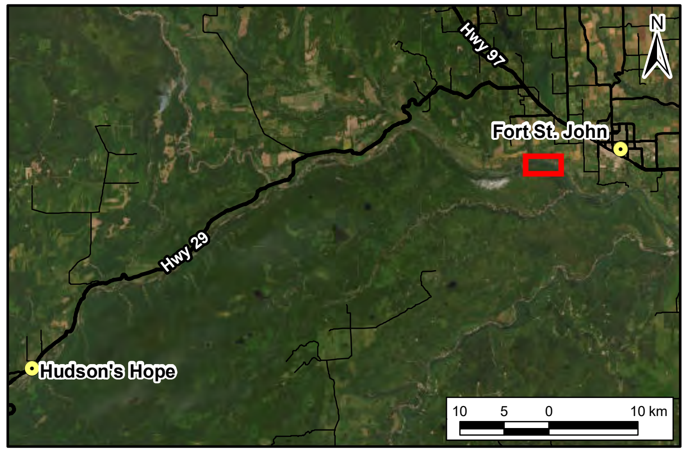


LEGEND

- ARU Station
- Peace River Transect #1 Standwatch Station
- Peace River Transect #2 Standwatch Station
- Peace River Transect #1
- Peace River Transect #2
- Project Footprint
- Watercourse
- Waterbody



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Imagery from ESRI; Maxar (2021).

STATUS
ISSUED FOR USE

SITE C
GROUND-NESTING RAPTOR MONITORING
2022 ANNUAL REPORT

Peace River Transect #1 and Transect #2 Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC Hydro Power smart

Scale: 1:10,000
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Metres

FILE NO.
PENW03042-02_Fig05_PeaceR_T1T2.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	EH	0

DATE	PROJECT NO.
December 22, 2022	ENW.PENW03042-02

TETRA TECH

Figure 5

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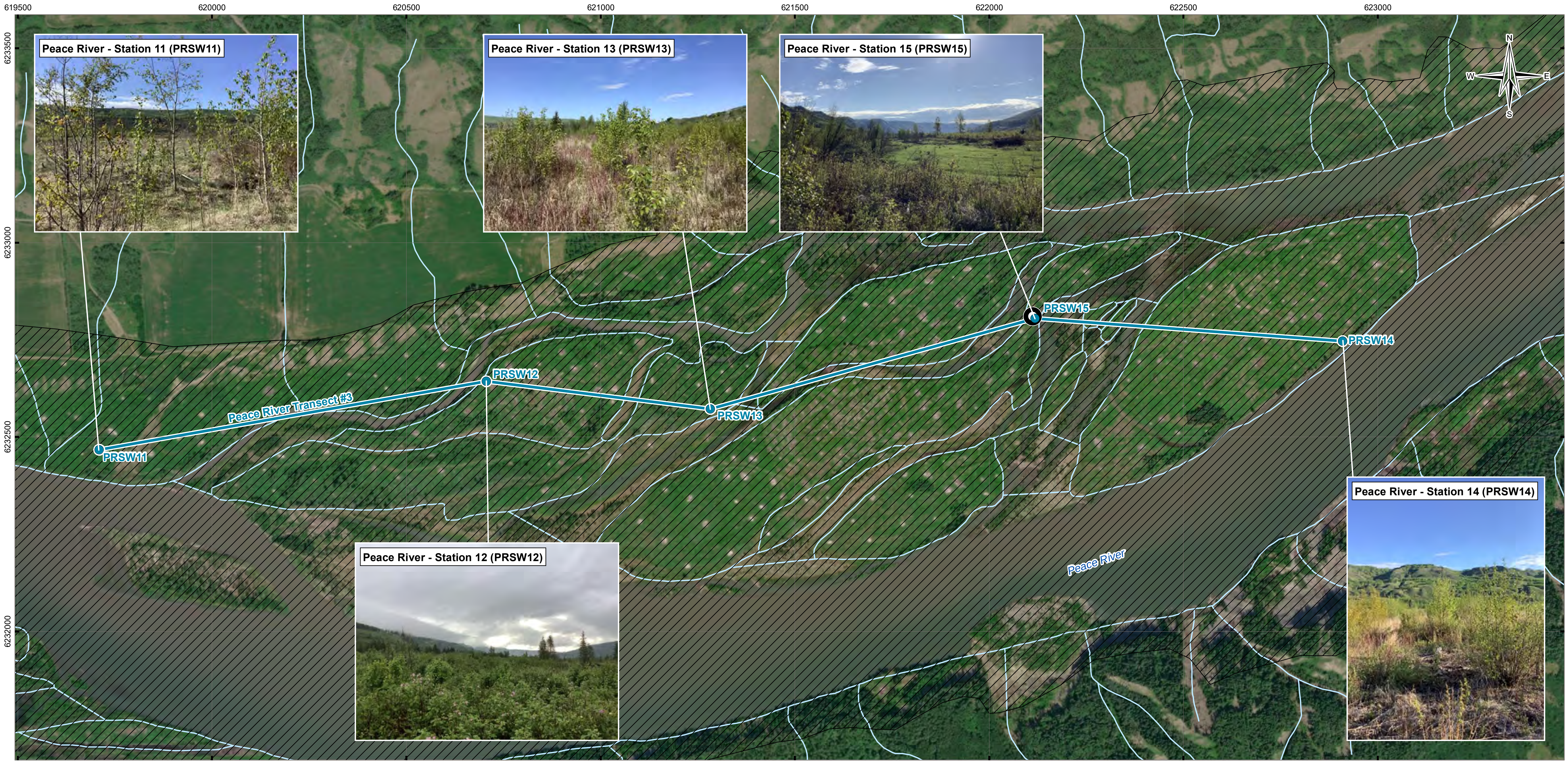

LEGEND

- ARU Station
- Peace River Transect #3 Standwatch Station
- Peace River Transect #3
- Project Footprint
- Watercourse
- Waterbody

NOTES
Base data source:
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Imagery from ESRI; Maxar (2021).

STATUS
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SITE C
GROUND-NESTING RAPTOR MONITORING
2022 ANNUAL REPORT

Peace River Transect #3
Standwatch Stations

PROJECTION: UTM Zone 10	DATUM: NAD83
Scale: 1:10,000 (200 100 0 200 Metres)	
FILE NO.: PENW03042-02_Fig06_PeaceR_T3.mxd	

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	EH	0

DATE: December 22, 2022
PROJECT NO.: ENW.PENW03042-02

CLIENT: BC Hydro Power smart

TETRA TECH

Figure 6

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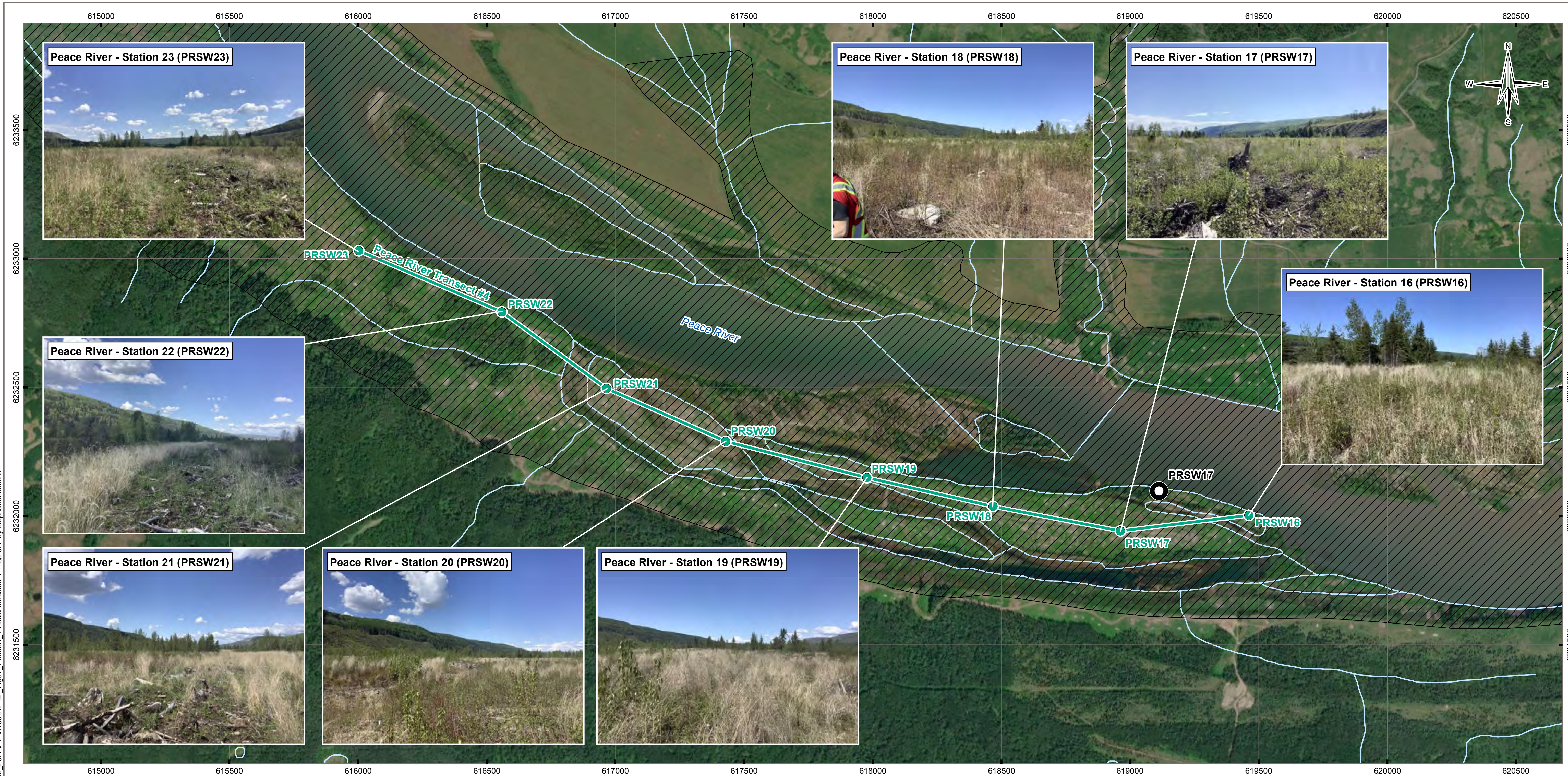

LEGEND

- ARU Station
- Peace River Transect #4 Standwatch Station
- Peace River Transect #4
- Project Footprint
- Watercourse
- Waterbody

NOTES
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Imagery from ESRI; Maxar (2021).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2022 ANNUAL REPORT

Peace River Transect #4 Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC Hydro Power smart

Scale: 1:15,000
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Metres

FILE NO.
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TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	EH	0

DATE	PROJECT NO.
December 22, 2022	ENW.PENW03042-02

Figure 7

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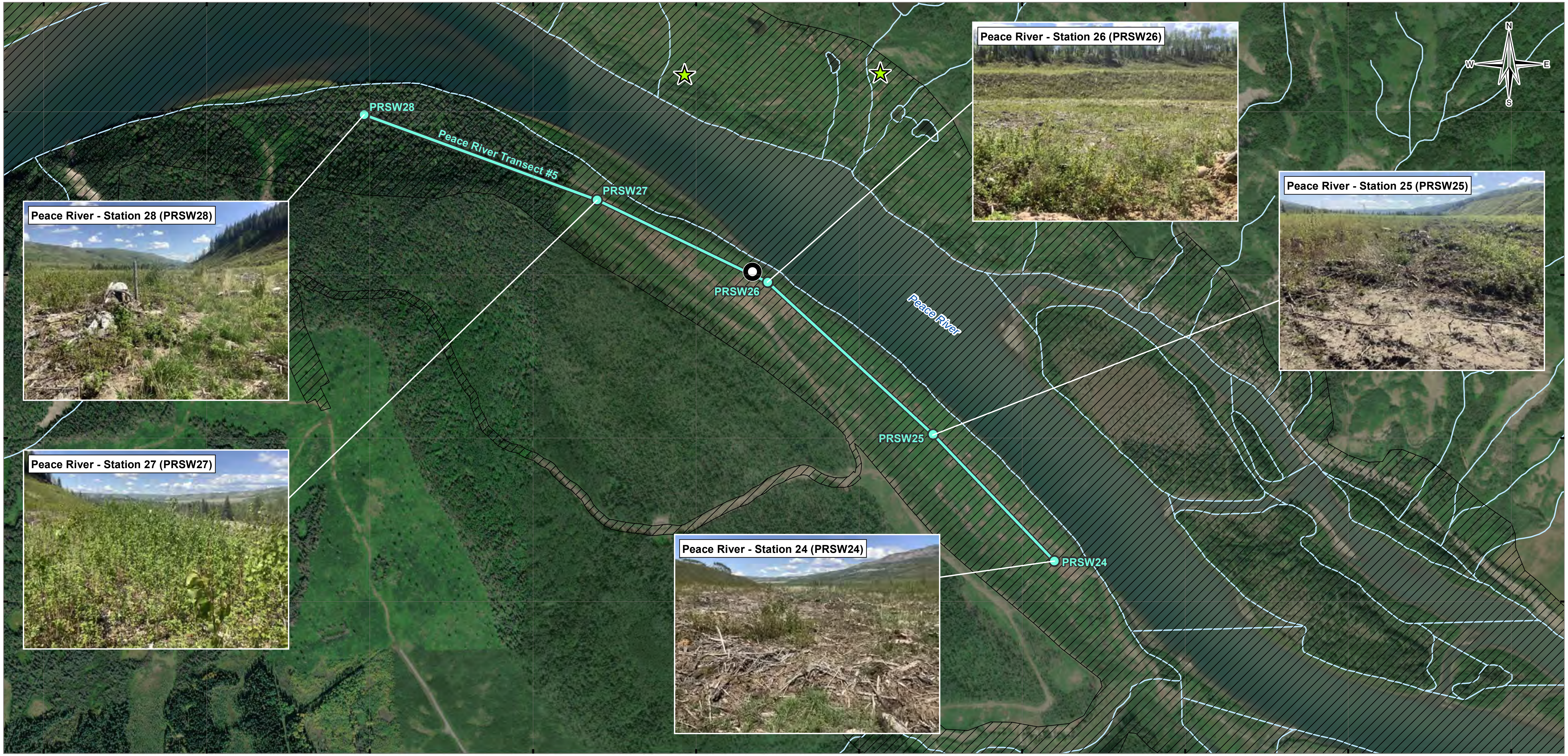
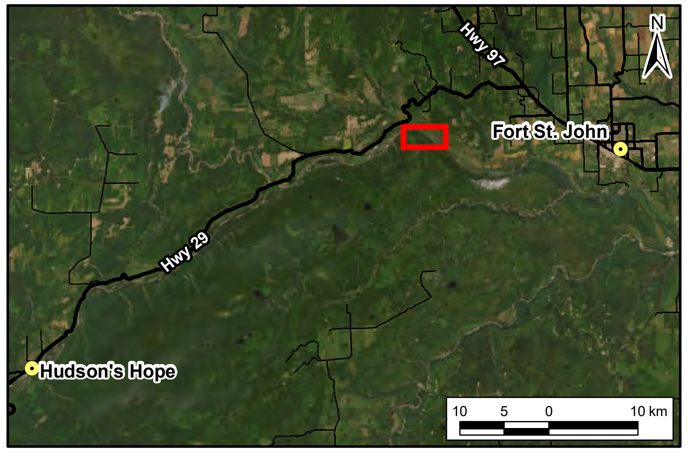


LEGEND

- Northern Harrier Observation
- ARU Station
- Peace River Transect #5 Standwatch Station
- Peace River Transect #5
- Project Footprint
- Watercourse
- Waterbody



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Imagery from ESRI; Maxar (2016/2021).

STATUS
ISSUED FOR USE

SITE C
GROUND-NESTING RAPTOR MONITORING
2022 ANNUAL REPORT

Peace River Transect #5
Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC Hydro Power smart

Scale: 1:12,000
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Metres

FILE NO.
PENW03042-02_Fig08_PeaceR_T5.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	EH	0

DATE	PROJECT NO.
December 22, 2022	ENW.PENW03042-02

Figure 8

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APPENDIX A
INCIDENTAL WILDLIFE OBSERVATIONS

Table A.1: Incidental Observation of Other Raptors During Ground-Nesting Raptor Surveys

Common Name	Scientific Name	BC List	COSEWIC/SARA [1]	Number Observed		
				Bear Flats	Cache Creek	Peace River
Golden Eagle	*Aquila chrysaetos*	Yellow	Not at Risk (May 1984)	2	-	-
Red-tailed Hawk	*Buteo jamaicensis*	Yellow	Not at Risk (May 1995)	-	-	5
Merlin	*Falco columbarius*	Yellow	Not at Risk (April 1985)	2	-	1
American Kestrel	*Falco sparverius*	Yellow	-	-	-	1
Bald Eagle	*Haliaeetus leucocephalus*	Yellow	Not at Risk (May 1984)	4	-	27

APPENDIX B
SURVEY STATION HISTORY 2016 – 2022

Survey Area	Station	Accompanying Transect	UTM Coordinates			Survey Year						
			Zone	Easting	Northing	2016	2017	2018	2019	2020	2021	2022
Compensation Sites	Wilder Creek Lands	No	-	-	-	Surveyed	Surveyed	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *
	Ruttledge Property	No	-	-	-	Surveyed	Surveyed	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *
	Marl Fen Property	No	-	-	-	Surveyed	Surveyed	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *
Highway 29	H29SW01	No	10	604838	6234918		Surveyed	Surveyed	Surveyed	Active Haul Road	Active Haul Road	Active Haul Road
	H29SW02	No	10	607633	6236693		Surveyed	Surveyed	Surveyed	Surveyed	Not surveyed. Site not within Headpond Area.	Not surveyed. Site not within Headpond Area.
	H29SW03	No	10	609150	6237937		Surveyed	Surveyed	Renamed CCSW05 and included in the CC Transect.	Renamed CCSW05 and included in the CC Transect.	Renamed CCSW05 and included in the CC Transect.	Renamed CCSW05 and included in the CC Transect.
	H29SW04	No	10	606078	6234708			Surveyed	Active Construction (Gravel Pit)	Active Construction (Gravel Pit)	Active Construction (Gravel Pit)	Active Construction (Gravel Pit)
	H29SW05	No	10	606918	6235242			Surveyed	Surveyed	Disturbed by construction - soil piles, grading etc. Established H29SW06 nearby as replacement.	Disturbed by construction - soil piles, grading etc. Established H29SW06 nearby as replacement.	Disturbed by construction - soil piles, grading etc. Established H29SW06 nearby as replacement.
	H29SW06	No	10	607050	6235314					Established to replace H29SW05	Surveyed	Not surveyed due to access issues - active construction area.
Peace River	PRSW01	No	10	623128	6232853		Surveyed	Surveyed	Surveyed	Redundant	Redundant	Redundant
	PRSW02	Peace River Transect 1	10	623914	6233025		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW03		10	624359	6233273		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW04		10	624854	6233389		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW05	Peace River Transect 2	10	625768	6233094		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW06		10	626233	6232844		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW07		10	626635	6232616		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW08		10	626969	6232228		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW09		10	627381	6231920		Surveyed	Surveyed	Active Construction	Active Construction	Active Construction	Active Construction
	PRSW10	No	10	617729	6232813				Surveyed	Redundant	Redundant	Redundant
	PRSW11	Peace River Transect 3	10	619709	6232467				Surveyed	Surveyed	Surveyed	Surveyed
	PRSW12		10	620706	6232643				Surveyed	Surveyed	Surveyed	Surveyed
	PRSW13		10	621282	6232572				Surveyed	Surveyed	Surveyed	Surveyed
	PRSW14		10	622910	6232747				Surveyed	Surveyed	Surveyed	Surveyed
	PRSW15		10	622118	6232805					Surveyed	Surveyed	Surveyed
	PRSW16	Peace River Transect 4	10	619462	6232003					Surveyed	Surveyed	Surveyed
	PRSW17		10	618963	6231942					Surveyed	Surveyed	Surveyed
	PRSW18		10	618468	6232038					Surveyed	Surveyed	Surveyed
	PRSW19		10	617978	623215					Surveyed	Surveyed	Surveyed
	PRSW20		10	617429	6232291					Surveyed	Surveyed	Surveyed
	PRSW21		10	616965	6232496					Surveyed	Surveyed	Surveyed
	PRSW22		10	616559	6232794					Surveyed	Surveyed	Surveyed
	PRSW23		10	616002	6233031					Surveyed	Surveyed	Surveyed
	PRSW24	Peace River Transect 5	10	613099	6235624					Surveyed	Surveyed	Surveyed
	PRSW25		10	612727	6236012					Surveyed	Surveyed	Surveyed
	PRSW26		10	612220	6236478					Surveyed	Surveyed	Surveyed
	PRSW27		10	611697	6236730					Surveyed	Surveyed	Surveyed
	PRSW28		10	610982	6236991					Surveyed	Surveyed	Surveyed
	PRSW29	No	10	597439	6231064					Surveyed	Not surveyed. Site not within Headpond Area.	Not surveyed. Site not within Headpond Area.
	PRSW30	No	10	598178	6232247					Surveyed	Not surveyed. Site not within Headpond Area.	Not surveyed. Site not within Headpond Area.

Survey Area	Station	Accompanying Transect	UTM Coordinates			Survey Year						
			Zone	Easting	Northing	2016	2017	2018	2019	2020	2021	2022
	PRSW31	No	10	600081	6233281					Surveyed	Surveyed	Surveyed
	PRSW32	No	10	602255	6233351					Surveyed	Surveyed	Surveyed
	PRSW33	No	10	606725	6234293					Surveyed	Surveyed	Surveyed
	PRSW34	No	10	607721	6235469					Surveyed	Surveyed	Surveyed
	PRSW35	No	10	609368	6236803					Surveyed	Surveyed	Surveyed
	PRSW36	No	10	598278	6232689					Surveyed - Called HRSW04 in the field.	Not surveyed. Site not within Headpond Area.	Not surveyed. Site not within Headpond Area.
Moberly River	MRSW01	No	10	628328	6230312				Surveyed	Active Construction	Active Construction	Active Construction
Bear Flats	BFSW01	Bear Flats Transect	10	611077	6237965				Surveyed	Surveyed	Surveyed	Surveyed
	BFSW02		10	611561	6237465				Surveyed	Surveyed	Surveyed	Surveyed
	BFSW03		10	612031	6237301				Surveyed	Surveyed	Surveyed	Surveyed
	BFSW04		10	612483	6237076				Surveyed	Surveyed	Surveyed	Surveyed
	BFSW05		10	612839	6236812				Surveyed	Surveyed	Surveyed	Surveyed
Cache Creek	CCSW01	Cache Creek Transect	10	607653	6239245				Surveyed	No Access due to high water levels	Active Construction	Active Construction
	CCSW02 / CCSW02B		10	608345	6239034				Surveyed	Surveyed	Active Construction	Active Construction
	CCSW03		10	608729	6238798				Surveyed	Surveyed	Active Construction	Active Construction
	CCSW04		10	609093	6238402				Surveyed	Surveyed	Active Construction	Active Construction
	CCSW05		10	609318	6237699				Surveyed	Surveyed	Active Construction	Active Construction
	CCSW06	No	10	609057	6237557					Surveyed	Active Construction	Active Construction
	CCSW07	No	10	608790	6237457						Established to replace CCSW06	Surveyed
Halfway River	HRSW01 / HRSW01-2	No	10	595783	6231568				Surveyed	Surveyed	Not surveyed. Site not within Headpond Area.	Not surveyed. Site not within Headpond Area.
	HRSW02	No	10	596262	6231237				Surveyed	Active Construction	Active Construction	Active Construction
	HRSW03	No	10	595800	6231049				Surveyed	Active Construction	Active Construction	Active Construction
Lynx Creek	LCSW01	No	10	571702	6214556					Surveyed	Not surveyed. Site not within Headpond Area.	Not surveyed. Site not within Headpond Area
	LCSW02	No	10	572132	6214265					Surveyed	Not surveyed. Site not within Headpond Area.	Not surveyed. Site not within Headpond Area.

Footnotes:

General - Green cell indicates the site was surveyed. Red cell indicates the site was not surveyed

* Surveys of the mitigiation areas will be performed again when the reservoir has been inundated or when there are substantial land use changes or habitat modifications.

APPENDIX C
PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project Manager, Report Reviewer
Elyse Hofs, B.Sc., Dipl.T., B.I.T. Tetra Tech Canada Inc.	Field Data Collection, Data Entry, Report Author
Heather Gauthier, R.T. Biol. Tetra Tech Canada Inc.	Field Data Collection

APPENDIX D
LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

NATURAL SCIENCES

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The Client acknowledges that it has fully cooperated with SEES JV with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for SEES JV to properly provide the services contracted for in the Contract, SEES JV has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

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During the performance of the work and the preparation of this Professional Document, SEES JV may have relied on information provided by third parties other than the Client.

While SEES JV endeavours to verify the accuracy of such information, SEES JV accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

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The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

SEES JV is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL ISSUES

The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

1.8 NOTIFICATION OF AUTHORITIES

SEES JV professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by SEES JV of regulatory contravention may require that regulatory agencies and other persons be informed. The client agrees that notification to such bodies or persons as required may be done by SEES JV in its reasonably exercised discretion.