Site C Clean Energy Project Agriculture Monitoring and Follow-up Program

2025 Annual Report

Prepared in accordance with the Agricultural Monitoring and Follow-up Program (December 22, 2015)
2025 Annual Report Submission Date: July 21, 2025

Table of Contents

1.0 Background

The Site C Clean Energy Project (the Project) is a hydroelectric dam and generating station under construction in northeast B.C. Construction started in July 2015 and has a projected in-service date of 2025. The Project will help meet future electricity needs by providing 1,100 megawatts of dependable capacity, and producing about 5,100 gigawatt hours of energy each year — enough to power the equivalent of 450,000 homes per year. Once built, the Project will be a source of clean, reliable and cost-effective electricity in B.C. for more than 100 years.

The key components of the Project are:

- Access roads and a temporary construction bridge across the river, at the dam site.
- Worker accommodation at the dam site.
- Upgrades to 240, 269, 271 and Old Fort roads.
- The realignment of six segments of Highway 29.
- Two temporary cofferdams across the river to allow for construction of the earthfill dam.
- Two new 500 kilovolt transmission lines connecting Site C to the Peace Canyon Substation, within an existing right-of-way.
- Shoreline protection at Hudson’s Hope, including upgrades to DA Thomas Road.
- An 800-metre roller-compacted-concrete buttress to enhance seismic protection.
- An earthfill dam, approximately 1,050 metres long and 60 metres high above the riverbed.
- A generating station with six 183 MW generating units.
- An 83-kilometre-long reservoir that will be, on average, two to three times the width of the current river.

2.0 Environmental Assessment Certificate Conditions

Condition 31 of the Environmental Assessment Certificate (EAC) requires the following:

> *“The Agriculture Monitoring and Follow-up Program must include at least the following:*
>
> *Monitoring for Project-induced changes in wildlife habitat utilization, and evaluation of associated crop or feed storage damage for, agricultural operations within 5 km of the reservoir, to assess if there is an increase in wildlife-related crop depredation due to Project-related habitat losses. Monitoring must include pre- and post- reservoir filling field surveys, wildlife monitoring, farm operator interviews, and analysis of relevant records related to wildlife-related crop depredation.*
>
> *Monitoring for Project-induced changes to humidity within 3 km of the reservoir, and evaluate associated effects on crop drying within this area. Monitoring must include collection and analysis of climate data, calculation of crop drying indices, and farm operator interviews.*
>
> *Monitoring for Project-induced changes to groundwater elevations within 2 km of the reservoir (the area potentially influenced by groundwater elevation changes), and evaluate*

associated effects on crop productivity. Monitoring must include field surveys and farm operator interviews.

Monitoring for climatic factors to estimate moisture deficits and to estimate irrigation water requirements in the vicinity of the reservoir to provide information for potential future irrigation projects. Data collection will be undertaken before reservoir filling, and in the 5 years after reservoir filling, and data will be reviewed as required for proposed irrigation projects.

The Agriculture Monitoring and Follow-up Program reports must be provided annually during the monitoring and follow-up period to affected agricultural land owners and tenure holders, and Ministry of Agriculture.

The results of the Agriculture Monitoring and Follow-up Program must inform the Farm Mitigation Plans.

Reporting must begin 180 days after the commencement of the monitoring and follow-up program that is to begin 180 days after commencement of construction.

The EAC Holder must provide this draft Agriculture Monitoring and Follow-up Program to the Ministry of Agriculture, Peace River Regional District and the District of Hudson's Hope for review within 90 days after the commencement of construction. The EAC Holder must file the final Agriculture Monitoring and Follow-up Program with EAO, Ministry of Agriculture, Peace River Regional District and the District of Hudson's Hope within 150 days of commencement of construction.

The EAC Holder must develop, implement and adhere to the final Agriculture Monitoring and Follow-up Program, and any amendments, to the satisfaction of EAO."

3.0 Agriculture Monitoring and Follow-up Program Overview

BC Hydro described the approach required by the above condition in the Agriculture Monitoring and Follow-up Program ("AMAFP"), submitted as final on December 22, 2015. The AMAFP was developed and has been implemented in accordance with Condition 31 of EAC #14-02, dated 14 October 2014, which was issued in respect of the Project.

Regarding the schedule presented in the AMAFP and those presented in this report (and previous Annual Reports), the discrepancies are due to changes to the reservoir filling schedule that occurred in 2017 and 2023. The most current project schedule dated January 2024 can be found on the Site C Project website here:

https://www.sitecproject.com/sites/default/files/SiteC_construction_schedule.pdf

The Project's Environmental Assessment assessed how the creation of the reservoir may result in site-specific changes that may affect agricultural operations on individual farm operations, and where Project effects on agricultural operations are not already addressed under agreements with BC Hydro. The monitoring programs, included as described in EAC Condition 31 and the AMAFP, will be used to determine if a Project-induced change has occurred as it relates to the following:

A. Effects on crops and stored feed as a results of changes in wildlife habitat utilization,
B. Effects on crop drying due to changes in humidity, and
C. Effects on crop productivity as a result in changes to groundwater elevations.

Upon completion of the above monitoring programs, the collected data will be evaluated and used to inform Individual Farm Mitigation Plans (where applicable) or on other mitigation measures.

Additional monitoring will occur for climatic factors to:

D. Estimate moisture deficits and irrigation water requirements.

The resulting estimations will be used in supporting future potential decisions regarding irrigation improvements, including support for projects that may be proposed under the Agricultural Mitigation and Compensation Plan.

The AMAFP states that monitoring, analysis and reporting will be undertaken in accordance with the following schedule:

Phase Description	**Timeline[1]**
Historical data review, baseline data collection[2], climate station siting and installation, preparation for field survey, consultation and interviews.	• January 2016 – December 2018
Data collection, field surveys, interviews, consultation, and data analysis.	• Five Years Prior to Reservoir Filling (December 2018 - December 2023[3]) • Five Year Post Reservoir Filling (January 2025 - January 2029)
Annual and Final Reporting	• July 2016 – July 2029

[1] Updated timeline as per 2024 schedule change

[2] Baseline data refers to the continued collection of data from existing climate stations and monitoring sites. As new stations and sites are added, and additional parameters are included at existing stations, this data will be incorporated into reporting as it becomes available.

[3] Site C reservoir commenced filling 25 August 2024.

The AMAFP stated that annual reports on the implementation of the AMAFP will be submitted beginning on July 21, 2016 (360 days after commencement of construction). These reports will include a summary of monitoring plan implementation activities. The annual reports will be posted on BC Hydro’s website and notifications sent to affected agricultural land owners and tenure holders, and the Ministry of Agriculture.

4.0 Annual Report Time Period and Format

The 2025 AMAFP Annual Report covers the time period from April 1, 2024 to March 31, 2025 and includes separate updates for each of the monitoring programs:

- Program A – Crop Damage Monitoring Program
- Program B – Crop Drying and Humidity Monitoring Program
- Program C – Groundwater and Crop Productivity Monitoring Program
- Program D – Irrigation Water Requirement Program

Program reporting, included in the appendices as a report or a memo, all employ a similar format:

- Introduction,
- Methods (i.e., study area and program activities),
- Results and analysis,
- Next steps, and
- References

5.0 Summary of Activities

Each of the programs are in the monitoring phase and a summary of each program for the reporting year is provided below.

5.1 Crop Damage Monitoring Program

BC Hydro's Crop Damage Monitoring Program (CDMP) contractor is Blackbird Environmental Ltd. (Blackbird), who developed and implemented activities to monitor for project-induced wildlife habitat utilization, while also evaluating the associated crop and feed storage damage.

During the reporting year, BC Hydro and the project team continued activities associated with the agricultural monitoring program in partnership with participating agricultural producers, which included field activities on their holdings beginning with the 2019 growing season and for the 10-year duration of the monitoring program. In total, 49 producers are participating in the program, representing approximately 9,200 hectares or 88% of the land currently utilized for agriculture production in the project area.

Additional activities during the reporting year would typically include engagement with:

- Ministry of Agriculture (AGRI),
  - Regional Agrologist
  - Agriculture Wildlife Program (AWP) Manager
- Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) wildlife biologists, and
- Regional agricultural producer groups.

One of the key tasks from the reporting year was to continue with the camera trapping and seasonal grazing exclusion plans. In total, 55 passive, unbaited camera traps were installed along benchmark field boundaries and 32 temporary grazing exclusion cages were installed on perennial forage benchmark fields.

During the 2024 growing season 30 benchmark sites were selected from the agriculture fields identified to be subject to higher wildlife pressures both pre- and post-inundation. Of this, 7 were used for annual crop production while 10 site contained a perennial forage stand.

5.2 Crop Drying and Humidity Monitoring Program

The Crop Drying and Humidity Monitoring Program (CDHMP) scope was assessed and developed in coordination with RWDI; the BC Hydro contractor responsible for climate station operation and management. Program scope was to monitor project-induced changes to humidity and evaluate associated effects within the area.

The climate stations currently available (as of the date of this report) were determined to be appropriate and sufficient for the purposes of the program. These stations monitor climate parameters on an ongoing basis to evaluate if changes occur and how these changes may affect crop drying indices.

5.3 Crop Productivity and Groundwater Monitoring Program

BC Hydro's Crop Productivity and Groundwater Monitoring Program (CPGMP) contractor is Blackbird, who developed and implemented activities to monitor and assess groundwater levels and related change to agricultural crops.

During the reporting year, BC Hydro and the project team oversaw activities associated with the program in order to meet the monitoring requirements as described in Condition 31. It was determined that the groundwater monitoring wells in the existing BC Hydro network could be employed within the CPGMP in place of installing all new wells. Only one (1) new well was installed in October 2019 in Bear Flats; identified to be a data collection gap area.

Blackbird will monitor in-season crop development through remote sensing, supplemented with field visits to assess crop variability in relation to soil moisture factors. Field methodology is being refined based on project experience.

5.4 Irrigation Water Requirements Program

The Irrigation Water Requirements Program (IWRP) was assessed and developed in coordination with RDWI.

The climate stations currently available (as of the date of this report) were determined to be appropriate and sufficient for the purposes of the program. These stations monitor climate parameters on an ongoing basis which will be available, when required, to support future proposed irrigation projects.

Appendix A – Crop Damage Monitoring Program Report

2025 Annual Report
Site C Clean Energy Project

Crop Damage Monitoring Program

Prepared for:

BC Hydro and Power Authority

July 14, 2025

Technical Report - R0

Project No.: 25016

Blackbird Environmental Ltd.
10624 101 Avenue | Fort St. John, BC | V1J 2B9 | 250.793.7262

Table of Contents

Table of Revisions

Revision No.	Date	Reason/Type of Revision
R0	July 14, 2025	Original report issued

1 Introduction

1.1 Project Background

The Site C Clean Energy Project (the Project) is a hydroelectric dam and generating station under construction along the Peace River in northeast British Columbia (BC). Construction started in July 2015 with the Project to be fully in service in Q4 of 2025 (BC Hydro 2025).

1.2 Regulatory Context

During the joint federal provincial environmental assessment process, the Project's Environmental Impact Statement (EIS; BC Hydro 2013) noted a potential for increased wildlife related crop damage.

Environmental Impact Statement Section 20.7.2.1 (page 20-53, lines 12 to 14) states: *"The loss of wildlife habitat in the reservoir may lead to an increase in wildlife in agricultural areas near the reservoir, which could lead to wildlife damage to crops and stored livestock feed for farm operations."*

The Environmental Assessment Certificate (EAC) for the Project (EAC #E14-02, issued October 14, 2014) contains a condition to develop an Agricultural Monitoring and Follow-Up Plan (AMAFP), which requires BC Hydro and Power Authority (BC Hydro) to monitor and assess wildlife habitat use and related damage to agricultural crops for a 10-year period including five years prior to reservoir filling and the first five years of operation.

Specifically, EAC condition No. 31 states: *"the Agriculture Monitoring and Follow-up Program must include monitoring for Project-induced changes in wildlife habitat, utilization, and evaluation of associated crop or feed storage damage for, agricultural operations within 5 km of the reservoir, to assess if there is an increase in wildlife related crop depredation due to Project related habitat losses. Monitoring must include pre- and post-reservoir filling field surveys, wildlife monitoring, farm operator interview, and analysis of relevant records related to wildlife related crop depredation."*

1.3 Scope

BC Hydro retained Blackbird Environmental Ltd. (Blackbird) in 2019 to implement the Crop Damage Monitoring Program (CDMP) component of the AMAFP for the Project. Blackbird's scope includes the development and implementation of field methods to monitor for Project-induced changes in wildlife habitat utilization and the evaluation of associated crop and feed storage damage patterns and trends.

As part of BC Hydro's annual reporting requirements, this report outlines Project activities completed in relation to the CDMP component between **April 1, 2024** and **March 31, 2025**.

Camera data recorded by the camera trap system during the 2024 growing season will be retrieved and analysed in the spring and summer of 2025. Consequently, the camera trap analysis information presented in Section 3.3 of this report is based on imagery acquired by the camera network during the period of January 1 and December 31, 2023 to ensure reliable summary statistics are presented.

As per the requirements of EAC Condition No. 31, the CDMP focuses on parcels with agricultural production within a five-kilometre buffer around the future Project reservoir (project area).

2 Methods

2.1 Ongoing Stakeholder Consultation & Producer Engagement

Blackbird's team developed and implemented a comprehensive agricultural producer outreach and engagement program for the CDMP. Blackbird continues to engage with landowners within the Project boundary on an ongoing basis throughout the growing season.

For all producers that expressed interest in the CDMP during initial engagement efforts in 2019, an in-person interview was conducted to gather project-relevant background information, including:

- farm/ranch operational and production information,
- historic wildlife damage patterns on temporal and spatial scales, and
- wildlife-related crop damage mitigation measures employed.

Producers participating in the CDMP were updated on project activities on their holdings during the spring of 2023, throughout the growing season, and a post-season interview program was implemented to gather information on observations and perceptions with regards to the 2023 growing season and wildlife-related crop damage in the 2023 crop.

Blackbird's team prepared a pre-recorded CDMP annual update presentation summarizing program activities during the 2024 growing season, assessment outcomes, challenges, and learnings during the spring of 2025. BC Hydro invited representatives from regional producer associations and provincial government representatives, specifically:

- Peace River Forage Association of BC,
- BC Grain Producers Association,
- Peace River Regional Cattlemen's Association,
- BC Breeder and Feeder Association,
- Peace Region Forage Seed Association, and
- BC Ministry of Agriculture and Food.

These groups were asked to review the virtual presentation and submit questions or comments, which will be responded to jointly by Blackbird and BC Hydro by the end of June 2025.

2.2 Crop Damage Monitoring

Blackbird's team has researched, developed, and implemented scientifically sound and defensible methods to assess and measure wildlife-related crop damaged in both annual and perennial crops in the CDMP project area. Throughout the growing season, field methods and techniques included:

- wildlife-related crop loss assessments,
- crop development and health monitoring, and
- remotely piloted aircraft system (RPAS) data acquisition.

Blackbird's team, in consultation with participating producers and BC Hydro project management, selected a total of 30 benchmark sites within the project area based on the outcome of initial engagement efforts, the review of available historic information, and a geospatial review of factors related to wildlife occurrence in the project area (i.e., proximity of escape or wintering habitat).

In 2024, we surveyed a total of 30 benchmark sites. Of these, 17 were active this year: 10 perennial sites and 7 annual sites. Several sites that were previously classified as perennial have been converted to annual due to increased land-use pressure associated with high commodity prices. A small number of sites were retired from the network entirely following changes in land ownership or access restrictions. Benchmark site classifications and coverage will continue to be revisited annually based on observed trends and logistical considerations.

Assessment procedures include remote sensing techniques (i.e., satellite, RPAS) and on-the-ground evaluations of crop health, yields, and wildlife-related damage patterns. Assessment methods were based on published standards, where available, and included clipping and drying of forage samples, enumerative evaluations of plants, tillers, heads, pods, and seeds, as well as area-based estimates of wildlife impacts and pellet counts.

Yield estimates from both annual and perennial crops were reconciled with yield information provided by the participating producers following harvest, where available.

2.3 Wildlife Habitat Utilization Monitoring

The 2024 growing season marked Blackbird's fifth season maintaining camera traps and collecting passively collected wildlife distribution and use frequency data on benchmark fields. Similarly, 2024 was the fifth year in which grazing exclusion cages were used to quantify wildlife-caused damage to perennial forage crops during the dormant season.

2.3.1 Camera Traps

A total of 55 passive, unbaited camera traps are being maintained along benchmark field perimeters throughout the CDMP focus area to monitor wildlife use patterns and frequencies (McIntyre et al. 2020, Gilbert et al. 2021, Kolowski & McShea 2021).

Camera trap data is retrieved during the growing season, formatted, and saved following provincial metadata standards (BC ECCS & FLNRORD 2019). The data is then analysed using a combination of machine learning technology and manual classification (Greenberg et al. 2019, Schneider et al. 2020, Norouzzadeh et al. 2021, Fennell et al. 2022). Classification results are analysed in R (Niedballa et al. 2016, Hongo et al. 2021).

2.3.2 Grazing Exclusion Cages

In the fall of 2024, Blackbird's team installed a total of 24 temporary grazing exclusion cages on perennial forage benchmark fields within the project area. Exclusion cages allow for an objective evaluation of dormant season impacts to forage stand composition and yields (Richer et al. 2005, Drewry et al. 2008, Medina-Roldán et al. 2012, Corgatelli et al. 2019).

Green-up assessments are completed in the spring and compare a plot within the exclusion cage to a plot adjacent to the cage location, and include pellet counts as well as plot health factors (e.g., species distribution, litter, ground, and live plant coverage, plant height, alfalfa crown development, grazing patterns). Following the assessments, the cages are removed to enable forage use during the growing season.

3 Results and Analysis

3.1 Ongoing Stakeholder Consultation & Producer Engagement

Blackbird's team has identified approximately 10,400 ha of land within the CDMP project area that is currently supporting agriculture production (not including Crown land under range tenures).

Fifty-four producers within the project area were originally engaged through direct means (i.e., phone or email) to provide information about the CDMP and offer interested producers an opportunity to participate in the program. As a result of this engagement, 49 of the producers expressed a general interest in participating in the CDMP.

These 49 producers operate on approximately 9,200 ha (88 %) of the land currently utilized for agricultural production within the project area. Of those 9,200 ha of agricultural land (partitioned into 203 fields and pastures), approximately 3,300 ha were used to produce annual crop (i.e., grain, oilseed, or pulse) during the 2022 growing season, with the remaining 5,900 ha used for perennial forage production.

Throughout the initial and ongoing producer engagements, producers consistently state that agricultural production within the CDMP project areas is subject to significant wildlife pressures. Primary species causing wildlife-related crop losses are perceived to be elk, mule deer, and black bears. For perennial forage crops, most quantitative and qualitative crop losses are believed to occur during the dormant season, particularly in the spring, with heavier losses associated with weather-induced harvest delays and a lack of available alternative foraging habitat, particularly during drought years.

3.2 Crop Damage Monitoring

Agricultural enterprises in the CDMP area operate in an environment with historically high ungulate and bear populations which exert significant pressures on most crop types (Thiessen 2009, Bridger 2016, Bridger 2018, Gagne-Delorme 2018).

Program assessment results indicate that perennial forage crops are subject to slightly lower crop losses during the growing season than annual crops. However, perennial crops in several of the benchmark fields have been observed to experience significant suppression losses during the dormant season. The absolute levels of yield losses in the monitored field crops continue to be a function of, at a minimum:

- the crop type,
- the location of the field or pasture on the landscape,
- ongoing nearby construction activities,
- seasonal wildlife migration patterns,
- annual weather patterns, and
- the time of year when the damage occurred.

Throughout the 2024 growing season, field methods and techniques, including loss assessments as well as remote sensing and on-the-ground crop health evaluations, were utilized based on past learnings and further refined to fit program information requirements.

3.3 Wildlife Habitat Utilization Monitoring

Camera trap maintenance and data retrieval is completed during crop health and wildlife damage assessment work throughout the growing season to minimize private land access requirements.

The camera trap network was active for a total of 69,944 camera trap days in 2023, with a total of 65,417 images collected. A preliminary classification indicates that the collected image data comprise:

- 41.8 % false trigger events (i.e., images collected when a camera trap is triggered but no animal, human, or vehicle is traversing its detection area),
- 49.3 % wildlife,
- 5.1 % domestic animals (primarily cows, bison, and horses), and
- 3.8 % humans or vehicles.

The most dominant wildlife species recorded to date is elk, which represents 19.6 % of the trigger events, with mule and white-tailed deer as the second numerous species group (17.1 %). Other target species for this program include black bear (1.0 % of all images) and moose (0.7 %).

Green-up assessments were completed in late spring of 2024 to assess dormant season damage to perennial forage crops within the project area. Plant health assessments were completed within the exclusion cages (i.e., unaffected by potential wildlife), to areas immediately adjacent to the cages. Several benchmark fields displayed signs of high wildlife pressure on perennial crops, with the majority damage caused specifically by elk utilizing these fields in early spring.

4 Recommendations

In compliance with EAC Condition No. 31, field surveys and producer engagement efforts will resume during the 2025 growing season with the goal of continuing monitoring until five years after reservoir filling. Similarly, Blackbird's team will continue to work closely with agricultural producers, agricultural associations, producer groups, and government agencies that may have data or local knowledge related to this monitoring plan.

No significant changes to the monitoring plan are planned for the coming 2025 growing season, however, the following refinements will be implemented:

1. Continue to complete RPAS assessments of benchmark sites through the 2025 growing season to document crop development, delineate crop health patterns, estimate forage yields, and objectively record wildlife impacts to field crops.

2. Continue destructive sampling of forage crops on benchmark fields during the growing season to further standardize and verify yield estimates and allow for an accurate characterizations of wildlife-related crop losses to growing stands. Implement non-destructive sampling approaches (e.g., rising plate meters, multispectral estimation methods) to further refine field methods for perennial forage assessments.

3. Utilize exclusion cages on select benchmark fields to allow for an objective evaluation of dormant season impacts to forage stand composition and yield.

5 Closure

Services provided by Blackbird for this technical report have been conducted in a manner consistent with the level of skill, care, and competence ordinarily exercised by registered members of the profession of agrology and biology currently practicing under similar conditions and like circumstances in the same jurisdiction in which the services were provided.

The conclusions of this report are based in part on information provided by others. Blackbird believes this information to be accurate but cannot guarantee or warrant its accuracy or completeness.

The information presented in this report was acquired, compiled, and interpreted exclusively for BC Hydro for the purposes described in this report.

If you have questions with regards to this report, feel free to contact Blackbird's team at your convenience by email at info@blackbird.ca.

6 References

BC Hydro. 2025. Site C advances with third generating unit online. Available at: https://www.bchydro.com/news/press_centre/news_releases/2025/site-c-third-generating-unit.html (accessed June 2025).

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Dated January 25, 2013, Amended August 2, 2013.

Bridger, M. 2016. 2016 Winter Moose Survey: MU 7-34. BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Fort St. John, BC.

Bridger, M. 2018. 2018 Winter Moose Survey: MU 7-32. BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Fort St. John, BC.

British Columbia Ministry of Environment and Climate Change Strategy and Ministry of Forests, Lands, Natural Resource Operations and Rural Development (BC ECCS & FLNRORD). 2019. Wildlife Camera Metadata Protocol. Standards for Components of British Columbia's Biodiversity No. 44. Available at: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/wcmp_v1.pdf (accessed June 2025).

Corgatelli, G., Mattiello, S., Colombini, S. and Crovetto, G.M. 2019. Impact of red deer (Cervus elaphus) on forage crops in a protected area. Agricultural Systems, 169, pp.41-48.

Drewry, J.J., Cameron, K.C. and Buchan, G.D. 2008. Pasture yield and soil physical property responses to soil compaction from treading and grazing – a review. Soil Research, 46(3), pp. 237-256.

Fennell, M., Beirne, C. and Burton, A.C. 2022. Use of object detection in camera trap image identification: assessing a method to rapidly and accurately classify human and animal detections for research and application in recreation ecology. Global Ecology and Conservation, 35, p.e02104.

Gagne-Delorme, A. 2018. 2018 Elk Survey in 7-20A. BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Fort St. John, BC.

Gilbert, N.A., Clare, J.D., Stenglein, J.L. and Zuckerberg, B. 2021. Abundance estimation of unmarked animals based on camera trap data. Conservation Biology, 35(1), pp. 88-100.

Greenberg, S., Godin, T. and Whittington, J. 2019. Design patterns for wildlife-related camera trap image analysis. Ecology and Evolution, 9(24), pp. 13706-13730.

Hongo, S., Nakashima, Y., Yajima, G. and Hongo, S. 2021. A practical guide for estimating animal density using camera traps: Focus on the REST model. bioRxiv, pp. 2021-05.

Kolowski, J.M., Oley, J. and McShea, W.J. 2021. High-density camera trap grid reveals lack of consistency in detection and capture rates across space and time. Ecosphere, 12(2), p.e03350.

McIntyre, T., Majelantle, T.L., Slip, D.J. and Harcourt, R.G. 2020. Quantifying imperfect camera trap detection probabilities: implications for density modelling. Wildlife Research, 47(2), pp.177-185.

Medina- Roldán, E., Paz-Ferreiro, J. and Bardgett, R.D. 2012. Grazing exclusion affects soil and plant communities, but has no impact on soil carbon storage in an upland grassland. Agriculture, Ecosystems & Environment. 149:118-23.

Niedballa, J., Sollmann, R., Courtiol, A. and Wilting, A. 2016. camtrapR: an R package for efficient camera trap data management. Methods in Ecology and Evolution, 7(12), pp. 1457-1462.

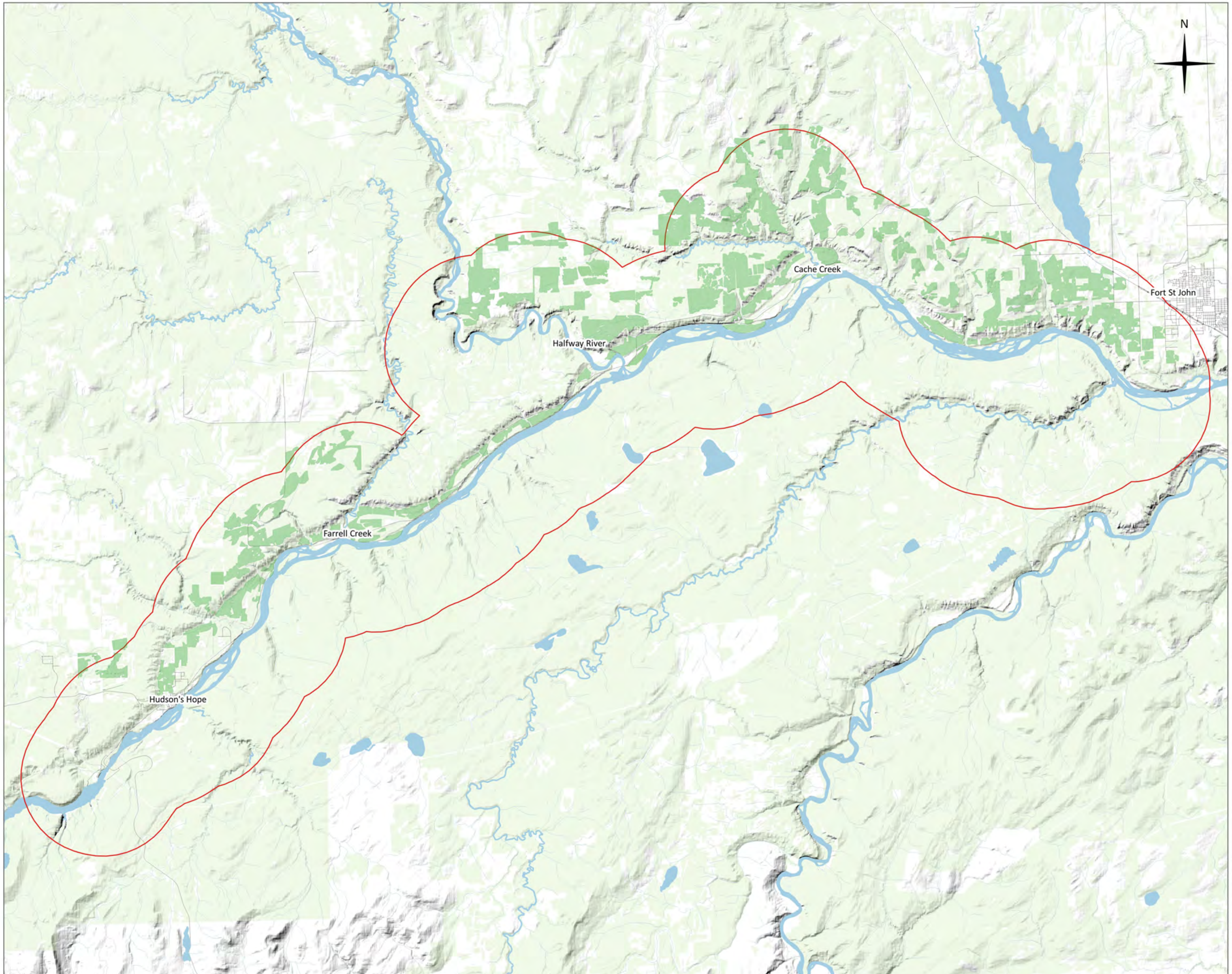
Norouzzadeh, M.S., Morris, D., Beery, S., Joshi, N., Jojic, N. and Clune, J. 2021. A deep active learning system for species identification and counting in camera trap images. Methods in Ecology and Evolution, 12(1), pp. 150-161.

Richer, M.C., Oullet, J.P., Lapointe, L., Crête, M. and Huot, J. 2005. Impacts of white-tailed deer grazing in hay fields of southern Québec. Wildlife Society Bulletin, 33(4), pp.1274-1281.

Schneider, S., Greenberg, S., Taylor, G.W. and Kremer, S.C. 2020. Three critical factors affecting automated image species recognition performance for camera traps. Ecology and evolution, 10(7), pp. 3503-3517.

Thiessen, C. 2009. Agriculture Zone Elk Inventory 2007/2008. Ministry of Environment, Fort St. John, BC.

Appendix A Project Area Overview



BC Hydro and Power Authority

Crop Damage Monitoring Program
Project Area Overview

Horizontal Scale 1:250,000

0 2 4 6 8 10 km

Map to scale when plotted on a page 280 mm x 432 mm (Tabloid)

Legend

- CDMP Project Area
- Agricultural Fields and Pastures
- Lakes & Rivers
- Road Network

Disclaimer

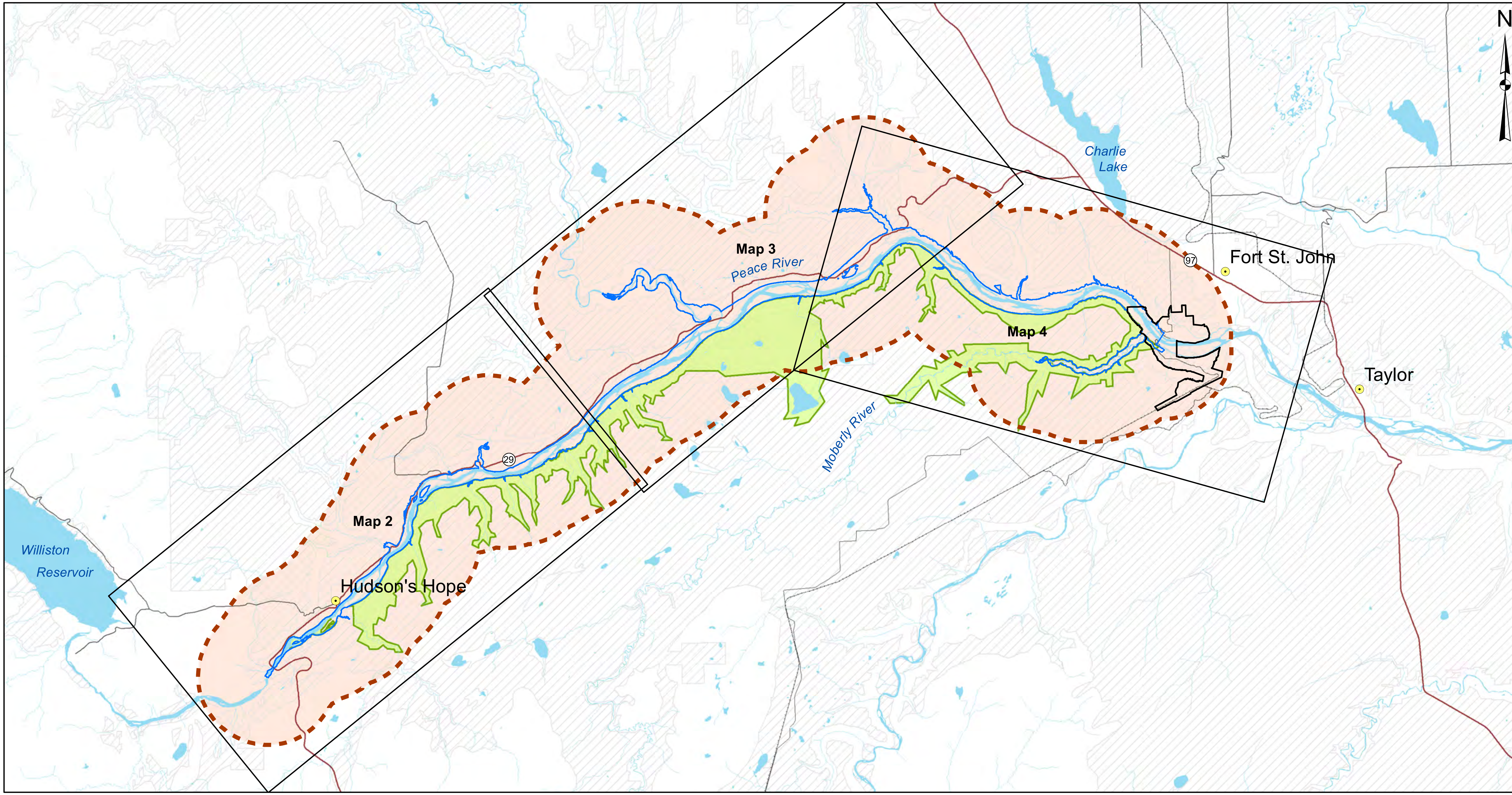
UTM Zone 10, NAD 83
Date of data acquisition: n/a
Data Credit: Blackbird Environmental Ltd., BC Geodata Warehouse
For representational purposes only, all locations are approximate.

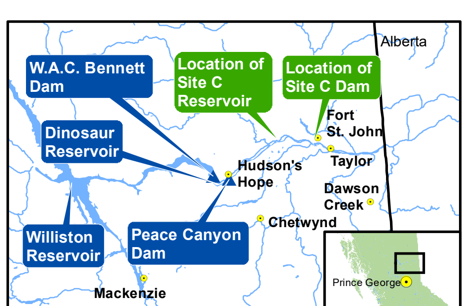
Our File:	21006	Gov. File #:	n/a	Revision #:	0
Client File:	n/a	GIS:	ML	Date:	June 12, 2021

Blackbird Environmental

blackbird.ca
Fort St. John, BC
250.793.7262

Figure 1





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for wildlife habitat utilization monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area
- Town
- Road
- Highway
- Railway

1:280,000

0 5 km

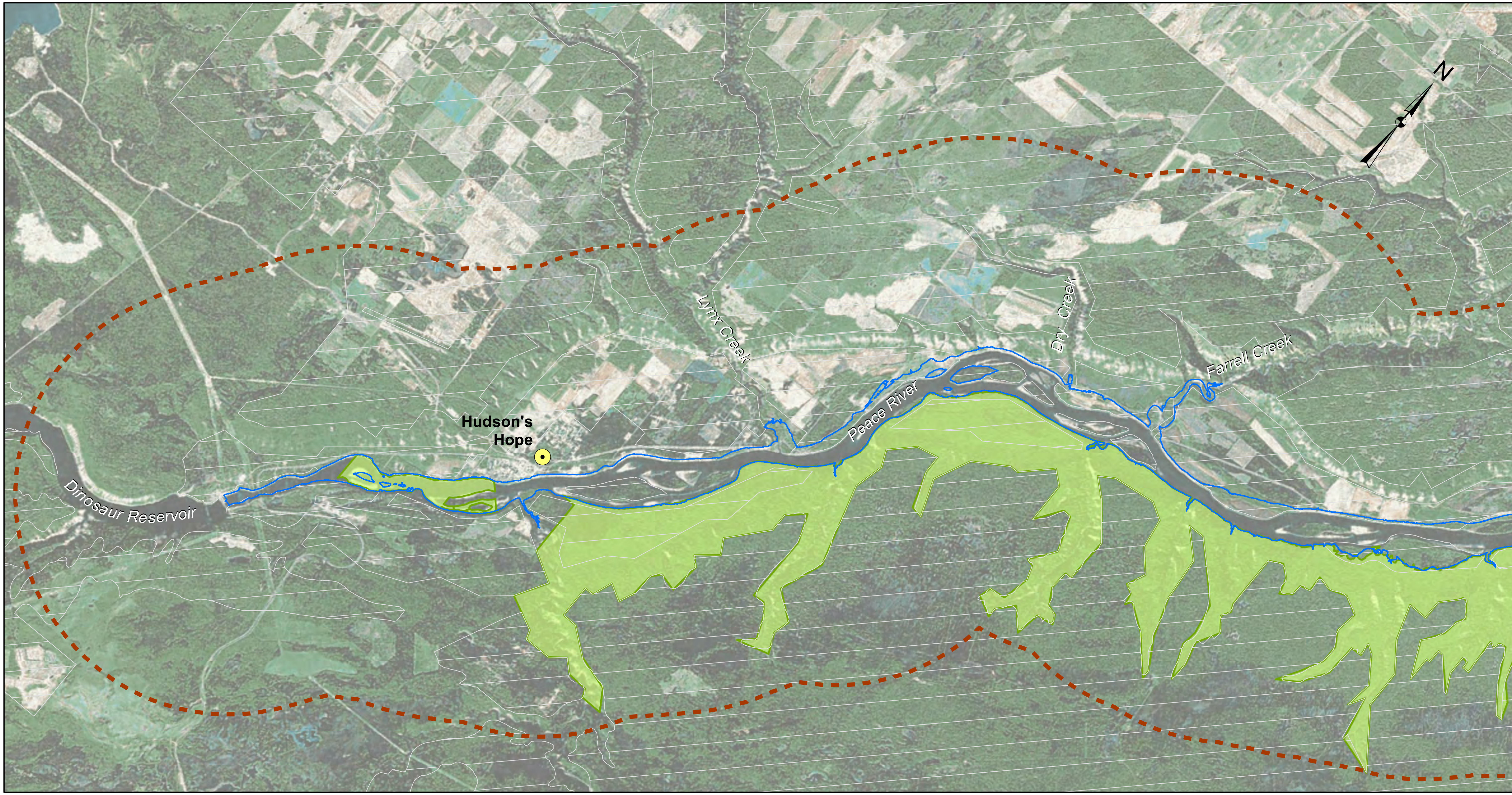
BC Hydro

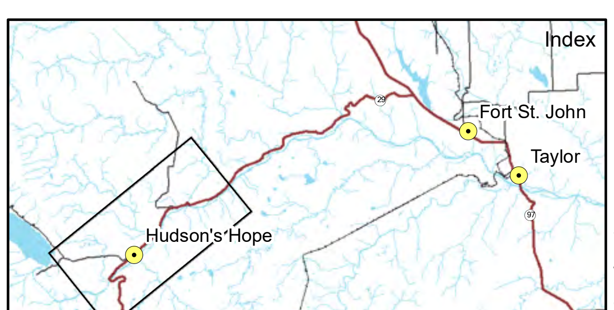
Wildlife Habitat Utilization Monitoring Area Identification - Overview Map 1 of 4

Date	July 14, 2016	DWG NO	1016-C14-07343-1	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGISProjects\Environment\Agriculture\Ag_5kmReservoirBoundary_Overview_1016_C14_07343-1.mxd





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos provided by ESRI
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for wildlife habitat utilization monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

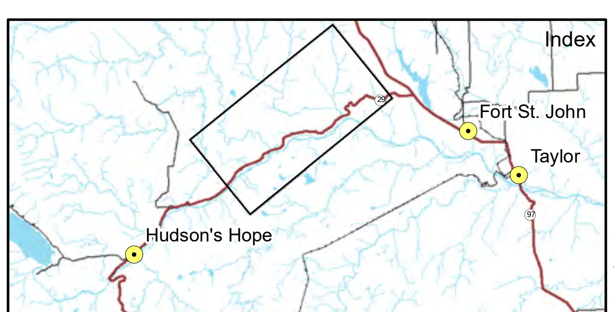
BC Hydro

Wildlife Habitat Utilization Monitoring Area Identification - Map 2 of 4

Date	July 14, 2016	DWG NO	1016-C14-07342-2	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGISProjects\Environment\Agriculture\Ag_5kmReservoirBoundary_1016_C14_07343-2-4.mxd



1:90,000

0 2 km

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos provided by ESRI
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for wildlife habitat utilization monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

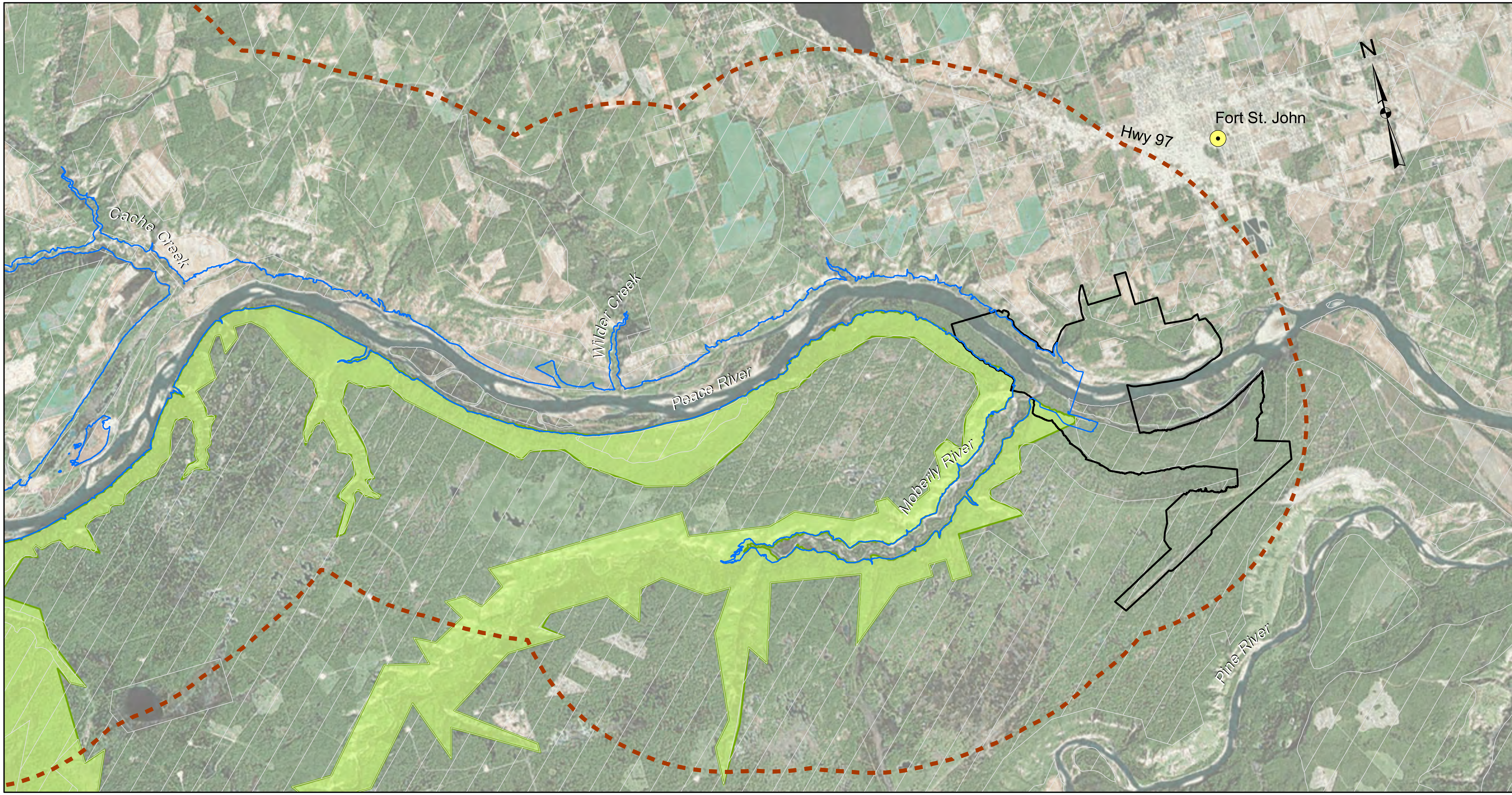
BC Hydro

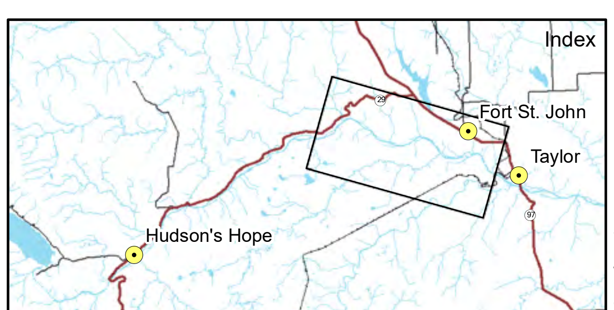
Wildlife Habitat Utilization Monitoring Area Identification - Map 3 of 4

Date	July 14, 2016	DWG NO	1016-C14-07342-3	R 0

Path: X:\ArcGIS\Projects\Environment\Agriculture\Ag_5kmReservoirBoundary_1016_C14_07343-2-4.mxd

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos provided by ESRI
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for wildlife habitat utilization monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:90,000

0 2 km

BC Hydro

Wildlife Habitat Utilization Monitoring Area Identification - Map 4 of 4

Date	July 14, 2016	DWG NO	1016-C14-07342-4	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGIS\Projects\Environment\Agriculture\Ag_5kmReservoirBoundary_1016_C14_07343-2-4.mxd

Appendix B – Crop Drying and Humidity Monitoring Program Report

REPORT

SITE C AGRICULTURAL CLIMATE REPORT

FORT ST. JOHN, BC

2025 PRE-RESERVOIR REPORT

RWDI # 2410907

July 17, 2025

SUBMITTED TO

Dan Gorton, B.Sc., P.Ag., PMP
Senior Environmental Coordinator
Physical Environment
Site C Clean Energy Project
Dan.Gorton@bchydro.com

BC Hydro
Site C Consultation Office
Fort St. John, BC

SUBMITTED BY

Laura Dailyde, P. Eng., PMP
Senior Project Manager / Associate
Laura.Dailyde@rwdi.com

Christian Reuten, Ph.D., ACM, CAQP
Technical Director / Associate
Christian.Reuten@rwdi.com

Iain Hawthorne, Ph.D.
Senior Field Specialist
Iain.Hawthorne@rwdi.com

RWDI
Suite 280 – 1385 West 8th Avenue,
Vancouver, Canada, V6H 3V9
T: 604.730.5688
F: 519.823.1316

EXECUTIVE SUMMARY

This report provides a summary and analysis of measured eddy covariance (EC) evapotranspiration (ET), modelled climate moisture deficit (CMD), and calculated good drying days (GDD) from a crop drying model (Dyrer and Brown, 1977), for the five-year period before filling of the Site C Dam (2019-2023) in Northeastern British Columbia.

Upgrades were made to the EC systems at Stations 1 and 4 of the climate station network for BC Hydro's Site C ("the Project") in 2024 to allow easier and more timely computation of hourly ET and reduce down time from aging equipment as the Project moves into the phase of monitoring the impacts of the filled dam on local climate and crop drying.

The Peace Region has been increasingly under drought conditions from 2019 through 2023, and soil moisture was very low at the beginning of 2023 (RWDI 2024). The Peace River region entered drought level 4 by June 23rd, 2023, because of rapid melt of a below-average snowpack and the warmest May-June period for more than 80 years (RWDI, 2024). Climate from 2019 through 2023 was increasingly warm and dry, in agreement with the expected effects of the Pacific Decadal Oscillations. It was observed that vegetation growth was slow and low in 2023, likely the result of the early-season dry conditions.

The highest EC ET at Stations 1 and 4 was measured in 2020, the year with the highest annual and growing season (GS) precipitation amounts at both stations. Cumulative measured ET at Station 1 was at its lowest in 2023, and modelled ET was comparable to the much cooler, wetter year in 2020. Statistical analyses indicated that increasing EC ET amounts correlate with increasing GS volumetric water content. A similar relationship was found between modelled ET and precipitation amounts. The modelled ET values were consistently higher than the measured EC values, suggesting that the model does not capture these controls well in this environment, and this is under review.

The calculated CMD increased from 2018 through 2022, and it decreased in 2023 compared to 2021 and 2022, caused by lower GS ET. During that year, the lowest average GS effective precipitation was also experienced. Some variables of importance are not well captured in this analysis. These are likely to include variations in stomatal conductance depending on vegetation type, plant growth stage, canopy structure, and vapour pressure deficit.

The cumulative GDD estimated for each year follow a slightly different trend from the CMD and can be seen to generally increase from 2018 through 2023, decreasing only in 2022 when compared to 2021. The year 2023 had the highest average GDD count of 140 days. As mentioned earlier, 2023 was the warmest growing season on average and had the lowest effective precipitation. Again, certain variables of importance are not well captured in this analysis.

Results in this report suggest that GS air temperature and precipitation are the most important variable controlling annual average CMD and GDD. Furthermore, the results suggest an important need to model ET, CMD and crop drying index for GDD output over period extended back into the cool phase of the Pacific Decadal Oscillations and to keep note of this during future analyses as data become available following the dam being filled.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

VERSION HISTORY

Index	Date	Pages	Authors
1	July 17, 2025	All	Iain Hawthorne, Ph.D. Christian Reuten, Ph.D., ACM

ACRONYMS

CDI	Crop Drying Index
CDM	Crop Drying Model
CMD	Climate Moisture Deficit
DM	Dry Matter (content)
DR	Drying Rate
EBC	Energy Balance Closure
EC	Eddy Covariance
EIS	Environmental Impact Statement
EP	Effective Precipitation
ET	Evapotranspiration
FCRN	Food Climate Research Network
FHAYD	Field Hay Drying Model
G	Soil Heat Flux
GDD	Good Drying Days
GS	Growing Season
H	Sensible Heat Flux
HF	High Frequency
Hz	Hertz
IRGA	Infrared Gas Analyzer (Open Path)
PET	Potential Evapotranspiration
PT	Priestley and Taylor
RWD	Rewetting through Dew Formation
RWP	Wetting Rate from Precipitation
VWC	Volumetric Water Content (soil)

1 INTRODUCTION

BC Hydro's Site C Clean Energy Project (the Project) in British Columbia's Peace region will create a new hydroelectric dam and generating station on the Peace River in the vicinity of the City of Fort St. John. To characterize the microclimate and to provide a baseline to assess future changes caused by the Project, BC Hydro installed a network of climate monitoring stations in the Peace River Valley. This network has been active since 2011, through the preparation and submission of the Project's Environmental Impact Statement, and throughout Project construction, which began in mid-2015.

We acknowledge this work is being conducted on the traditional territory of Treaty 8 First Nations of Dunne Zaa, Cree, and Tse'khene cultural descent.

The Site C Clean Energy Environmental Impact Statement (EIS) (BC Hydro, 2013) identified reservoir-induced changes to microclimate on adjacent agricultural operations as a key indicator (EIS Section 10, Table 20.3). Effect on crop drying is one reservoir-induced change that may occur. EIS Section 20.3.6 (page 20-50, lines 27 to 36) states: "Predicting the effect that the reservoir might have on crop drying is made difficult by the complexity of the effect of the reservoir on several climatic parameters that drive both drying and wetting effects. Generally, the RWDI model predicts increases in humidity up to 15% for stations located closely adjacent to the reservoir during the summer and fall months. The model predicts the effect on humidity during the summer and fall not to be statistically significant for locations not directly adjacent to the reservoir. The RWDI report predicts that effects on fog formation from the reservoir are in the order of 0.5% or less over the year. However, due to increased humidity, the reservoir could potentially have a small effect on crop drying during summer and early fall in the Peace River valley in areas adjacent to the reservoir."

As a result of these general conclusions, a commitment was made to monitor project-induced changes to humidity within 3 km of the reservoir and to evaluate associated effects on the calculated Climate Moisture Deficit (CMD) and Growing Degree Days (GDD) computed with a Crop Drying Model (CDM), within the area. Monitoring includes continued collection and analysis of climate data from the BC Hydro monitoring network, calculation of the Crop Drying Index (CDI) (Dyer and Brown, 1977), and farm operator interviews.

This report summarizes the results of the eddy covariance (EC) component of the baseline environmental measurement program for 2019 through 2023. This technique provides a direct measurement of evapotranspiration (ET) that is then used to facilitate the computation of the CMD at each of seven climate stations available for this study. The CMD for each station is then used as an input to a CDM, which computes the CDI and outputs GDD for each location. Using the annual averages measured and calculated in earlier years, an interannual spatial average has been calculated for each station to be used for comparison against the period after the dam is filled.

2 METHODS

The seven climate stations available for this study are listed in Table 2-1. As part of the collection of baseline environmental data for the Project area, EC systems continue to be operated at two meteorological stations: Station 1 (Attachie Flat Upper Terrace, installed on January 13, 2011) and Station 4 (Bear Flat, installed on December 2, 2010). Station locations are shown in Figure 2-1. Land use and ground cover vary between locations and station (Table 2-2).

Table 2-1: Available climate stations

Station Name	Latitude, Longitude	Elevation (m)	Distance (m)[1]
Station 1 – Attachie Flat Upper Terrace	56.23°N, -121.42°W	479	209
Station 3 – Attachie Plateau	56.23°N, -121.46°W	645	522
Station 4 – Bear Flat	56.27°N, -121.21°W	474	73
Station 6 – Farrell Creek	56.12°N, -121.70°W	471	70
Station 7B – Site C North Camp (Station 7 for short)	56.20°N, -120.90°W	581	573
Station 10 – Tea Creek	56.24°N, -120.95°W	653	812
Station 11 – Taylor	56.17°N, -120.76°W	411	9744

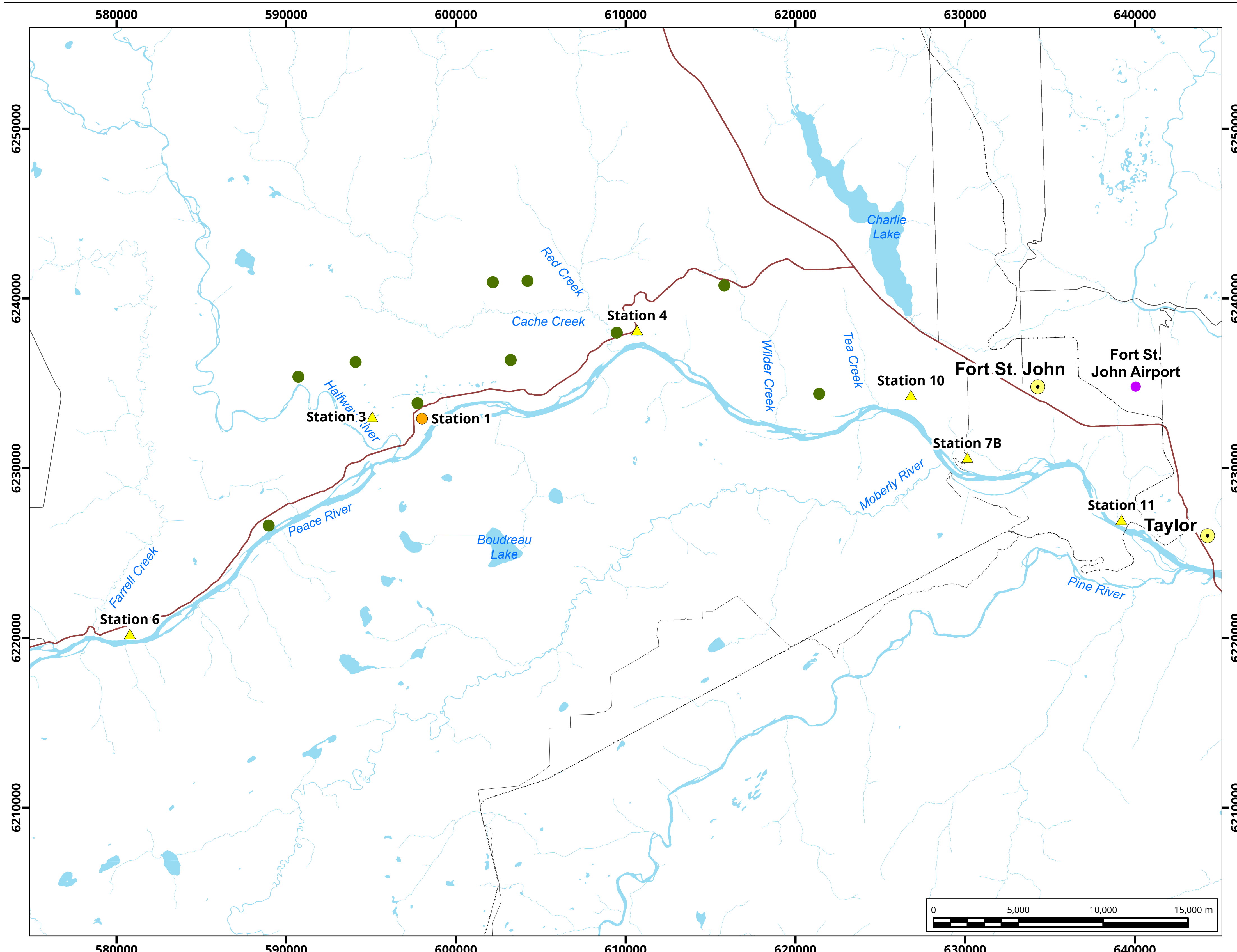
Notes: [1] Approximate distance from the reservoir high water mark.

Table 2-2: Dominant ground cover

Station Name	Dominant Ground Cover				
	2019	2020	2021	2022	2023
Station 1 – Attachie Flat Upper Terrace	Wheat and wild grasses	Wheat and wild grasses	Canola and wild grasses	Canola and wild grasses	Wheat and wild grasses
Station 3 – Attachie Plateau	Wheat and wild grasses	Wheat and wild grasses	Wheat and wild grasses	Wheat and wild grasses	Wheat and wild grasses
Station 4 – Bear Flat	Pasture (Grasses/wildflower/clover/alfalfa)	Pasture (Grasses/wildflower/clover/alfalfa)	Pasture (Grasses/wildflower/clover/alfalfa)	Pasture (Grasses/wildflower/clover/alfalfa)	Pasture (Grasses/wildflower/clover/alfalfa)
Station 6 – Farrell Creek	Unmanaged pasture (Grasses/wildflower/small shrubs)	Unmanaged pasture (Grasses/wildflower/small shrubs)	Unmanaged pasture (Grasses/wildflower/small shrubs)	Unmanaged pasture (Grasses/wildflower/small shrubs)	Unmanaged pasture (Grasses/wildflower/small shrubs)

Station Name	Dominant Ground Cover				
	2019	2020	2021	2022	2023
Station 7B – Site C North Camp (Station 7 for short)	Work site (Grasses/wildflower/small shrubs)	Work site (Grasses/wildflower/small shrubs)	Work site (Grasses/wildflower/small shrubs)	Work site (Grasses/wildflower/small shrubs)	Work site (Grasses/wildflower/small shrubs)
Station 10 – Tea Creek	Forage (alfalfa/clover)	Forage (alfalfa/clover)	Forage (alfalfa/clover)	Forage (alfalfa/clover)	Forage (alfalfa/clover)
Station 11 – Taylor	Unmanaged pasture (Grasses/wildflower/small shrubs)	Unmanaged pasture (Grasses/wildflower/small shrubs)	Unmanaged pasture (Grasses/wildflower/small shrubs)	Unmanaged pasture (Grasses/wildflower/small shrubs)	Unmanaged pasture (Grasses/wildflower/small shrubs)

One of the requirements of this monitoring program is to monitor climate variables to be used in the calculation of CMD and CDM within 3 km of the reservoir. Efforts are being made to better characterize differences between locations with the potential for feedback during farmer interviews. Table 2-1 shows that the climate stations provide spatial coverage up to 812 m from the reservoir edge. The inclusion of Station 11, a station approximately 9.7 km from the reservoir edge and outside the 3-km study area, will be helpful in monitoring downstream climate effects on agriculture after reservoir filling.



Legend

- Farm Interview Homes
- Meteorological and AQ
- Meteorological Only
- Environment Canada Meteorological Station
- City/District Municipality

Service Layer Credits: Hydrological and transportation data retrieved from Geogratis, 2021.

Station Location Map

Map Projection: NAD 1983 UTM Zone 10N

True North

Project #: 2410907

Drawn by: DJH	Figure: 2-1
Approx. Scale: 1:250,000	
Date Revised: July 10 2025	

Map Document: C:\GIS Temp - Copy\1601625\Misc AQ Deliverables\1601625_BC_Hydro_Misc_AQ_Deliverables.aprx

2.1 Eddy Covariance Measurements

The EC technique has become the standard method for measuring sensible heat flux (*H*) and latent heat flux (λ*E*) over footprints of ≤ 1 km^2 (Baldocchi, 2003). Knowledge of the partitioning of available energy (R_n – *G*, or net radiation minus soil heat flux) between sensible and latent heat fluxes is critical for understanding the interaction of the measured ecosystem with the overall water cycle, atmospheric boundary layer development, weather, and climate (Wilson et al. 2002).

Since the installation, continuous 10-Hz measurements of the three components of the wind vector and air temperature have been made using a 3-dimensional ultrasonic anemometer (model CSAT3, Campbell Scientific Inc. (CSI), Logan, Utah), while 10-Hz turbulent fluctuations of carbon dioxide (CO_2) and water (H_2O) vapour have been measured using an open-path infrared gas analyzer (IRGA) (model LI-7500A, LI-COR, Inc., Lincoln, Nebraska). Signals were measured with a data logger (CSI, model CR1000) with a synchronous-device-for-measurement connection. High frequency (HF) data were stored on a compact flash card that was replaced every 2-3 weeks, access and operations permitting. Half-hourly covariances and other statistics were calculated on the data logger (to provide near-real time diagnostics) and from the raw HF data using in-house MATLAB processing code.

Due to aging equipment, after more than 10 years of constant operation, a system upgrade was required. In June 2024, both EC systems at Stations 1 and 4 were upgraded to collect and process data through the Licor SMART Flux system. Basic flux computations remained the same, and efforts are being made to compare flux computation methods pre and post upgrade. The HF and computed flux data are now being backed up to an industrial USB with efforts ongoing to provide remote access to instrumentation for better observational capabilities.

The fluxes *H* and λ*E* were calculated as the half-hourly covariances of the sonic air temperature and H_2O mixing ratio with the vertical wind velocity (*w*). Further details of the flux calculations can be found in Brown et al. (2010). Latent heat flux *λE* is calculated using Equation 1 below.

$$\boldsymbol{\lambda E = \lambda \rho_a \overline{w' s_v{}'}} \qquad \text{Equation 1}$$

where ρ_a is the dry air density, *w* is the vertical wind velocity, s_v is the H_2O mixing ratio, λ is the latent heat of vaporization, and the primes indicate fluctuations from the half-hourly mean value and the overbar indicates the time average. The calculation is a 30-minute block average with no detrending applied.

For each year of available data (2018-2023), the CMD was calculated and CDM run using a daily time step to allow the computation of cumulative monthly and GS GDD.

2.2 Climate Moisture Deficit Calculations

Daily potential evapotranspiration (PET) from May to September was calculated each year for each of the seven BC Hydro climate stations, for which air temperature (T_a), net radiation (R_n), and precipitation (P) data were collected, using the Priestley-Taylor (PT) energy balance formulation (Priestley and Taylor, 1972) in Equation 2 below. This approach has been shown to accurately estimate PET (LE_0) from a forage crop in the Peace River region of British Columbia (Davis & Davies, 1981; Davis, 1978).

$$\boldsymbol{LE_0 = \frac{1}{L}\alpha\frac{s}{s+\gamma}(R_n - G)} \text{ or } \boldsymbol{\lambda E = \alpha\frac{s}{s+\gamma}(R_n - G)} \quad \text{Equation 2}$$

where:

$LE_0 = \frac{\lambda E}{L}$ = potential evapotranspiration (mm day^{-1});
λE = latent heat flux (W m^{-2} day^{-1});
L = volumetric latent heat of evaporation for water (W m^{-2} day^{-1});
s = slope of the saturation vapour pressure-temperature curve;
γ = psychrometric constant;
R_n = net radiation flux at the surface (W m^{-2} day^{-1});
G = soil heat flux (W m^{-2} day^{-1}); and
α = the PT proportionality constant (shown to have a value close to 1.26 in studies in the Peace River region (Davis & Davies, 1981) and elsewhere).

By making direct measurements of ET using EC, the PT equation can be re-arranged to provide an improved estimate of α. For consistency in the computations and comparisons and to correct for difference in instrumentation between the climate stations, the R_n values used were estimated from:

0.559 * Incoming Shortwave Radiation - 17.9 W m^{-2} (Golder, 2012, Appendix A)

A growing season (GS) assessment of the daily PT proportionality constant α was performed by comparing modelled LE_0 estimates to EC measured LE_0. In this way, an improved parametrization of the PT energy balance model was possible by then selecting occasions when incoming energy and water were not limiting to plant growth to estimate α. In this report, α values determined in each year's individual analysis up to this point were used for each year's LE_0 estimates (RWDI, 2020, 2021, 2022, 2023, 2024).

The slope of the saturation vapour pressure-temperature curve (s), shown below in Equation 3, was calculated following Eq. 13 in the Food and Agriculture Organization Crop Evapotranspiration Guidelines (Allen et al., 1998) as follows:

$$s = 4098 \times 0.6108 \times \exp[(17.27 \times T_a) / (T_a + 237.3)] / (T_a + 237.3)^2 \quad \text{Equation 3}$$

where T_a = air temperature (°C) at two meters height.

A value of γ = 0.062 was used for the psychrometric constant in Equation 2 (Table 2.2 in the FAO Guidelines lists values for different altitudes above sea level).

Site-specific CMD was computed daily by subtracting the effective precipitation (*EP*) from the cumulative daily LE_0 as shown in Equation 4, for each station:

$$\boldsymbol{CMD = Cumulative\ Daily\ LE_o - \big((Cumulative\ Daily\ P - 5) * 0.75\big)} \qquad \text{Equation 4}$$

The values accumulate over the course of the GS for each station to a GS maximum by the end of September.

2.3 Crop Drying Model Calculation Steps

The CDM follows closely the Field Hay Drying Model (FHAYD) described by Dyer and Brown (1977), with improvements where measured data are now available. The main computational steps are described here. On a daily time step, a CDI is first calculated using Equation 5:

$$\boldsymbol{CDI = Cumulative\ Daily\ LE_o - (Cumulative\ Daily\ P * 0.2)} \qquad \text{Equation 5}$$

The drying rate (*DR*) and wetting rate from precipitation (*RWP*) are calculated using empirical constants provided in Dyer and Brown (1977), as shown in Equations 6 and 7:

$$\boldsymbol{DR = CDI \times 4.3} \qquad \text{Equation 6}$$

$$\boldsymbol{RWP = 0.5 \times Cumulative\ Daily\ P \times 1.03} \qquad \text{Equation 7}$$

The last wetting rate calculation accounts for rewetting through dew formation (*RWD*) only occurring on specific nights when RH > 90% and the calculated dew point temperature was above air temperature. The total amount of moisture added to the hay was computed from the average number of hours when dew was formed (X_{ave}) and could not be larger than 10%. This was multiplied by the ratio of the dry matter content (*DM*) of the crop (90%) and the day's prior moisture (M_{n-1}) content as shown in Equation 8:

$$\boldsymbol{RWD = \frac{DM}{M_{n-1}} \times \frac{0.1}{X_{ave}}} \qquad \text{Equation 8}$$

It was assumed that the starting moisture content by wet weight of the crop material was 80% at the start of each month for all stations, and the total number of days until dry (<20 % moisture content) was estimated. Additionally, the total number of GDD (defined as days when *DR* > *RWP*+*RWD*) within each month was calculated.

2.4 System Uptime/Data Loss

System uptime describes when the EC system was operating and HF data card collection was successful. Time periods when the IRGA/sonic anemometer are malfunctioning or the system experiences a power outage can contribute to data loss. At other times (e.g., CF card failure), the 30-minute fluxes that are downloaded daily can be carefully assessed for use when computations are reliable.

From 2018 through 2022, system performance at Stations 1 and 4 was reliable for reporting purposes, and data uptime was over 95% complete. Station 4 encountered problems resulting in loss of reliable EC data in 2023, and issues with HF data synchronization on the data logger increased at both stations across the years. Access to the stations was compromised in 2023 due to construction project blocking access, safety concerns due to local forest fires resulting in evacuation alerts and orders, and farm operations. Testing at Station 4 using the spare IRGA to resolve operational issues was not successful. Data loss at both stations was due to local power outages and synchronicity issues between the data logger and data card, as well as computational issues through the Station 4 data logger. Since replacing the EC data logger at Station 4 was not a viable long-term option, recommendations were made to upgrade the EC systems at Stations 1 and 4 to ensure measurement reliability into the future. The utilization of a spare IRGA allowed annual calibrations without associated data loss at Stations 1 and 4. Additionally, instrumentation at the climate stations was collecting data that could be used to gap-fill through modelling (described in Section 2.6) for any periods without computed half-hourly fluxes.

2.5 Quality Assurance and Quality Control Measures

Data from the Site C climate stations and half-hourly computed fluxes were remotely downloaded on a regular basis to RWDI computers using Campbell Scientific Loggernet software over cellular connections until the system upgrades in 2023. Since then, this has been done through the Licor Smart Flux System, with efforts ongoing to ensure remote connections for system monitoring. In addition, HF data for the EC calculations were collected monthly from data cards and are now collected from industrial USB. Stations with AC power (Stations 1 and 4) have hourly collection intervals, whereas data from solar powered stations (Stations 3, 6, 7, 10, and 11) are collected daily to preserve battery power at the stations.

Data QA procedures are in line with those used by regulatory agencies, in particular the British Columbia Ministry of the Environment and Climate Change Strategy. QA is carried out at least fortnightly. This involved running R-scripts to plot the data over the recent period to allow for a visual inspection so the operator can detect anomalous trends or data outliers. In 2024, this process was updated to use ENVISTA ARM, a more user-friendly QA/QC tool adopted to be more in line with the database management of the Ministry.

Additional monthly QA/QC is conducted to remove or flag any anomalous data points. Corrections are also applied to the data, where appropriate, such as setting precipitation to 0 mm when a large value is recorded at the same hour when maintenance was performed on the precipitation gauge in question.

The EC measurements are manually downloaded monthly on site by RWDI. The QA of these data includes:

- Plausibility checking for each variable from the IRGA and sonic anemometer (i.e., checking measurement from the EC equipment against plausible thresholds so that, for example, unreasonable wind speeds of 500 km/h or CO_2 concentrations of 20,000 ppm for the atmospheric background are discarded).
- Removal of spikes in the data.
- Flagging measurements using the diagnostic flags output by each instrument. For example, neither the sonic anemometer nor the IRGA produce reliable data during rain and snow which is indicated by a diagnostic flag, i.e., the IRGA starts reporting that its optical path is being obstructed due to water on the optical windows. Precipitation data from the climate stations are used to help confirm that the data from the IRGA and sonic anemometer can indeed be discarded during these periods.

- Checking the energy balance closure (EBC). A CNR4 4-way radiometer and soil heat flux plates are operated at the EC sites. Because of conservation of energy, the net radiation (R_n) as measured by the CNR4 minus the soil heat flux (G) as measured by the soil heat flux plates should equal the sum of the sensible heat flux (H) and latent heat (water vapour) flux (λE) measured by the EC equipment. Any difference is checked and reported to show the degree to which the EC method is capturing all turbulent fluxes.
- Redundant measurements are used to check the EC instrumentation such as air temperature (obtained from the sonic anemometer) and humidity (from the IRGA).

All QA/QC tasks have both automated and manual components. Every EC trace is inspected after the data is collected, so as not to rely completely on automation.

In a natural forest or grassland ecosystem, filling data gaps in the λE fluxes would typically be accomplished using protocols slightly modified from those used in the Fluxnet Canada Research Network and the Canadian Carbon Program (Barr et al., 2004; Brown et al., 2010). This approach is best suited to natural ecosystems where the response of the local vegetation is largely the result of the integration of the phenological response of the individual species of plants and trees and environmental variables such as light, air and soil temperatures, and moisture.

In the agricultural settings of the Site C EC stations, the biological response is affected by human factors such as farmers controlling the timing of sowing and planting. Gap-filling of the latent heat flux λE was accomplished using the EBC model approach (Amiro et al., 2006) with no additional uncertainty as the sensible heat flux H continued to be measured throughout the IRGA calibration period.

2.6 Uncertainty Analysis

Uncertainties associated with calculating annual totals of ET from the half-hour EC fluxes were determined using techniques detailed extensively elsewhere (Brown et al. 2010, Krishnan et al. 2006, Morgenstern et al. 2004). Random errors were assessed using propagation of errors following Morgenstern et al. (2004), in which up to a 20% error is randomly assigned to each half-hourly measured flux (λE). The uncertainty due to the gap filling algorithms was estimated using Monte Carlo simulation following the procedure of Krishnan et al. (2006). Briefly, gaps were created in annual λE ranging from a half-hour to ten days in length, and a uniformly distributed random number generator was applied to day- and night-time readings separately to approximate the typical diurnal distribution of data gaps in the annual dataset for each site. For each iteration, these gaps were filled using the standard Food Climate Research Network (FCRN) gap filling approach as modified by Brown et al. (2010). This procedure was repeated 1,000 times, and the simulated annual values of ET were then sorted to determine the 95% confidence intervals. For the Site C EC stations, the combined random and systematic errors introduced from the gap filling procedure was approximately 10 mm for the annual ET.

Finally, as was standard Fluxnet protocol, the annual totals for ET reported were initially not corrected for EBC. Performing this correction on λE was important prior to use in the calculation of the CMD and in the CDM, and so this was done to provide the most accurate estimate of ET.

For the results and analyses below, monthly GDD was computed only for:

- days, months, and years with >75% of the hourly values were used; and
- months with 90% of the days available, were used

Previous years' results were recalculated with these criteria; therefore, some values differ from the earlier released annual reports.

3 RESULTS

The measured climate variables used as input to the CMD calculation and CDM are summarized across the months and years from 2019 through 2023 to help characterize differences between the stations and potential influences on ET. The Pacific Decadal Oscillation (PDO) is introduced to assess its potential influence on regional climate. Following that, ET measurements at Stations 1 and 4 are summarized and relationships with important climate variables investigated. Lastly the interannual difference in the CMD and GDD output from the CDM is summarized and discussed in the context of relationships established with the measured ET.

3.1 Model Input Climate Variables

This section provides a review of BCH Site C climate station data with a focus on input variables of interest to the CMD and CDM. Previous annual reports describe in detail the climate conditions for each year.

3.1.1 Interannual Monthly Climate

Figure 3-1 shows that the average interannual monthly air temperatures become positive in April, with the warmest month being July, and drop below zero again in November. Station 7 has the highest interannual average monthly air average temperature, likely because of its south facing aspect and nearby gravel car parks storing and radiating heat. Relative humidity is highest in January and lowest in May. Station 1 has consistently higher relative humidity than other stations, except for Station 11 in late summer and winter. This is likely due to fog forming conditions being more prevalent at these two stations because of their proximity to the Peace River. Precipitation is generally lowest in March, increasing to a maximum during the growing season in June and a secondary maximum in August.

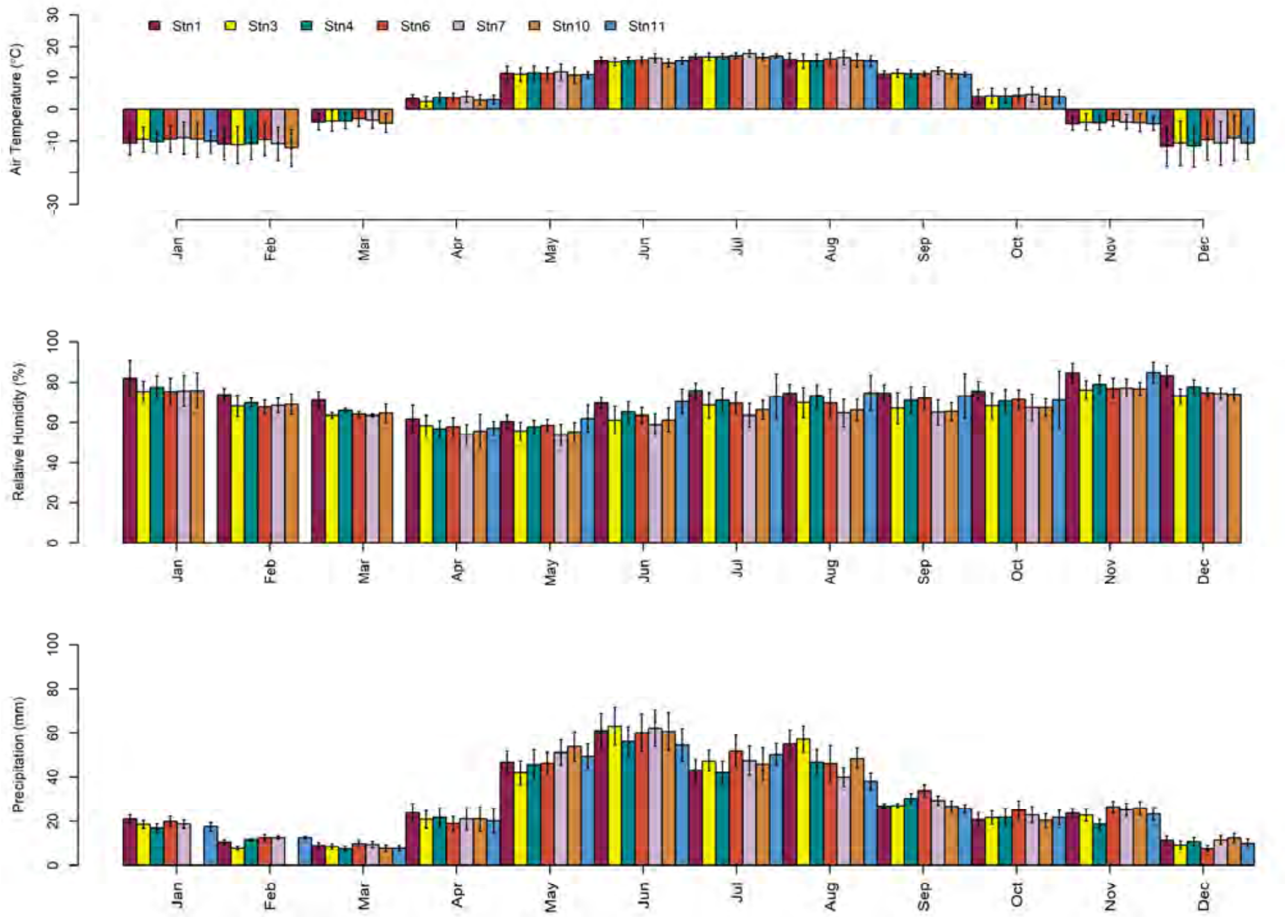


Figure 3-1: Mean interannual monthly air temperature, relative humidity, and precipitation from 2019 to 2023. Error bars are ±1 standard deviation of the stations' monthly mean values. Where gaps exist, less than 75% of the annual monthly values were available.

Figure 3-2 shows the average monthly incoming solar radiation reaching its peak during June, when daylight hours are at their maximum. On average, the monthly soil heat flux becomes positive in April after the snow melts, decreases from May through August, and becomes negative again in September as temperatures and daylight hours decrease. Finally, monthly soil water content is at its peak in April and May and decreases through the summer to a minimum in winter when the ground is typically frozen at the 10 cm measurement depth. The soil water content peaks in April and May as a direct result of snowmelt, and higher volumetric water contents in June, resulting from higher average monthly precipitation when compared to other months. Station 3 monthly volumetric water content is not showing for months before November due to extensive instrumentation malfunctions resulting from wire damage by rodents in 2019 and irreparable damage from field stubble burning in 2021.

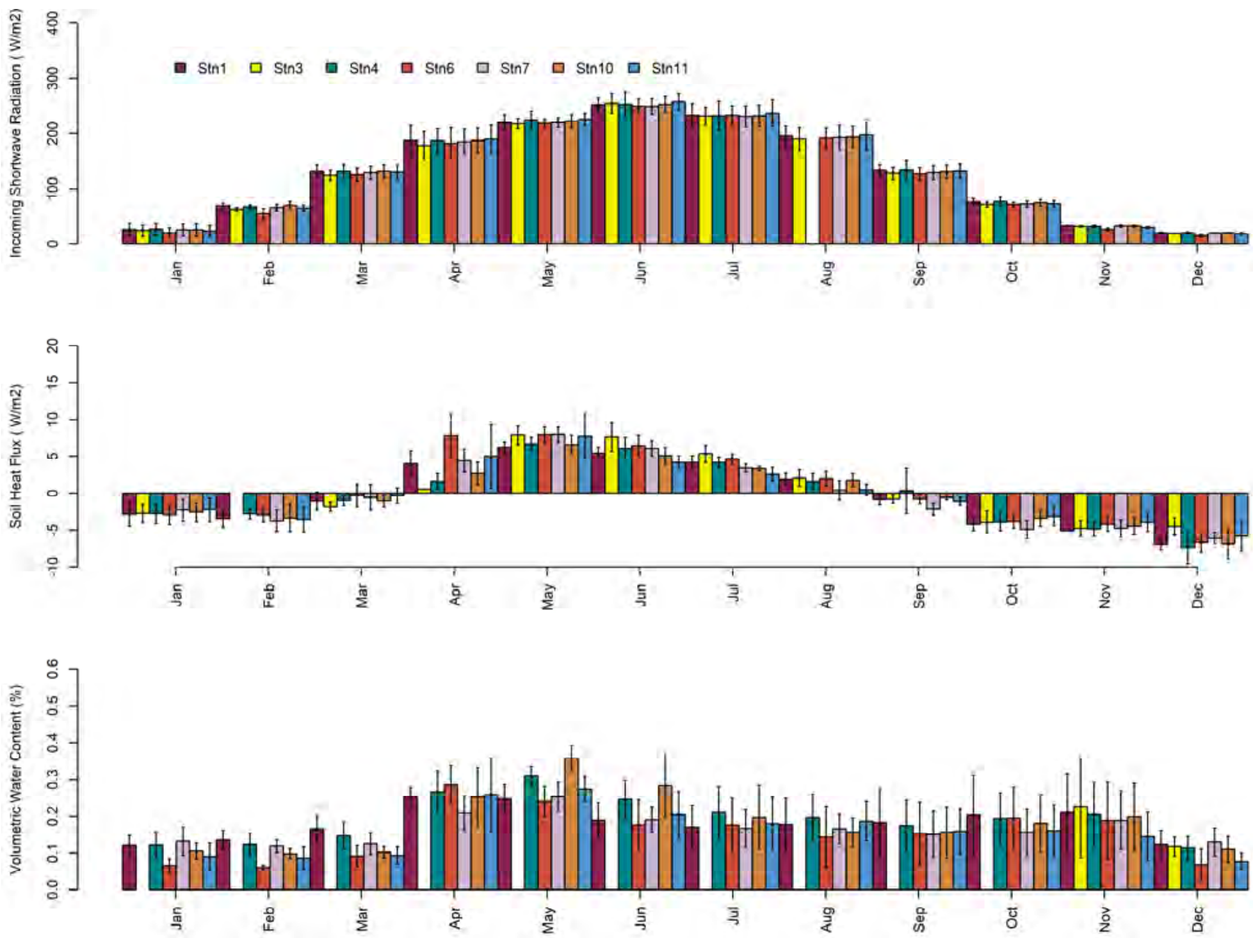


Figure 3-2: Mean interannual monthly incoming shortwave radiation, soil heat flux and volumetric water content from 2019 to 2023. Error bars are ±1 standard deviation of the stations' monthly mean values. Where gaps exist, less than 75% of the annual monthly values were available.

3.1.2 Interannual Growing Season Climate

Figure 3-3 shows annual average air temperature, relative humidity, and precipitation, averaged over all stations. Year-on-year temperatures increased, while relative humidity and precipitation generally decreased. The lowest total growing season precipitation was measured in 2023, when temperatures were the highest and relative humidity was lowest.

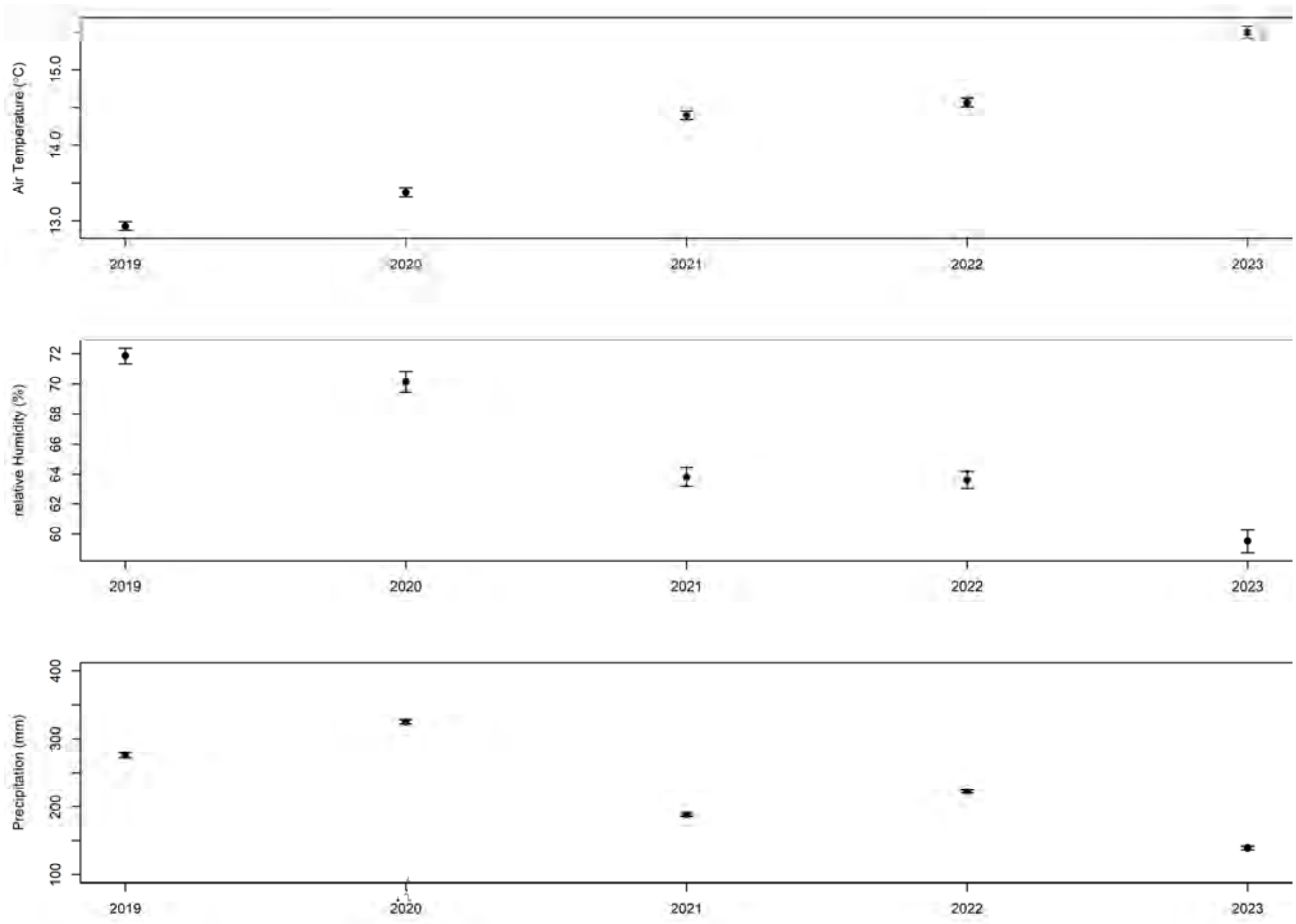


Figure 3-3: Annual air temperature, relative humidity and precipitation for all station data. Error bars are ±1 standard error of the stations hourly mean values.

Figure 3-4 shows that the annual average incoming solar radiation increased from 2019 to 2022 and decreased in 2023. The increase from 2019 to 2022 was likely caused by decreasing cloud cover related to decreased precipitation, while the extreme fire season in 2023 caused a regional decrease in incoming solar radiation. As expected from the increasing temperature and decreasing precipitation trends in Figure 3-3, Figure 3-4 shows increasing average soil heat flux and decreasing soil volumetric water content trends.

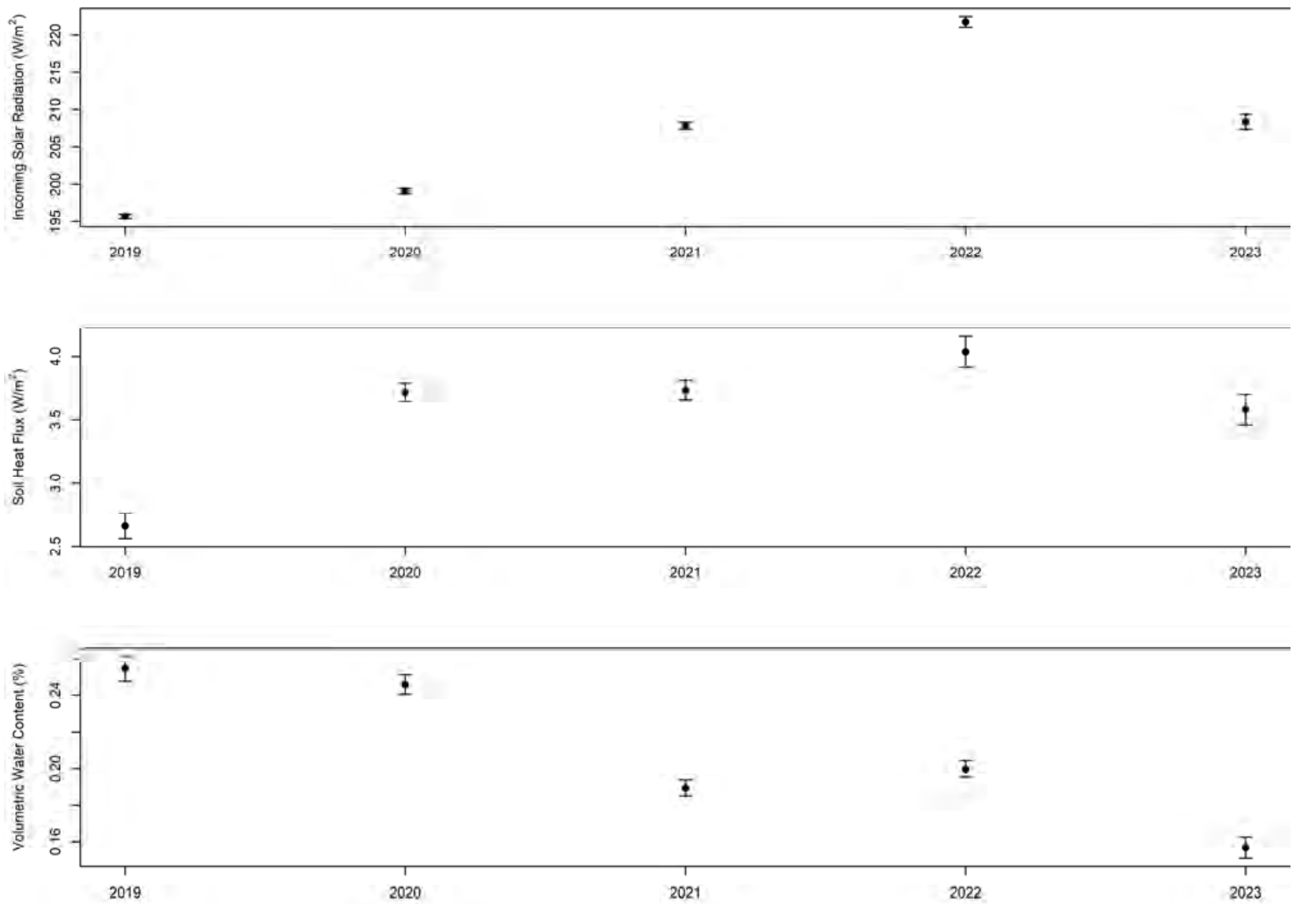


Figure 3-4: Annual incoming solar radiation, soil heat flux and volumetric water content for all station data. Error bars are ±1 standard error of the stations hourly mean values.

3.1.3 Pacific Decadal Oscillation

The Pacific Decadal Oscillation (PDO) is a pattern of climate variability identified by long-term trends in the sea surface temperatures (SST) and sea level pressures (SLP) of the Northern Pacific (Mantua, 1999). The PDO phases are classified as positive and negative. The PDO is defined as positive when SST are cool in the interior North Pacific and warm along the Pacific Coast, and SLP over the North Pacific are below average. When SST are warm in the interior North Pacific and cool along the Pacific Coast, or SLP over the North Pacific are above average, the PDO is defined as negative. Evidence shows that the PDO has been consistently negative since 2019, reaching record extreme negative values in 2024. Below-average SST along the Pacific Coast likely caused increasingly drier-than-normal conditions, while above-average SLP over the North Pacific likely preferentially favored synoptic scale patterns causing higher temperatures in the Project region. However, the Project region is sensitive to the exact location of the high SLP anomaly over the interior Pacific Ocean. A more westerly location of the positive SLP anomaly can cause lower temperatures and increased precipitation over the interior of Northern British Columbia. Most recent data suggest that this might indeed be the case this summer. There is a risk of misinterpreting the impact of the reservoir on the surrounding environment if external factors such as the PDO are not accounted for.

Measuring climate variability through years with both positive and negative PDO is important, particularly when trying to investigate climate impacts from land-use changes. Developing the CMD and CDI models for years prior to 2019 is in progress, where possible, to ideally include the 2014-2016 period of persistent positive PDO and the intermittent period from 2016 through 2019 and will be useful for better understanding the impact of the PDO on regional climate.

3.2 Evapotranspiration

Cumulative EC ET measured at Stations 1 and 4 for 2019-2023 are shown in Figure 3-5. Cumulative EC ET and P totals, GS R_n, and T_a for each year are presented for comparison in Table 3-1. Station 4 has consistently higher EC ET than Station 1. From Figure 3-5 it can be seen that very little ET occurs before 75-100 days into the year (March-April). The rate increases throughout the growing season as temperatures increase (Figure 3-2) and photosynthetic activity increases with increasing seasonal vegetation cover (Appendix B). The rate begins to taper off around days 200-250 (July-August), when soil water is more limited and vegetation begins to senesce or is harvested. The highest EC ET at both stations was measured in 2020, the same year that had the highest annual and GS P amounts at both stations.

Two-sided Kendall tau rank correlation analyses of the GS EC ET vs. GS T_a, RH, P, VWC, and R_n indicate that GS EC ET has an insignificant weak negative correlation with GS T_a (ĩ = -0.39, p-value = 0.14), an insignificant weak positive correlation with GS RH (ĩ = 0.23, p-value = 0.40), a significant weak positive correlation with GS P (ĩ = 0.56, p-value = 0.04) , a significant moderate positive correlation with GS VWC (ĩ = 0.78, p-value = 0.004), an insignificant correlation with GS R_n (ĩ = 0.05, p-value = 0.84). These results suggest that GS VWC is the most important variable controlling GS EC ET. In turn, VWC is controlled P, which explains the (moderate) correlations of GS EC ET with P.

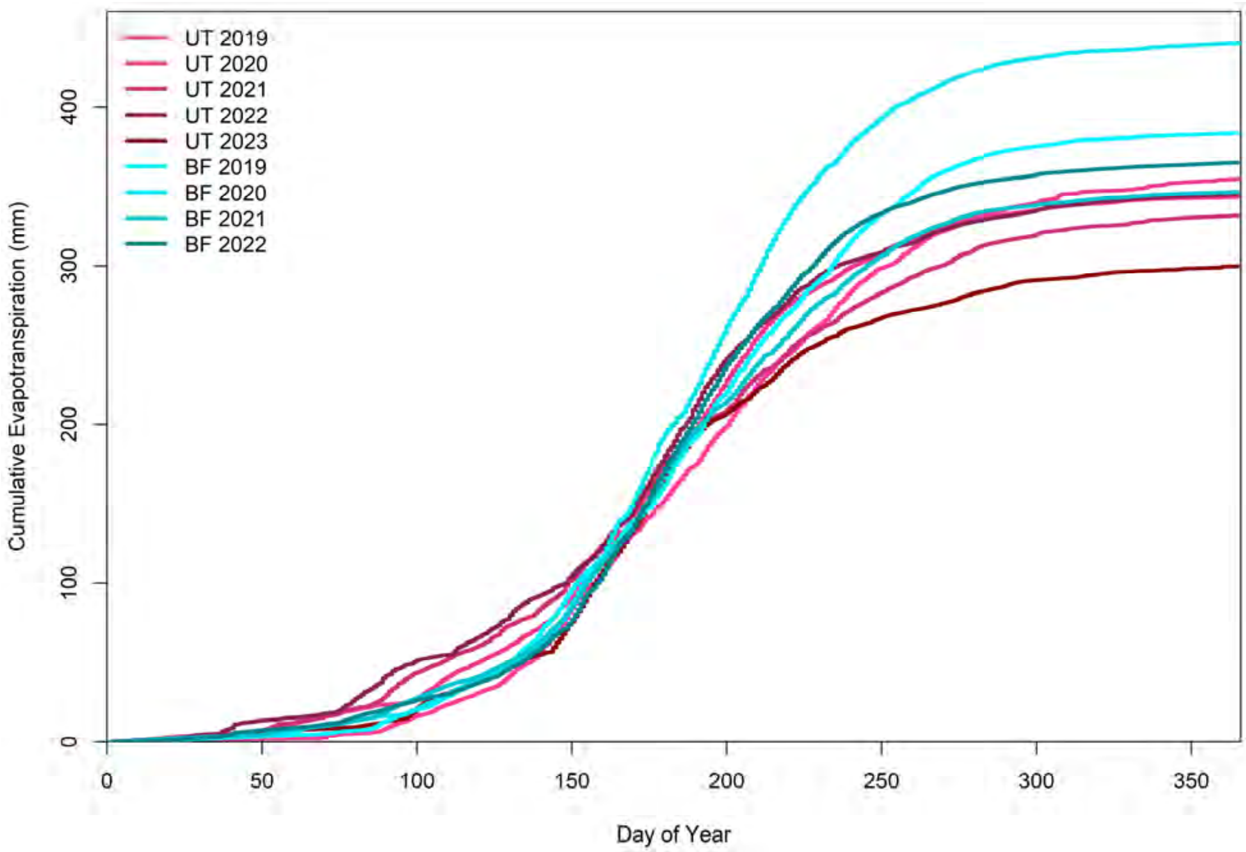


Figure 3-5: Stations 1 (UT) and 4 (BF) cumulative measured evapotranspiration for 2019-2023.

Table 3-1: Annual and growing season (GS) measured climate variables and measured and modelled evapotranspiration.

Year	Station	*GS Rn* (W/m^2)	*GS Ta* (°C)	*Annual P* (mm)	*GS P* (mm)	*GS EP* (mm)	*GS VWC* (%)	*Measured Annual ET* (mm)	*Measured GS ET* (mm)	*Modelled GS ET* (mm)
2019	**1**	107.8	12.8	410	282	84	25	344	293	259
	4	102.2	12.9	389	292	81	28	384	324	261
2020	**1**	93.9	13.2	462	329	138	24	355	276	330
	4	92.7	13.1	416	297	105	27	440	378	328
2021	**1**	100.2	14.3	279	172	47	17	332	244	404
	4	96.8	14.4	289	182	56	20	347	288	394
2022	**1**	105	14.5	350	215	77	17	345	259	450
	4	111	14.6	352	209	77	20	365	311	459
2023	**1**	97.2	15.7	266	166	58	14	300	237	430

Modelled ET values are systematically higher than the measured EC values, suggesting that the model does not capture these controls in this environment well, and this is under review. The latter is not clearly visible in the cumulative results in Table 3-1, where the model only includes ET values during the day and currently assumes zero ET at night (Dye and Brown. 1977). Though rates would be smaller as a result of cooler temperatures and no sunlight exposure, evaporation is still possible at night and more likely after warmer daytime temperatures in summer when there is significant heat energy stored in the soil and vegetation.

An analysis of the modelled ET for all stations is described here. Two-sided Kendall tau Rank Correlation analyses of the GS EC ET vs. GS T_a, RH, P, VWC, and R_n indicates that GS ET has a significant weak positive correlation (ĩ = 0.36, p-value = 0.002) with GS T_a , an insignificant weak negative correlation (ĩ = -0.22, p-value = 0.08) with GS.RH, an insignificant negative correlation (ĩ = -0.17, p-value = 0.15) with GS P, a significant weak negative correlation (ĩ = -0.25, p-value = 0.05) with GS VWC and a significant weak positive correlation (ĩ = -0.44, p-value < 0.005) with GS R_n. When we remove the 2023 year with smokey skies, these correlations increase with GS T_a (ĩ = 0.65, p-value < 0.005) , a significant weak negative correlation with GS RH (ĩ = -0.37, p-value = 0.007), a weak negative correlation with GS P (ĩ = -0.37, p-value = 0.006), a weak negative correlation with GS VWC (ĩ = -0.41, p-value = 0.004), and a weak positive correlation with GS R_n (ĩ = 0.60, p-value < 0.005). Once the wildfire smoke as an external factor to the climate system is removed, GS T_a is the most important controlling variable.

These results suggest that the variables controlling ET in this work are, in decreasing order of importance: GS, T_a, R_n, VWC, P, and RH. With R_n and T_a being used to model ET, the stronger correlations with those variables are unsurprising. The relationships determined between P, RH, and VWC are therefore more relevant for discussion. The statistically significant negative correlations with P, RH, and VWC contradicts the findings from the same data analysis using measured EC, where we would expect an increase in ET with increasing water availability in the soil as a consequence of increasing P. Further inspection of the relationship determined that there is a partitioning of the data with elevated ET measured in 2021 and 2022 when compared to 2019 and 2020. Performing the analysis again of GS EC ET vs. GS P and GS EP on these two periods independently yielded significant weak positive correlation (ĩ = 0.40, p-value < 0.05) for GS.EP during 2021 and 2022 and an insignificant weak positive correlation (ĩ = 0.25, p-value < 0.21) for GS.EP during 2019 and 2021 This is starting to come into agreement with findings from the analysis using measured EC, where we would expect an increase in ET with increasing water availability in the soil as a consequence of increasing P and hints at the complexity of the relationships between ET and different climate variables depending on other factors not well covered here.

3.3 Climate Moisture Deficit and Good Drying Days

The CMD can be seen to generally increase from 2018 through 2022, decreasing in 2023 when compared to 2021 and 2022 (Table 3-2 and Figure 3-6). This decrease was caused by lower GS ET. The year 2023 also had the lowest average GS EP (56 mm). Two-sided Kendall tau Rank Correlation analyses of CMD vs. GS, T_a, R_n , VWC, P and RH indicated significant weak positive correlations with T_a (ĩ = 0.38, p-value < 0.005) and R_n (ĩ = 0.45, p-value < 0.005) and significant weak negative correlations with VWC (ĩ = -0.36, p-value < 0.005), P (ĩ = -0.37, p-value < 0.005). In this analysis, the relationship between CMD and GS P was negative, indicating that as GS P increased the CMD was reduced.

The Peace Region has been increasingly under drought conditions throughout the period from 2019 to 2023, and soil moisture was very low at the beginning of 2023 (RWDI 2024). Cumulative measured ET at Station 1 was at its lowest in 2023 (Figure 3-5), and modelled ET was comparable to the much cooler, wetter year in 2020 (Figure 3-3 and 3-6). The Peace River region entered drought level 4 by June 23rd as a result of rapid melt of a below average snowpack and the warmest May-June period for more than 80 years (RWDI, 2024). It was observed that vegetation growth was slow and low in 2023, likely the result of these early season dry conditions. Also of note is the decrease in incoming solar radiation (used to calculate R_n) in 2023, likely the result of an extensive fire season beginning in May and prevalent smokey skies in the area (RWDI, 2024). Incoming solar radiation is an important driver of photosynthesis; a decrease would likely result in decreased ET.

The cumulative GDD estimated for each year follows a slightly different trend from the CMD and can be seen to generally increase from 2018 through 2023, decreasing only in 2022 when compared to 2021 (Table 3-2 and Figure 3-7). The year 2023 stands out with the highest average GDD count of 140 days. As mentioned earlier, 2023 was the warmest GS on average had the lowest EP. Two-sided Kendall tau rank correlation analyses of the GDD vs. GS T_a, RH, P, VWC, and R_n indicated significant weak positive correlations with T_a (ĩ = 0.38, p-value < 0.005) and significant weak negative correlations with VWC (ĩ = -0.30, p-value < 0.02), P (ĩ = -0.49, p-value < 0.005). This analysis suggests that precipitation is the most important of the variables described here for exerting some control on annual average CMD and GDD.

Table 3-2: Annual and growing season climate, ET, CMD and GDD results.

Year	Station	GS Rn (W/m²)	GS Ta (°C)	P (mm)	GS P (mm)	GS EP (mm)	GS VWC (%)	GS ET (mm)	CMD (mm)	GDD (#days)
	1	12.8	107.8	410	282	82	25	259	176	130
	3	12.6	90.5	426	311	91	36	253	163	126
	4	12.9	102.2	388	292	79	27	261	179	137
2019	6	13.1	89.6	416	292	94	23	246	156	129
	7	13.6	91.8	399	276	79	22	253	173	131
	10	12.4	108.2	383	259	69	22	254	184	136
	11	13.1	91.9	339	220	51	23	269	218	135
	1	13.2	93.9	462	329	140	24	330	192	129
	3	13.1	94.4	423	306	147		262	122	134
	4	13.1	92.7	416	297	107	27	328	223	135
2020	6	13.4	93	509	361	153	22	315	162	132
	7	13.9	93	458	319	131	20	322	193	132
	10	12.7	93.2	479	350	150	29	317	168	132
	11	13.4	96.4	431	310	122	25	340	217	135
	1	14.3	100.2	279	172	46	17	404	358	130
	3	14.3	97	283	181	46		390	344	134
2021	4	14.4	96.8	289	182	56	20	394	339	134
	6	14.5	97.4	316	186	55	16	385	330	134
	7	15.3	97.8	335	216	69	19	393	325	133

Year	Station	GS Rn (W/m^2)	GS Ta (°C)	P (mm)	GS P (mm)	GS EP (mm)	GS VWC (%)	GS ET (mm)	CMD (mm)	GDD (#days)
	10	14.1	97.3	323	201	72	23	387	315	136
	11	14.2	100.5	287	181	51	19	418	368	136
2022	**1**	14.5	105	350	215	78	17	450	372	128
	3	14.4	104.3	367	243	95	26	435	342	130
	4	14.6	111	352	209	78	20	459	382	134
	6	14.6	103	357	237	94	18	426	333	134
	7	15.4	105	357	209	71	17	444	375	135
	10	14.2	106	348	220	75	23	438	363	133
	11	14.2	109	372	225	75	18	442	363	133
2023	**1**	15.7	97.2	266	166	54	14	430	372	137
	3	15.8	97.3	230	142	56	22	322	271	142
	4	15.8	100.8	205	125	58	18	352	306	140
	6	15.6	97.2	193	114	55	9	265	223	141
	7	16.7	98.4	210	130	45	14	287	248	142
	10	15.5	99.5		147	51	18	360	311	137
	11	15.4	99	228	153	70	14	264	205	140

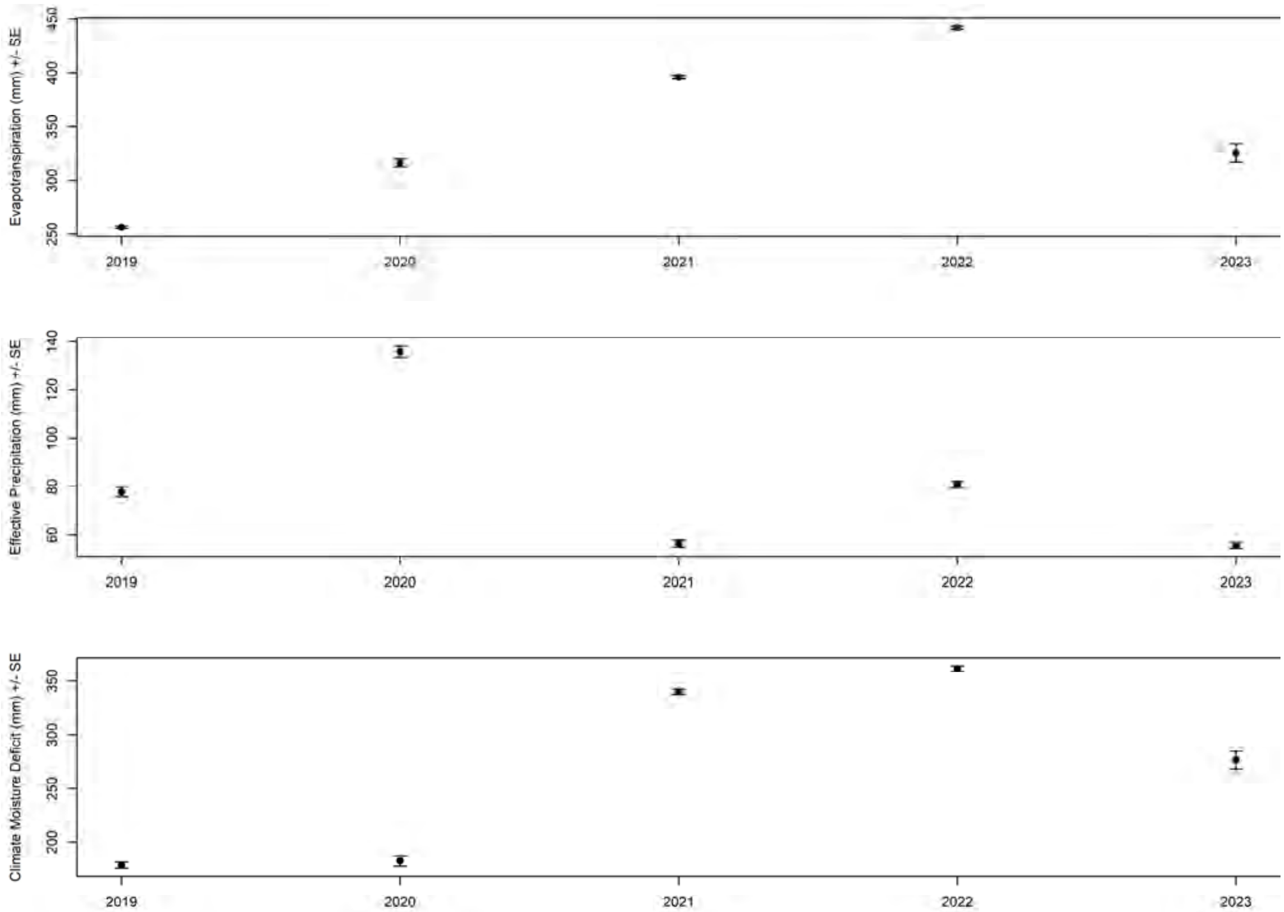


Figure 3-6: Annual average GS ET, EP, and CMD. Error bars are ±1 standard error of the stations' annual GS mean values.

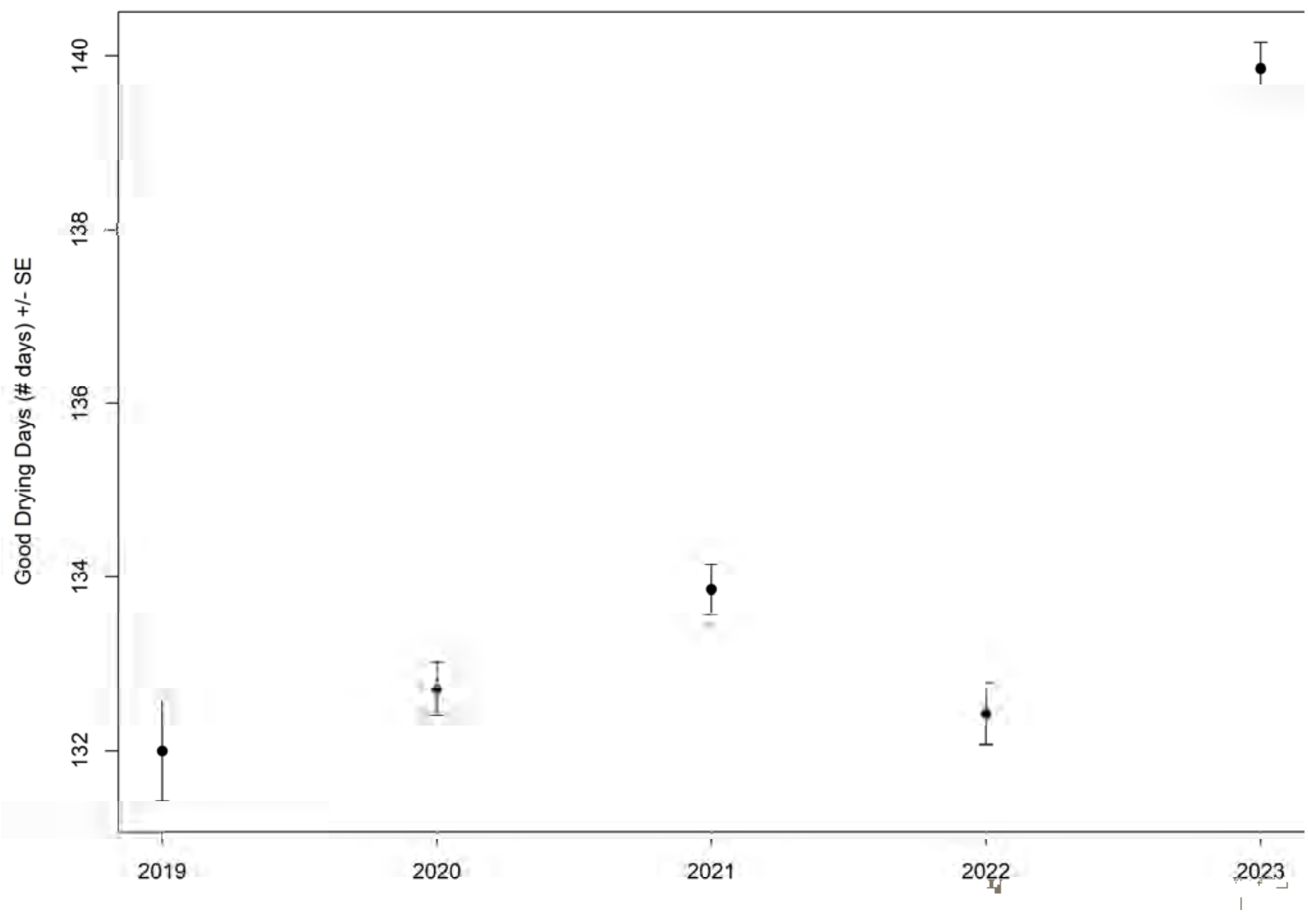


Figure 3-7: Annual average GS GDD. Error bars are ±1 standard error of the stations' annual GS mean values.

4 SUMMARY OF RESULTS

Climatologically, there was an increasing trend in GS T_a from 13ºC in 2019 to 16ºC in 2023 and a decreasing trend in GS P from 325 mm in 2020 to 140 mm in 2023. Relative humidity decreased from 71% in 2019 to 60% in 2023. The trend in GS VWC matched that of GS P, decreasing from 25% in 2019 to 16% in 2023. Incoming solar radiation increased from 2019 through 2022 from 196 W/m^2 to 221 W/m^2. In 2023, likely as a result of the extensive fire season and smokey skies, incoming solar radiation dropped to 206 W/m^2. Incoming solar radiation is an important driver of photosynthesis, and a decrease would likely result in decreased ET; this is indeed supported by the results summarized below. The Peace Region has been increasingly under drought conditions throughout the period from 2019 to 2023, and soil moisture was very low at the beginning of 2023 (RWDI 2024). In summary, climate was increasingly warm and dry from 2019 through 2023, which might partially be related to the observed negative PDO over the same period.

In this report, we showed that very little ET occurs before 75-100 days into the year (March-April) and that the rate increases throughout the growing season and begins to taper off around days 200-250 (July-August). This annual pattern is expected with increasing temperatures through spring as photosynthetic activity ramps up with increasing seasonal vegetation cover, followed by a slowing rate when soil water is more limited and vegetation begins to senesce or is harvested. The highest EC ET at both stations was measured in 2020, the year with the highest annual and GS precipitation amounts at Stations 1 and 4. Cumulative measured ET at Station 1 was at its lowest in 2023, and modelled ET was comparable to the much cooler, wetter 2020. In 2023, the Peace River region entered drought level 4 by June 23rd as a result of rapid melt of a below average snowpack and the warmest May-June period for more than 80 years (RWDI, 2024). Statistical analysis indicated that GS VWC is the most important variable controlling GS EC ET. The negative relationship with T_a and RH indicates that soil water was limited during warmer years. The modelled ET values were consistently higher than the measured EC values, suggesting that the model does not capture these controls well in this environment, and this is under review.

The CMD calculated can be seen to generally increase from 2019 through 2022, decreasing in 2023 when compared to 2021 and 2022 caused by lower GS ET. 2023 also had the lowest average GS EP. Statistical analyses indicated some influence of GS Ta, Rn, P and VWC on annual average CMD. However, the low correlation coefficients suggest there are more variables of importance that are not well captured in this analysis. These likely include variations in stomatal conductance depending on vegetation type, plant growth stage, canopy structure, and vapour pressure deficit. It was observed that vegetation growth was slow and low in 2023, likely the result of the early season dry conditions.

The cumulative GDD estimated for each year follows a slightly different trend from the CMD and can be seen to generally increase from 2018 through 2023, decreasing only in 2022 when compared to 2021. The year 2023 had the highest average GDD count of 140 days. As mentioned earlier, 2023 was the warmest growing season on average and had the lowest EP. Statistical analysis indicated significant weak positive correlations with T_a and significant weak negative correlations with VWC and P Similar to the CMD these results suggest that more variables of importance are not well captured in the analyses. Results in this report suggest that GS T_a and P are the most important variables controlling annual average CMD and GDD. Furthermore, the results suggest an important need to model ET, CMD, and CDI for GDD output over a period extended back into the cool phase of the PDO and keep note of this during future analyses as data becomes available following the dam being filled.

5 STATEMENT OF LIMITATIONS

This report was prepared by RWDI AIR Inc. (“RWDI”) for BC Hydro (“Client”). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein (“Project”). This report was prepared using scientific principles, published methodologies and professional judgment in assessing available information and data. The findings presented within this document are based on available data within the limits of the existing information, budgeted scope of work, and schedule. The conclusions contained in this report are based on the information available to RWDI when this report was prepared; subsequent changes made by the Client after the date of this report have not been reflected in the conclusions.

This report was prepared for the exclusive use of BC Hydro. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. RWDI accepts no responsibility for damages, if any, suffered by any third party as result of decisions made or actions based on this report.

6 REFERENCES

Allen, R.J., Pereira, L.S., Raes, D., and Smith, M., 1998. Crop evapotranspiration – Guidelines for computing crop water requirements – FAO Irrigation and drainage paper 56.

Amiro, B.D., Barr, A.G., Black, T.A., Iwashitad, H., Kljun, N., McCaughey, J.H., Morgenstern, K., Murayama, S., Nesic, Z., Orchansky, A.L., and Saigusa, N., 2006. Carbon, energy and water fluxes at mature and disturbed forest sites, Saskatchewan, Canada. Agricultural and Forest Meteorology: 136, 237–251.

Baldocchi, D.D., 2003. Assessing the eddy covariance technique for evaluating carbon dioxide exchange rates of ecosystems: past, present and future. Global Change Biology: 9, 479–492.

Barr, A.G., Black, T.A., Hogg, E.H., Kljun, N., Morgenstern, K., and Nesic, Z., 2004. Inter-annual variability in the leaf area index of a boreal aspen-hazelnut forest in relation to net ecosystem production. Agricultural and Forest Meteorology: 126, 237–255.

BC Hydro, 2013. Site C Clean Energy Project Environmental Impact Statement. Dated January 25, 2013; Amended August 2, 2013.

Brown, M., Black, T.A., Nesic, Z., Foord, V.N., Spittlehouse, D.L., Fredeen, A.L., Grant, N.J., Burton, P.J., Trofymow, J.A., 2010. Impact of mountain pine beetle on the net ecosystem production of Lodgepole pine stands in British Columbia. Agricultural and Forest Meteorology: 150, 254-264.

Davis, R., 1978. Pasture Productivity and Climate in the Peace River Region. MSc thesis. McMaster University: Hamilton, ON.

Davis, R., and Davies, J., 1981. Potential evapotranspiration in the Peace River Region of British Columbia. Atmosphere-Ocean 19: 251-260.

Dyer, J.A., and Brown, D.M., 1977. A climatic simulator for field-drying hay. Agricultural Meteorology: 18, 37-48.

Golder, 2012. Site C Clean Energy Project - Agricultural Assessment Supporting Documentation. Appendix A.

Krishnan, P., Black, T.A., Grant, N.J., Barr, A.G., Hogg, E.H. Jassal, R.S., and Morgenstern, K., 2006. Impact of changing soil moisture distribution on net ecosystem productivity of a boreal aspen forest during and following drought. Agricultural and Forest Meteorology: 139, 208–223.

Mantua, N.J., 1999: The Pacific Decadal Oscillation. A brief overview for non-specialists, *Encyclopedia of Environmental Change*.

Morgenstern, K., Black, T.A., Humphreys, E.R., Griffis, T.J., Drewitt, G.B., Cai, T., Nesic, Z., Spittlehouse, D.L., and Livingston, N.J., 2004. Sensitivity and uncertainty of the carbon balance of a pacific northwest Douglas-fir forest during an el Niño/La Niña cycle. Agricultural and Forest Meteorology: 123, 201–219.

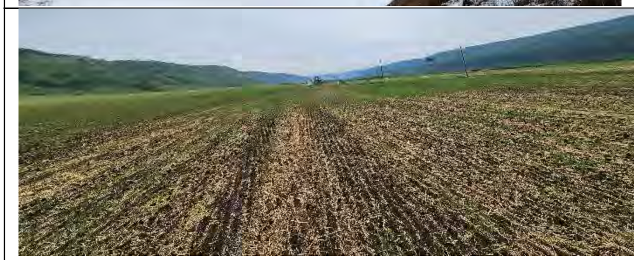
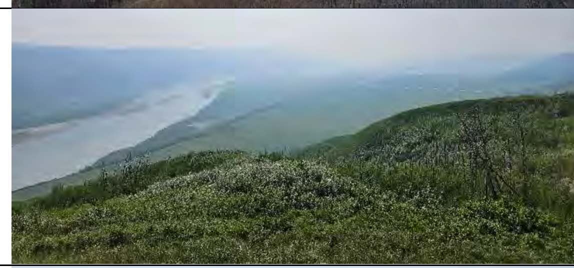
Priestley, C., and Taylor, R., 1972. On assessment of surface heat flux and evaporation using large-scale parameters. Monthly Weather Review 100: 81-92.

RWDI AIR Inc., 2024. Site C Climate and Air Quality Monitoring: 2023 Annual Report. RWDI Project Number 2301410.

Wilson K, et al., 2002. Energy balance closure at FLUXNET sites. Agricultural and Forest Meteorology: 113:223-243.

APPENDIX A

Site Pictures

	
	
No image available	

Station 1 March through August 2023 shows the leafing out and dieback experienced across the region. Short growing season observed in May, June, and July with harvesting of the wheat crop occurring in mid-August.

Station 3 August 15th 2023.

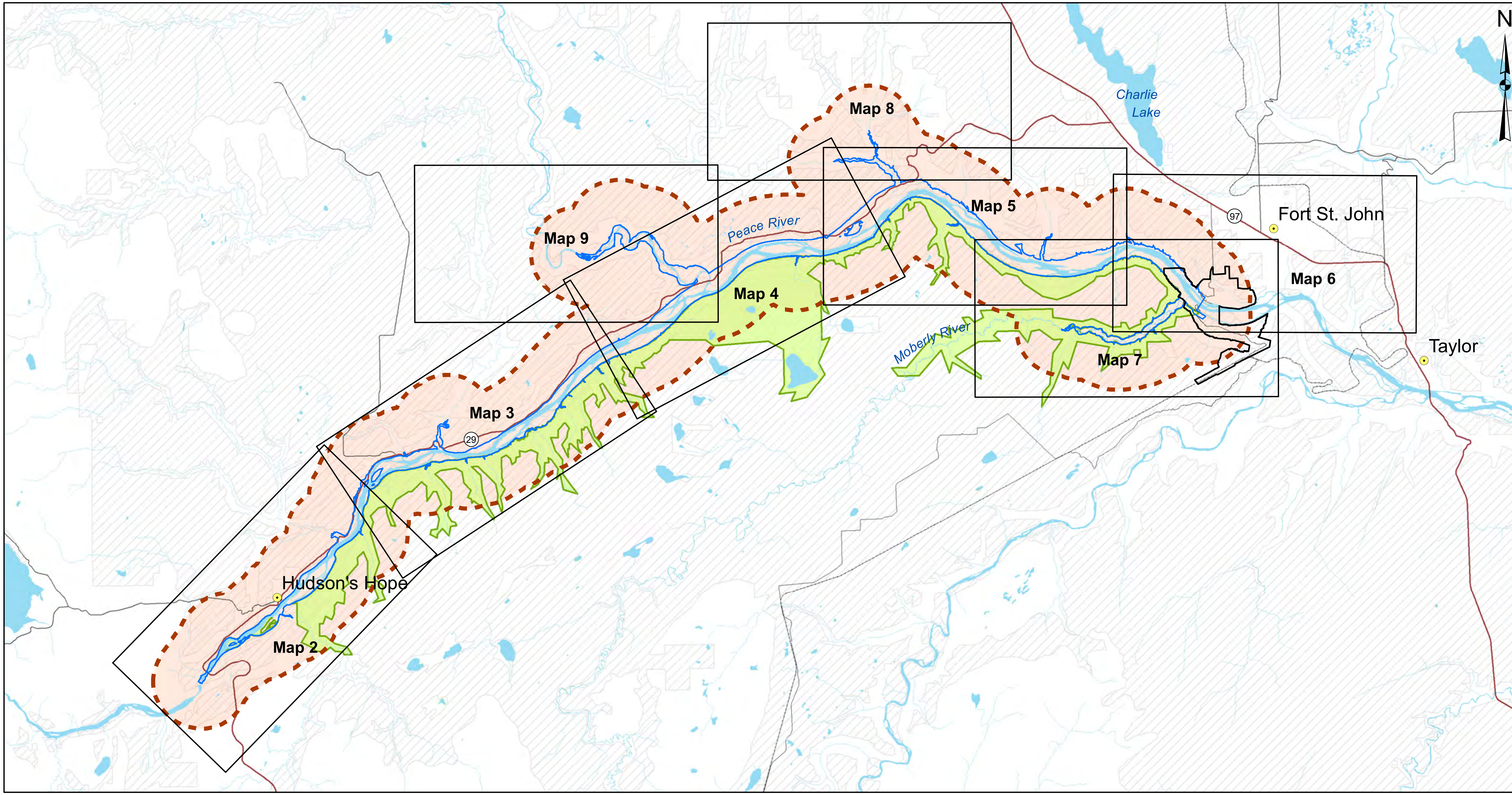
Station 4 April 12th, May 25th, and July 14th 2023.

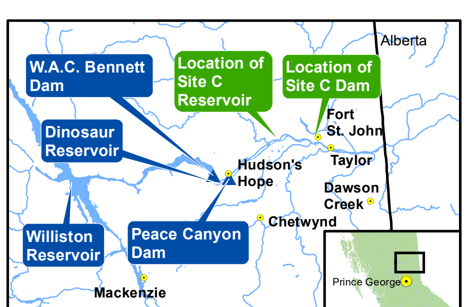
Station 6 July 13th and August 4th 2023.

Station 7 May 24th 2023

Station 10 April 12th and June 7th 2023.

Station 11 in August 2023.





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Path: X:\ArcGISProjects\Environment\Agriculture\Ag_3kmReservoirBoundary_Overview_1016_C14_07342-1.mxd

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area
- Town
- Road
- Highway
- Railway

1:250,000

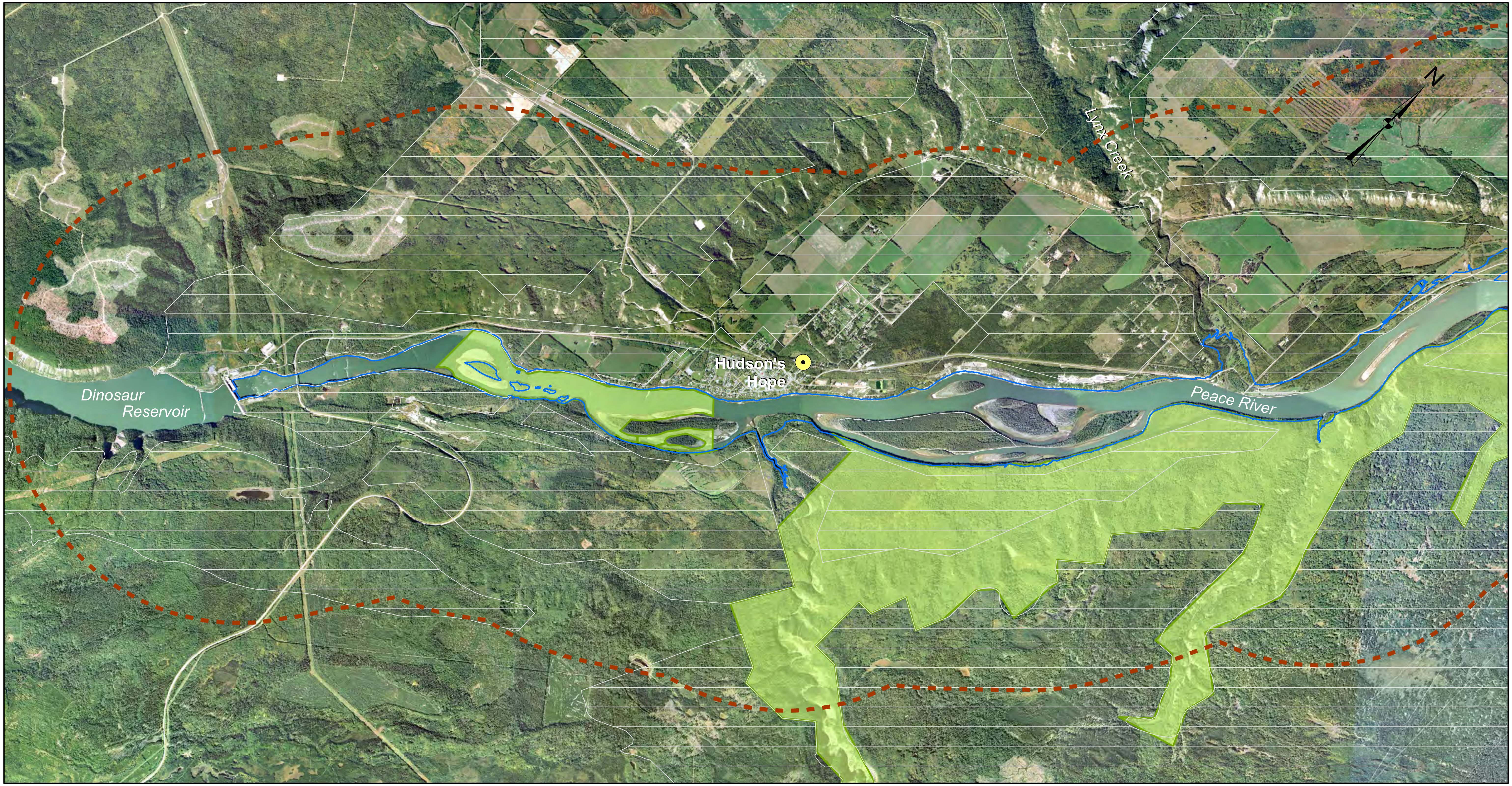
0 5 km

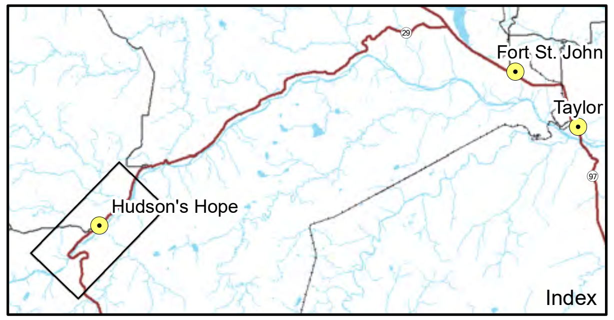
BC Hydro

Crop Drying Monitoring Area Identification - Overview Map 1 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-1	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:50,000 0 2 km

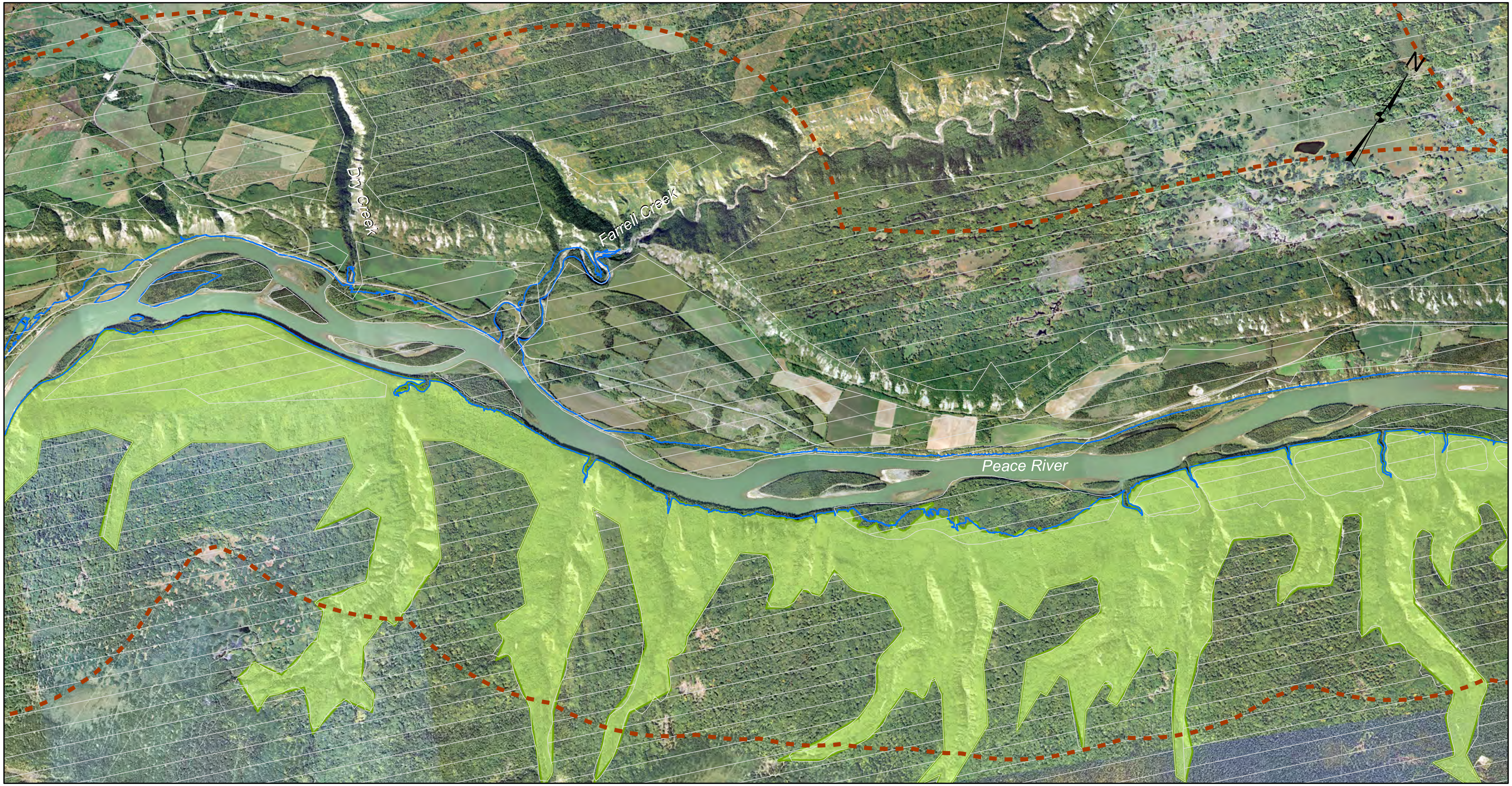
BC Hydro

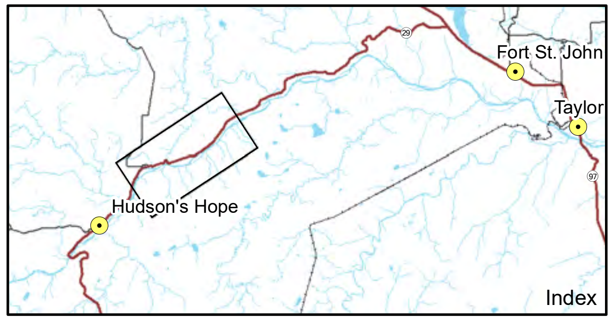
Crop Drying Monitoring - Area Identification Map 2 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-2	R 0

Path: X:\ArcGIS\Projects\Environment\Agriculture\Ag_3kmReservoirBoundary_1016_C14_07342-2-9.mxd

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:50,000

0 2 km

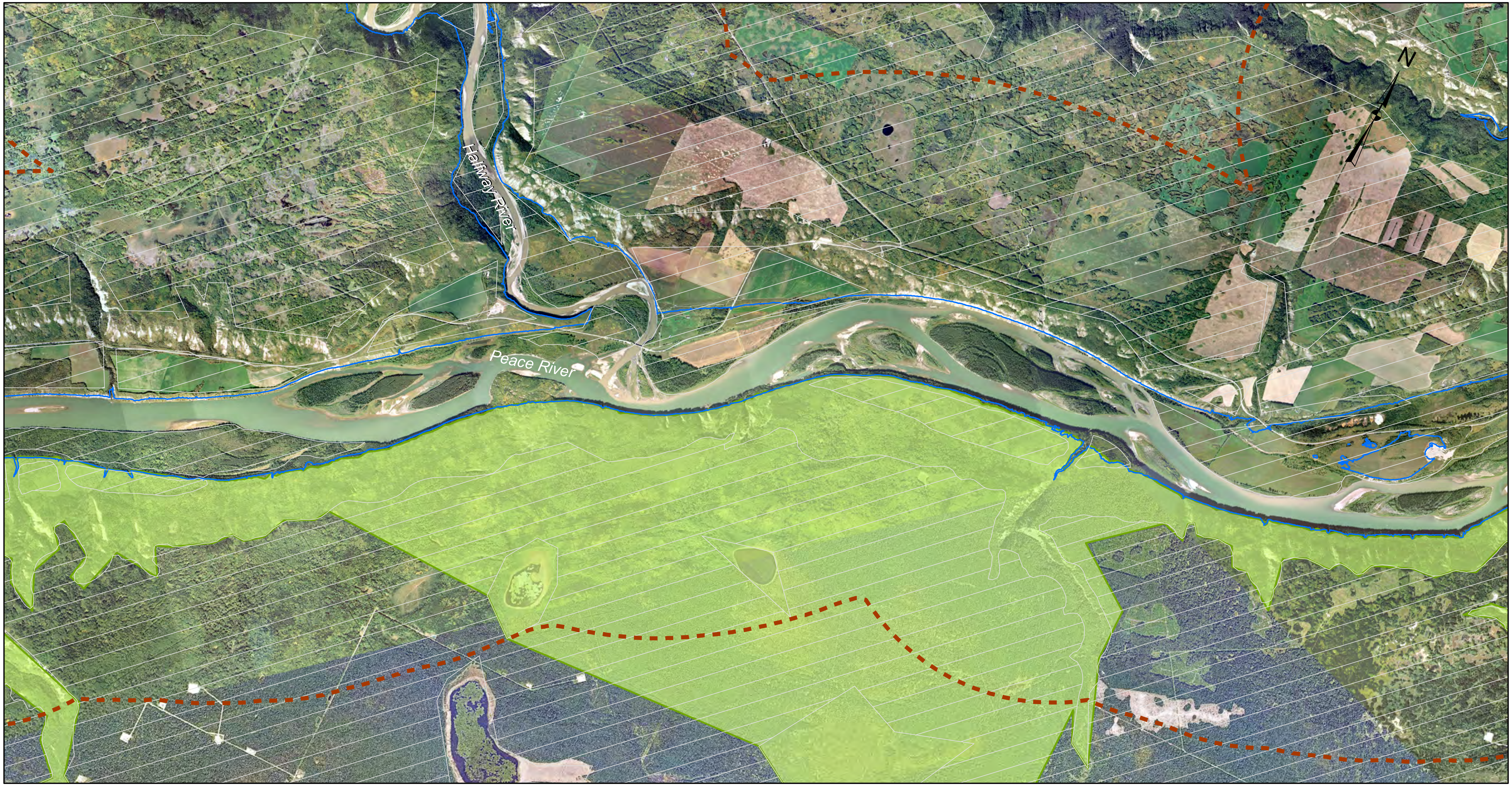
BC Hydro

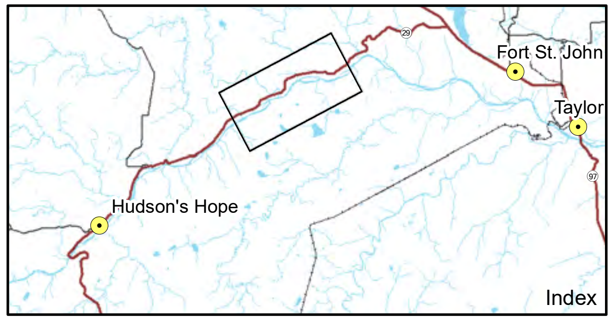
Crop Drying Monitoring - Area Identification Map 3 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-3	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGIS\Projects\Environment\Agriculture\Ag_3kmReservoirBoundary_1016_C14_07342-2-9.mxd





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:50,000

0 2 km

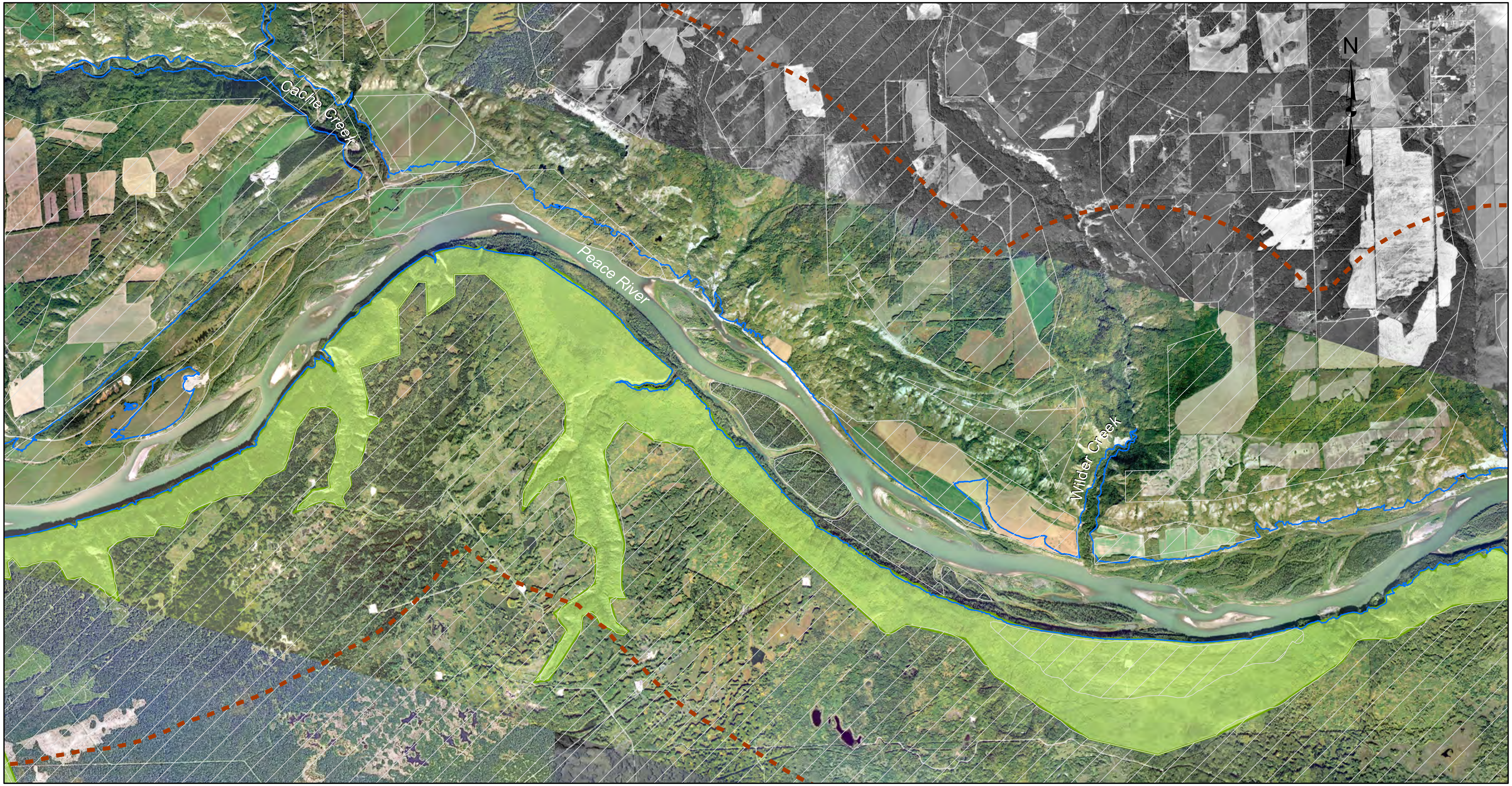
BC Hydro

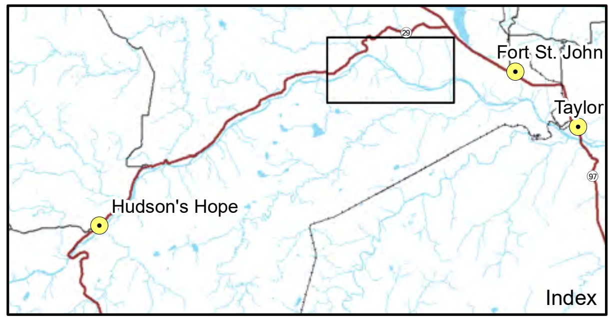
Crop Drying Monitoring - Area Identification Map 4 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-4	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGISProjects\Environment\Agriculture\Ag_3kmReservoirBoundary_1016_C14_07342-2-9.mxd





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:50,000

0 2 km

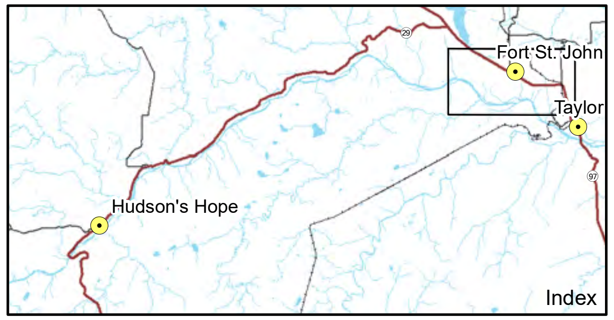
BC Hydro

Crop Drying Monitoring - Area Identification Map 5 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-5	R 0

Path: X:\ArcGISProjects\Environment\Agriculture\Ag_3kmReservoirBoundary_1016_C14_07342-2-9.mxd

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.



Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:50,000

0 2 km

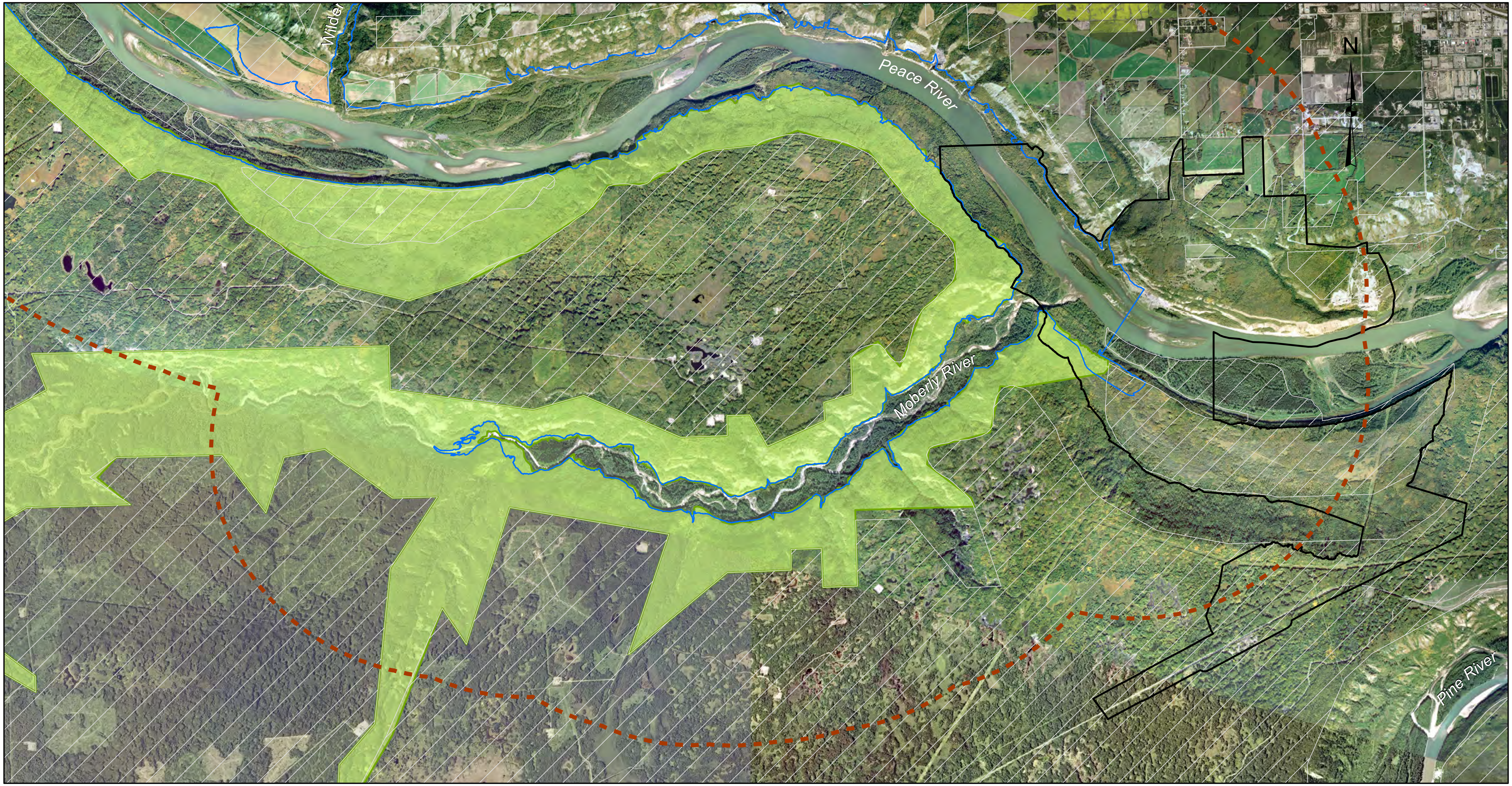
BC Hydro

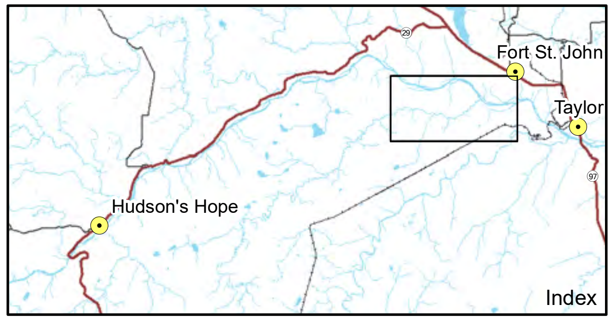
Crop Drying Monitoring - Area Identification Map 6 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-6	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGIS\Projects\Environment\Agriculture\Ag_3kmReservoirBoundary_1016_C14_07342-2-9.mxd





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:50,000

0 2 km

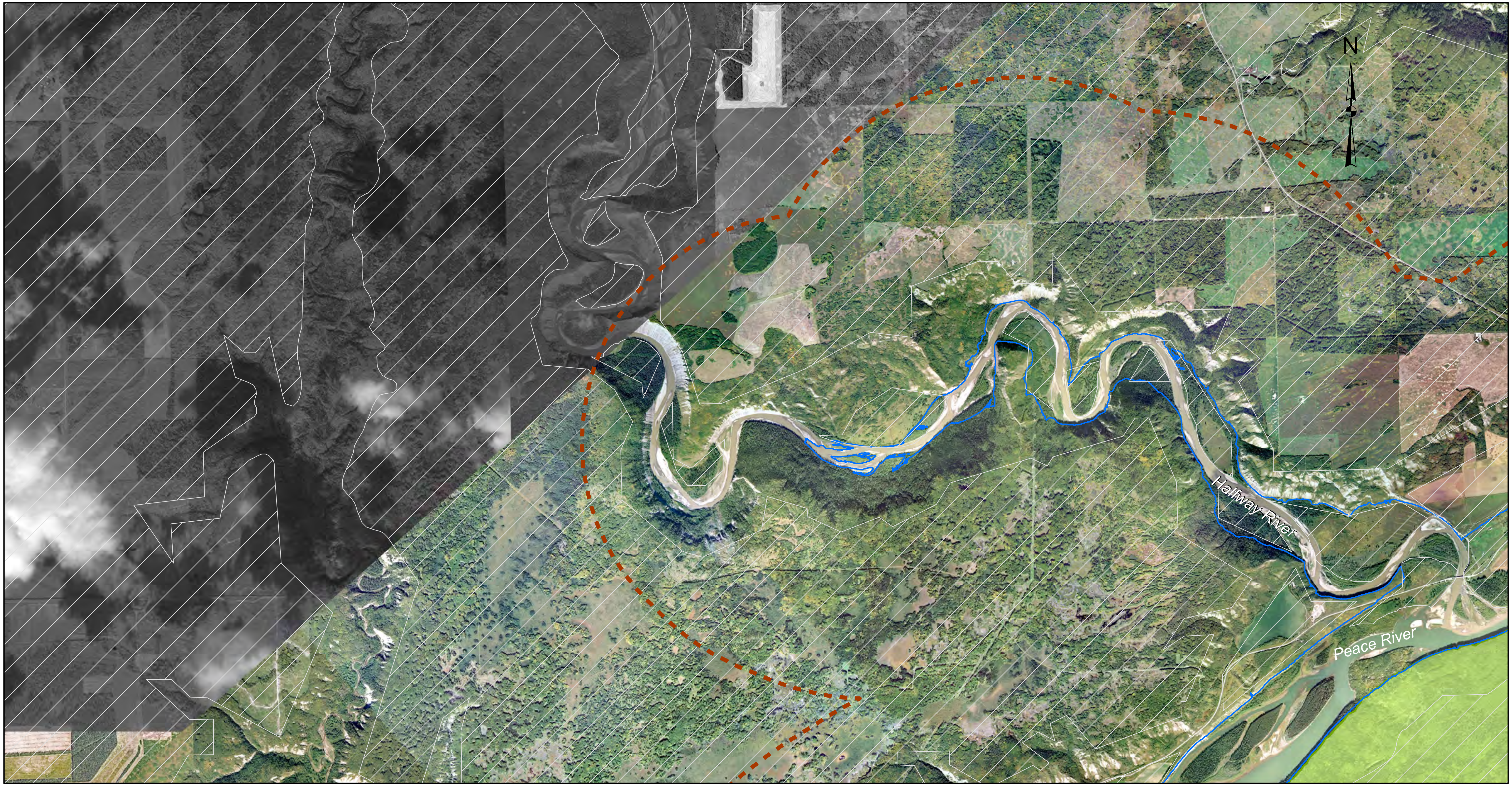
BC Hydro

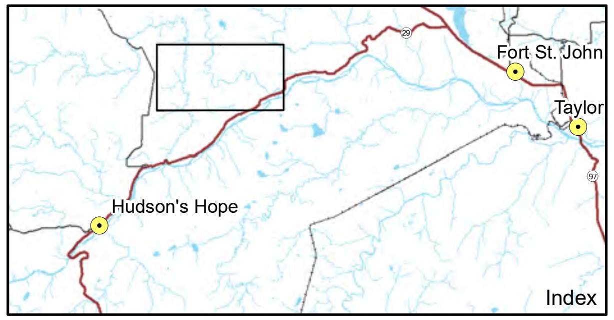
Crop Drying Monitoring - Area Identification Map 7 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-7	R 0

Path: X:\ArcGISProjects\Environment\Agriculture\Ag_3kmReservoirBoundary_1016_C14_07342-2-9.mxd

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:50,000 — 0 — 2 km

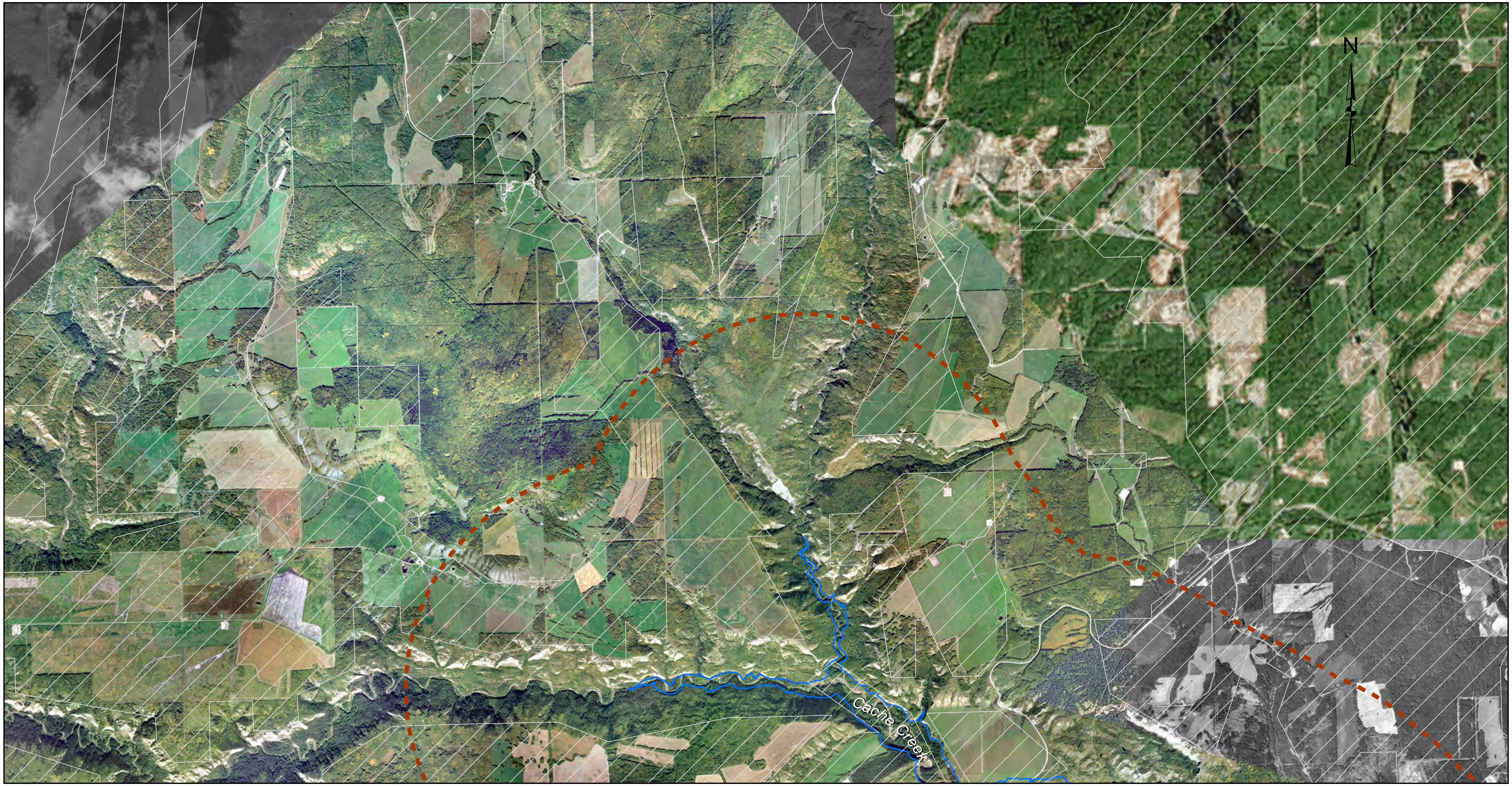
BC Hydro

Crop Drying Monitoring - Area Identification Map 8 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-8	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGISProjects\Environment\Agriculture\Ag_3kmReservoirBoundary_1016_C14_07342-2-9.mxd



Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Area to be considered for crop drying monitoring
- Agricultural Land Reserve
- Proposed Reservoir
- Proposed Peace Boudreau Protected Area
- Dam Site Area

1:50,000

0 2 km

BC Hydro

Crop Drying Monitoring - Area Identification Map 9 of 9

Date	July 14, 2016	DWG NO	1016-C14-07342-9	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGISProjects\Environment\Agriculture\Ag_3kmReservoirBoundary_1016_C14_07342-2-9.mxd

Appendix C – Crop Productivity and Groundwater Monitoring Program Report

BC Hydro and Power Authority
333 Dunsmuir Street
Vancouver, BC V6B 5R3

Blackbird File: 25016
July 18, 2025

**RE: Crop Productivity and Groundwater Monitoring Program
Site C Clean Energy Project
2025 Annual Report**

1 Project Background and Scope

The Site C Clean Energy Project (the Project) is a hydroelectric dam and generating station under construction along the Peace River in northeast British Columbia (BC). Construction started in July 2015 and is expected to be fully in service by fall 2025 (BC Hydro 2025).

During the joint federal-provincial environmental assessment process, the Project's Environmental Impact Statement (EIS; BC Hydro 2013) noted a potential for the elevation of groundwater to rise in the vicinity of the reservoir and identified changes to local hydrology and groundwater as a key indicator (Table 20.3).

EIS Section 20.3.2.2 (page 20-34, lines 7 to 9) states: *"The reservoir would result in rises in the groundwater elevation in areas near the reservoir and may affect agricultural land where the water table is anticipated to rise within 1 m of surface. Yields or the range of suitable crops may be affected on agricultural properties located on low terraces and banks near the proposed reservoir. However, since the majority of the cultivated lands within the local assessment area are located topographically above the proposed reservoir levels by greater than 1 meter and in most cases by greater than 10 m, only limited effects related to water table rise are anticipated*."

As a result, the Environmental Assessment Certificate for the Project (EAC # E14-02, issued Oct. 14, 2014) contains a condition to develop an Agricultural Monitoring and Follow-Up Plan (AMAFP), which requires BC Hydro to monitor and assess groundwater level and any related effects on agricultural crops for a 10-year period which includes the five years prior to reservoir filling and the first five years of operation.

Specifically, EAC Condition No. 31 states: *"The Agriculture Monitoring and Follow-up Program must include monitoring for Project-induced changes to groundwater elevations within 2 km of the reservoir (the area potentially influenced by groundwater elevation changes) and evaluate associated effects on crop productivity. Monitoring must include field surveys and farm operator interviews."*

BC Hydro and Power Authority (BC Hydro) has retained Blackbird Environmental Ltd. (Blackbird) to implement the Crop Productivity and Groundwater Monitoring Program (CPGMP) component of the AMAFP. Blackbird's scope includes the development and implementation of a desktop and field program to monitor for project-related changes in groundwater and soil moisture levels, specifically focused on areas used for agricultural production within a two-kilometre buffer around the future Project reservoir.

As part of BC Hydro's annual reporting requirements, this report outlines Project activities completed in relation to the CPGMP component of the AMAFP between **April 1, 2024,** and **March 31, 2025**.

2 Project Activities

Groundwater monitoring under this program is being conducted through a variety of methods and technologies including a network of soil moisture sensors, crop health and development monitoring, as well as cooperation with BC Hydro's hydrology specialists and contractor to access data derived from the existing well network in the project area.

The AMAFP identifies several sites for groundwater monitoring and potential crop impacts within 2 km of the reservoir, which defines the focus of the CPGMP. At these locations, Blackbird has deployed soil probes at depths of 10, 30, and 100 cm to log moisture, temperature, and electrical conductivity data at one-hour intervals throughout the year. Soil moisture monitoring benchmarks are located on land currently owned by BC Hydro near Bear Flats, Halfway, Farrell Creek, and Lynx Creek in landscape positions and field locations that reduce the potential of an impact on agricultural operations. The combined runtime of the four sensor stations during the monitoring period was 1,460 station-days (i.e., no outages during the 2024-2025 monitoring period).

The 2024 growing season marked the fifth full year of data being collected in the valley. All data collected has been compiled and will be analyzed later in 2025 (i.e., after the five-year pre-inundation dataset is complete and available) for trends. The five-year pre-inundation data will then be used to compare the five-year post-inundation data.

BC Hydro's existing groundwater monitoring network within the Peace River valley is used to monitor actual groundwater levels in the immediate vicinity of the identified monitoring sites. In early 2019, Blackbird's team reviewed the current groundwater monitoring network in relation to the previously identified focus areas and determined a requirement for additional shallow groundwater monitoring infrastructure. One additional shallow groundwater monitoring well was installed in the Bear Flat area in late 2019.

Blackbird's team monitored crop development during the 2024 growing season through remote-sensing techniques to minimize the disturbance caused by field inspections whenever feasible. Field inspections were completed at the monitoring locations in early spring and in mid-to-late July to assess crop variability in relation to soil moisture factors.

3 Recommendations

In accordance with EAC Condition No. 31, field surveys and producer interviews will continue to be completed with the goal of continuing monitoring until five years after reservoir filling. Similarly, Blackbird's team will continue to work closely with agriculture producers, agricultural associations, producer groups, and government agencies that may have data or local knowledge related to this monitoring plan.

To date, no significant trends or effects on crop productivity or groundwater elevation have been observed. The current five-year pre-inundation monitoring phase is nearing completion, and post-inundation data collection is expected to begin following reservoir filling in fall 2025.

No significant changes to the monitoring plan are planned for the coming 2025 growing season, with monitoring activities focused on monitoring crop development using remote sensing and field surveys.

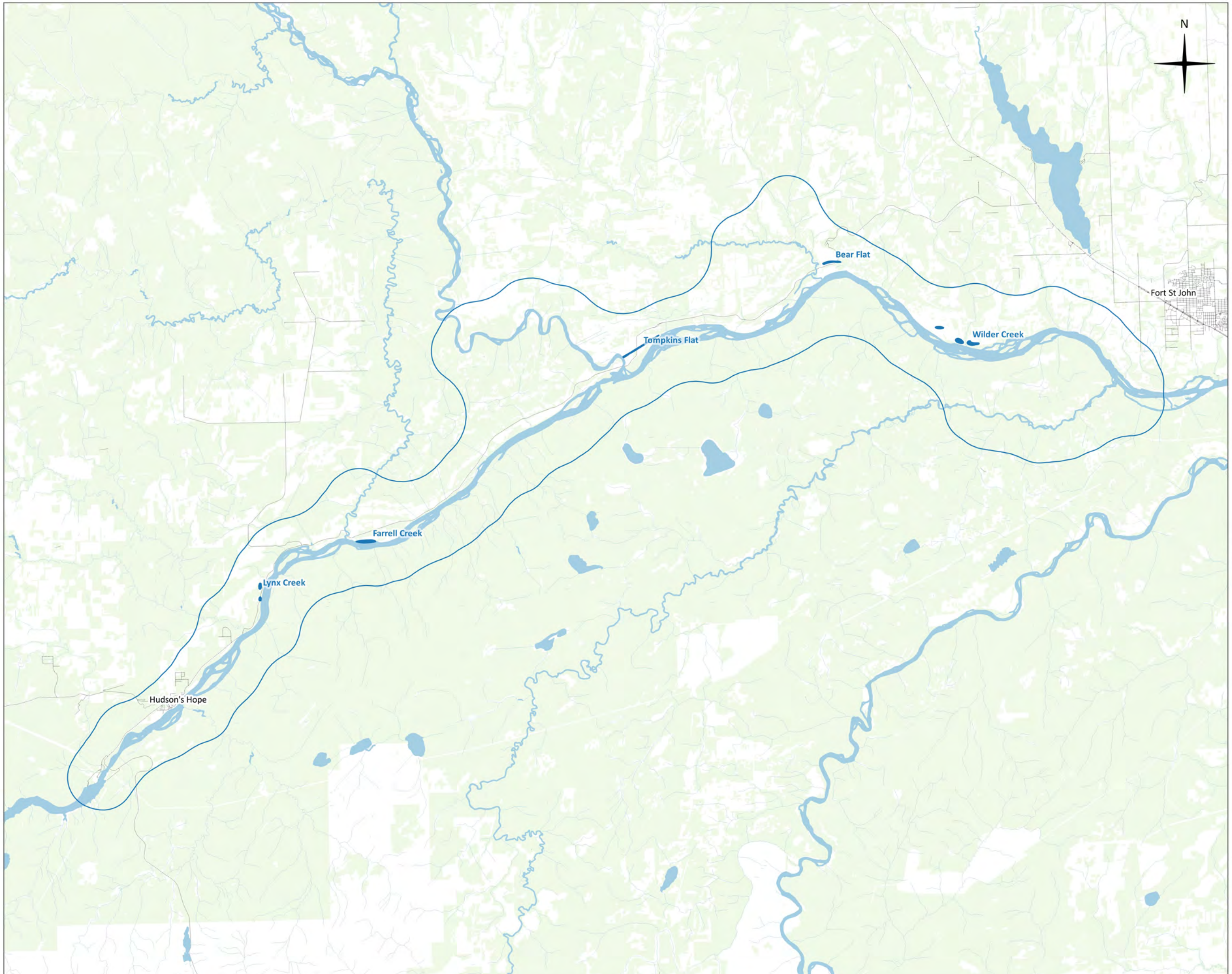
4 Closure

Services provided by Blackbird for this memorandum have been conducted in a manner consistent with the level of skill, care, and competence ordinarily exercised by registered members of the profession of agrology and biology currently practicing under similar conditions and circumstances in the same jurisdiction in which the services were provided.

The conclusions of this memorandum are based in part on information provided by others. Blackbird believes this information to be accurate but does not guarantee or warrant its accuracy or completeness.

The information presented in this memorandum was acquired, compiled, and interpreted exclusively for BC Hydro for the purposes described in this report.

Please feel free to contact Blackbird's team at your convenience by email at info@blackbird.ca for any questions regarding this memorandum.



BC Hydro and Power Authority

Crop Productivity and Groundwater Monitoring Program
Project Area Overview

1:30,000,000

Horizontal Scale 1:250,000

0 2 4 6 8 10 km

Map to scale when plotted on a page 280 mm x 432 mm (Tabloid)

Legend

- CPGMP Project Area
- Lakes & Rivers
- Crop Productivity and Groundwater Monitoring Areas
- Road Network

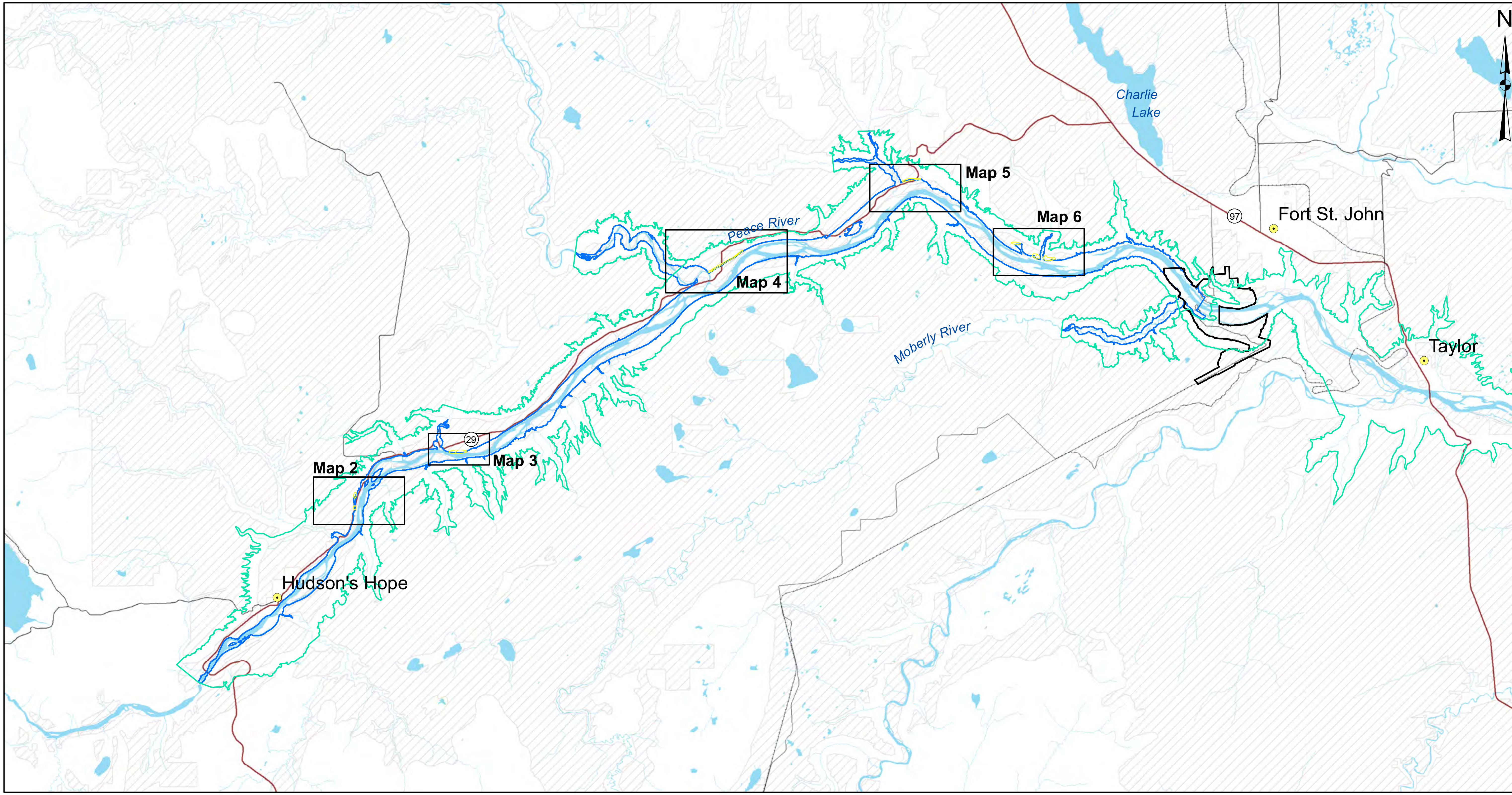
Disclaimer

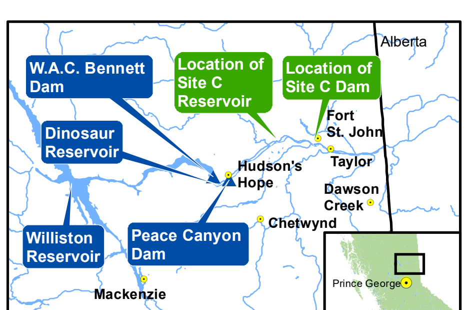
UTM Zone 10, NAD 83
Date of data acquisition: n/a
Data Credit: Blackbird Environmental Ltd., BC Geodata Warehouse
For representational purposes only, all locations are approximate.

Our File:	21006	Gov. File #:	n/a	Revision #:	2
Client File:	n/a	GIS:	ML	Date:	June 5, 2021

Blackbird Environmental
blackbird.ca
Fort St. John, BC
250.793.7262

Figure 1





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Groundwater Monitoring Area
- Peace River and Tributary Valleys Definition
- Proposed Reservoir
- Dam Site Area
- Agricultural Land Reserve
- Town
- Road
- Highway
- Railway

1:250,000

0 5 km

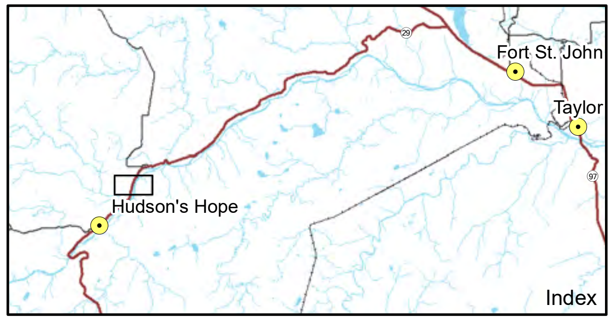
BC Hydro

Groundwater Monitoring Areas
Overview
Map 1 of 6

Date	July 14, 2016	DWG NO	1016-C14-07345-1	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGISProjects\Environment\Physical_Environment\Ground_Water\Groundwater_Monitoring_Overview_1016_C14_07345-1.mxd



Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Groundwater Monitoring Area
- Peace River and Tributary Valleys Definition
- Proposed Reservoir
- Dam Site Area
- Agricultural Land Reserve

1:15,000 0 0.5 km

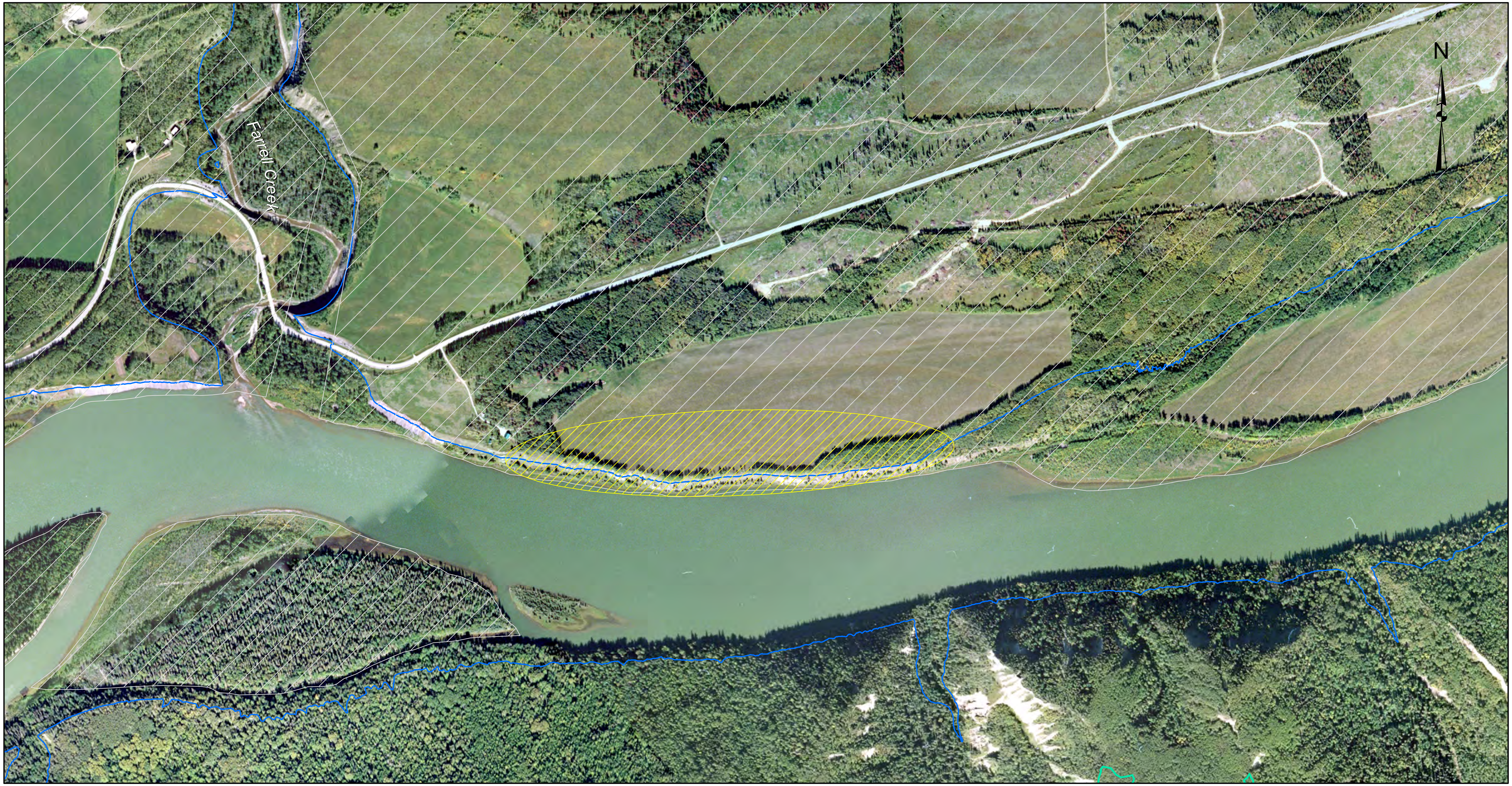
BC Hydro

Groundwater Monitoring Areas
Map 2 of 6

Date	July 14, 2016	DWG NO	1016-C14-07345-2	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGISProjects\Environment\Physical_Environment\Ground_Water\Groundwater\Groundwater_Monitoring_1016_C14_07345-2-6.mxd



Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Groundwater Monitoring Area
- Peace River and Tributary Valleys Definition
- Proposed Reservoir
- Dam Site Area
- Agricultural Land Reserve

1:10,000 0 0.5 km

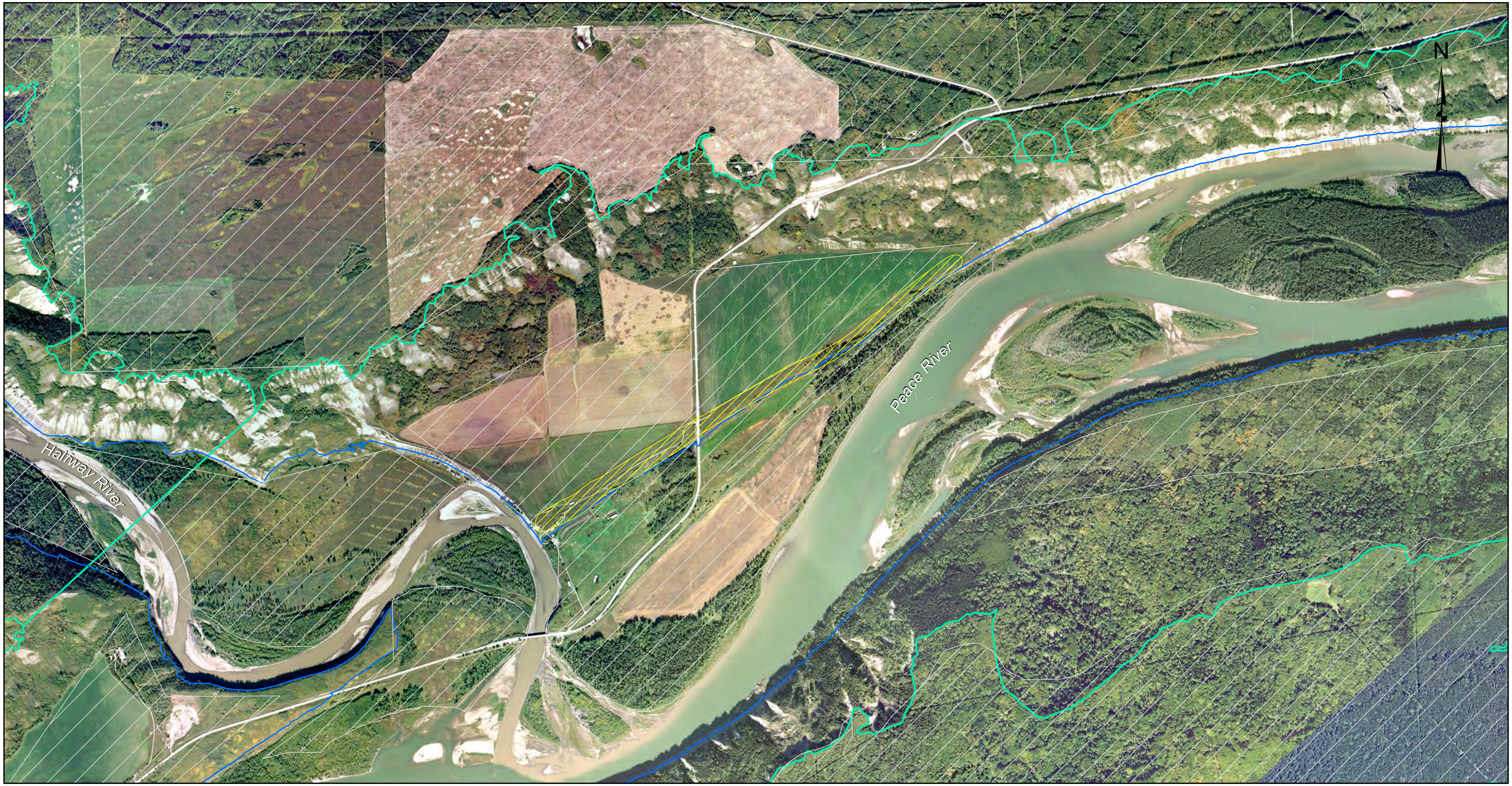
BC Hydro

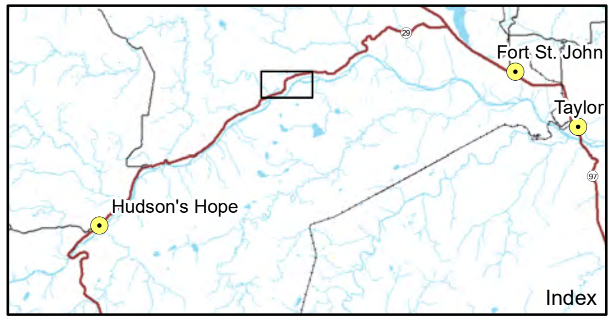
Groundwater Monitoring Areas
Map 3 of 6

Date	July 14, 2016	DWG NO	1016-C14-07345-3	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGIS\Projects\Environment\Physical_Environment\Ground_Water\Groundwater_Monitoring_1016_C14_07345-2-6.mxd





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Groundwater Monitoring Area
- Peace River and Tributary Valleys Definition
- Proposed Reservoir
- Dam Site Area
- Agricultural Land Reserve

1:20,000 0 0.5 km

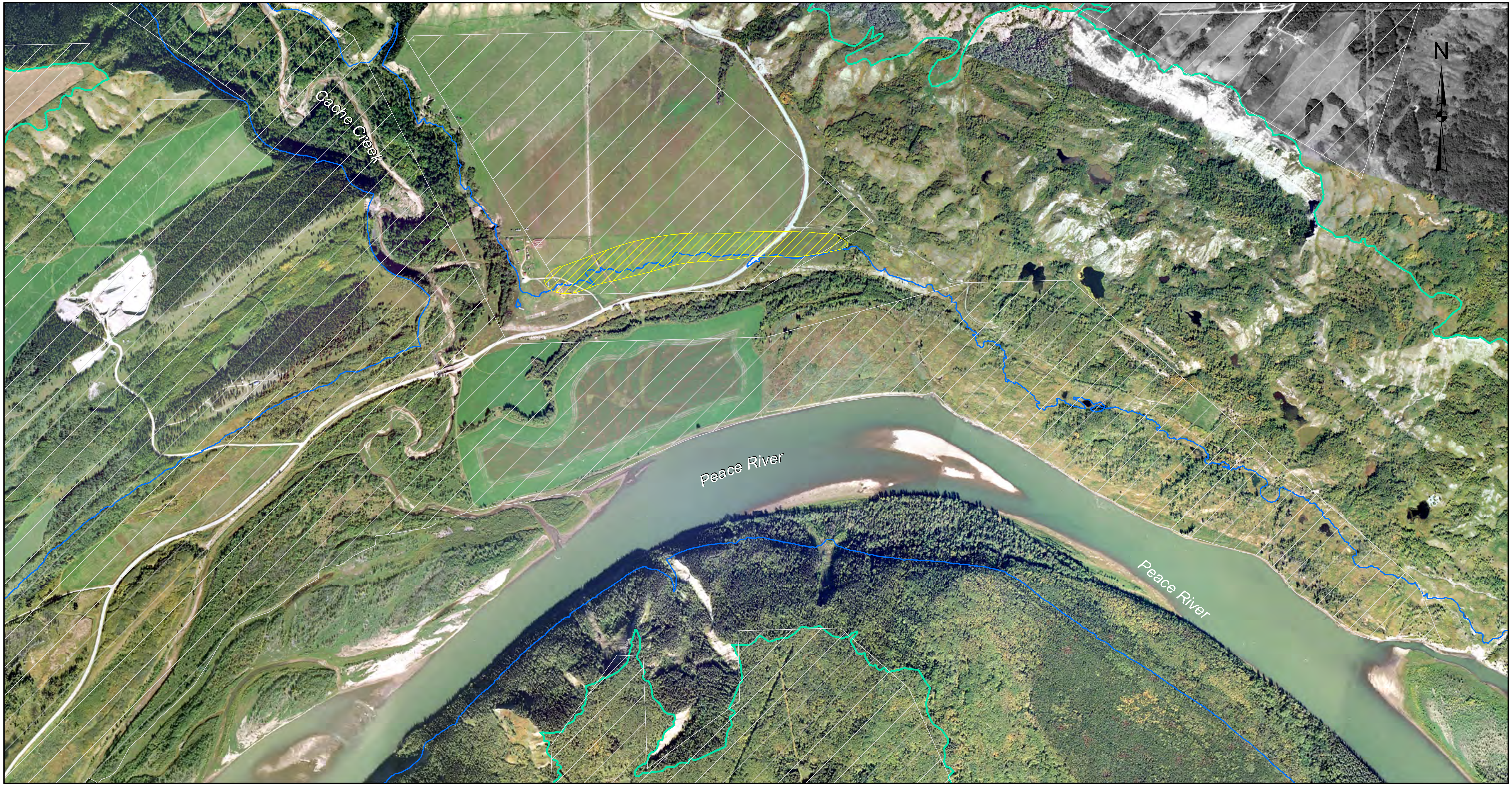
BC Hydro

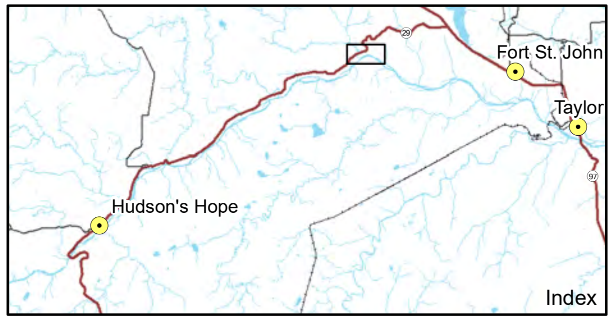
Groundwater Monitoring Areas
Map 4 of 6

Date	July 14, 2016	DWG NO	1016-C14-07345-4	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGISProjects\Environment\Physical_Environment\Ground_Water\Groundwater_Monitoring_1016_C14_07345-2-6.mxd





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Groundwater Monitoring Area
- Peace River and Tributary Valleys Definition
- Proposed Reservoir
- Dam Site Area
- Agricultural Land Reserve

1:15,000 0 0.5 km

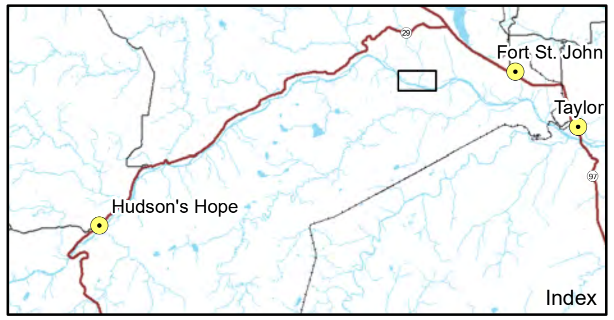
BC Hydro

Groundwater Monitoring Areas
Map 5 of 6

Date	July 14, 2016	DWG NO	1016-C14-07345-5	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGIS\Projects\Environment\Physical_Environment\Ground_Water\Groundwater_Monitoring_1016_C14_07345-2-6.mxd



Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Groundwater Monitoring Area
- Peace River and Tributary Valleys Definition
- Proposed Reservoir
- Dam Site Area
- Agricultural Land Reserve

1:15,000 0 0.5 km

BC Hydro

Groundwater Monitoring Areas
Map 6 of 6

Date	July 14, 2016	DWG NO	1016-C14-07345-6	R 0

Path: X:\ArcGISProjects\Environment\Physical_Environment\Ground_Water\Groundwater_Monitoring_1016_C14_07345-2-6.mxd

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Appendix D – Irrigation Water Requirements Program Report

Introduction

The Site C Clean Energy Project's Environmental Impact Statement (BC Hydro. 2013) ("EIS") Section 20.3.4.1.2 identifies irrigation improvements as a potential mitigation measure for the permanent loss of agricultural land. Lines 25 to 27, page 20-42, of this section state: "Irrigation research, demonstration projects, and funding assistance for irrigation water supply infrastructure will be considered within the proposed agricultural compensation fund."

EAC Condition 31 states: "The Agriculture Monitoring and Follow-up Program must include monitoring for climatic factors to estimate moisture deficits and to estimate irrigation water requirements in the vicinity of the reservoir to provide information for potential future irrigation projects. Data collection will be undertaken before reservoir filling, and in the 5 years after reservoir filling, and data will be reviewed as required for proposed irrigation projects."

In accordance with EAC Condition 31, this study will monitor climate data and estimate irrigation water requirements. The objective of this monitoring program is to collect and analyze climate data to generate estimates of irrigation water requirements.

Methods

<u>Study Location</u>: The study areas are agricultural operations within 3 km of the reservoir. The plan relies on climate station installation, maintenance, and data collection tasks carried out in the Appendix B: Monitoring Potential Effects on Crop Drying Plan.

<u>Activities</u>: Activities have included coordination of data needs with Appendix B: Monitoring Potential Effects on Crop Drying Plan, mapping, baseline data collection, climate station siting, and consideration of consultation input.

Maps supporting this program are included in Appendix B: Monitoring Potential Effects on Crop Drying Plan.

To ensure that all parameters required for the successful completion of this program, coordination with the Crop Drying and Humidity Monitoring Program is required for future climate station siting and any necessary network upgrades.

Irrigation was discussed during the consultation process and included numerous submissions by regional agricultural producers and associations for the Framework of the Agricultural Mitigation and Compensation Plan. Content relevant to irrigation was considered and will be retained for future use in this program.

Results and Analysis

During the program establishment phase there are limited results or analysis required. The climate stations are collecting information that will provide baseline information to support future analysis.

Next Steps

In the five years pre- and post-reservoir filling, complete summaries of the collected data from the new and existing BC Hydro climate stations will be analyzed annually to estimate irrigation water demand (as required). It should be noted that:

- The existing climate station network was upgraded and expanded between January 2016 and December 2017 and that data collected will be the baseline for any future irrigation project.
- Efforts will be made to collaborate with associations, producer groups and government agencies that may have data or local knowledge related to this monitoring program. Examples may include the BC Grain Producers Association which has funded the following study; *Evaluation of Irrigation Potential in the BC Peace Region*.

References

BC Grain Producers Association (2015) "Peace – Evaluation of Irrigation Potential in the BC Peace Region" Available at: http://www.bcgrain.com/Current_Projects.html. Accessed: December 2015.

FAO. (1998). Crop Evapotranspiration – Guidelines for Computing Crop Water Requirements. Rome: Food and Agriculture Organization of the United Nations – Paper 56.

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Dated January 25, 2013; Amended August 2, 2013.

Appendix E – Climate Stations Information

The following tables show information specific to the BC Hydro's existing climate station network.

Table 1 - Periods of Operation for Climate Stations Supporting the AMAFP

Monitoring Station	Period of Operation
Attachie Flat Upper Terrace	2011 - Present
Attachie Flat Lower Terrace[1]	2010 - 2017
Attachie Plateau	2010 - Present
Bear Flat	2010 - Present
Farrell Creek	2009 - Present
Site C Dam[2]	2010 - 2016
Site C North Camp[3]	2016 - Present
Old Fort	2011 - Present
85th Avenue	2013 - Present
Tea Creek	2017 – Present
Taylor	2017 – Present
Fort St. John Airport[4]	1942 – Present

[1] Attachie Flat Lower Terrace was closed in 2017 due to the location being inside the Site C reservoir

[2] Site C Dam Station was relocated in 2016 to an area adjacent to the camp and offices. It is now the Site C North Camp Station

[3] Site C North Camp Climate Station has instruments in two areas located near the Site C offices

[4] Fort St. John Airport is operated by Environment Canada

Table 2 - Locations & Elevations of Current Climate Stations Supporting the AMAFP

Monitoring Station	UTM NAD 83 (m)	Latitude and Longitude (decimal degrees)	Elevation (m)
Attachie Flat Upper Terrace	597983 E, 6232938 N	56.23N, -121.41W	479
Attachie Plateau	595065 E, 6233032 N	56.23N, -121.46W	645
Bear Flat	610669 E,6238135 N	56.27N, -121.21W	474
Farrell Creek	580779 E, 6220238 N	56.12N, -121.70W	471
Site C North Camp[1]	630127 E, 6230625 N	56.20N, -120.90W	581
Old Fort	634,890 E, 6,230,532 N	56.20N, -120.83W	421

85th Avenue	633,033 E, 6,233,949 N	56.23N, -120.85W	686
Tea Creek	626812 E, 6234340 N	56.24N, -120.95W	653
Taylor	639212 E, 6226929 N	56.17N, -120.76W	411
Fort St. John Airport	640053 E, 6234872 N	56.24N, -120.74W	695

[1] The “Site C Dam” meteorological station was decommissioned from its original location on April 13, 2016 due to excavation at that location. It was relocated to a new location, “Site C North Camp”, on July 7, 2016.

Full reports including tabular summaries of the agricultural monitoring parameters are included in the 2014 through to 2025 *Site Climate and Air Quality Monitoring Annual Reports*. These parameters include:

- air temperature,
- humidity,
- precipitation,
- solar radiation,
- wind speed,
- wind direction,
- barometric pressure,
- net radiation,
- soil temperature,
- soil heat flux,
- soil water content, and
- relative humidity.

References:

RWDI Inc. (2015), Site C Climate & Air Quality Monitoring Annual Report 2014, Final. August 26, 2015.

RWDI Inc. (2016), Site C Climate & Air Quality Monitoring Annual Report 2015, Final. June 9, 2016.

RWDI Inc. (2017), Site C Climate & Air Quality Monitoring Annual Report 2016, Rev. 1. June 14, 2017.

RWDI Inc. (2018), Site C Climate & Air Quality Monitoring Annual Report 2017, Final. March 12, 2018.

RWDI Inc. (2019), Site C Climate & Air Quality Monitoring Annual Report 2018, Final. February 22, 2019.

RWDI Inc. (2020), Site C Climate & Air Quality Monitoring Annual Report 2019, Final. March 31, 2020.

RWDI Inc. (2021), Site C Climate & Air Quality Monitoring Annual Report 2020, Final. March 19, 2021.

RWDI Inc. (2022), Site C Climate & Air Quality Monitoring Annual Report 2021, Final. March 8, 2022.

RWDI Inc. (2023), Site C Climate & Air Quality Monitoring Annual Report 2022, Final. March 22, 2023.

RWDI Inc. (2024), Site C Climate & Air Quality Monitoring Annual Report 2023, Final. March 19, 2024.

RWDI Inc. (2025), Site C Climate & Air Quality Monitoring Annual Report 2024, Final. March 24, 2025.