BC Hydro
Power smart

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

2019 Annual Report

Prepared in accordance with the Agricultural Monitoring and Follow-up Program (December 22, 2015)
2019 Annual Report Submission Date: July 19, 2019

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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 will be in service in 2024. 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.

In regard to the schedule presented in the AMAFP and those presented in this report (and the 2018 Annual Report), the discrepancy is due to the change to reservoir filling schedule that occurred in 2017. The most current project schedule dated May 2019 can be found on the Site C Project website here:

https://www.sitecproject.com/sites/default/files/site-c-construction-schedule-20190503.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 for 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) • Five Year Post Reservoir Filling (January 2024 - January 2029)
Annual and Final Reporting	• July 2016 – July 2029

[1] Updated timeline as per 2017 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.

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 2019 AMAFP Annual Report covers the time period from April 1, 2018 to March 31, 2019 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 as appendices, 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 monitoring programs are in various phases of implementation and a summary for each program for the reporting year is provided below.

5.1 Crop Damage Monitoring Program

BC Hydro's Crop Damage Monitoring Program (CDMP) contractor was selected through a Request for Proposal (RFP). The successful contractor was Blackbird Environmental Ltd. (Blackbird).

During the reporting year, BC Hydro and the project team focused efforts on:

- Engagement with
  - Ministry of Agriculture's Regional Agrologist,
  - Ministry of Agriculture's Wildlife Compensation Program Manager,
  - Regional agricultural producer groups, and
  - Subject-matter experts.
- Desktop review
  - Geospatial analysis of the Project area,
  - Literature reference, and
  - Historical data collection.
- Field methodology development
  - Data collection forms,
  - Outreach strategies for prospective participants, and
  - Consultation processes.

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 development included baseline data review (as collected and described in previous AMAFP Annual Reports), as well as consultation with both internal (BC Hydro) and external (RWDI) subject matter experts.

Farm operations identified in the 2018 Annual Report were confirmed and strategies were proposed to coordinate interviews with the CDMP (see Section 5.1 for an overview).

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

The Crop Productivity and Groundwater Monitoring Program (CPGMP) scope was assessed to determine appropriate next steps in order to meet the monitoring requirements as described in Condition 31.

The CPGMP implementation is underway with Blackbird to identify opportunities to combine data collection for the CDMP with the information required for this program.

It was determined that groundwater monitoring wells in the existing BC Hydro network could be employed within the CPGMP in place of installing all new wells. Some new installations are anticipated in areas where the existing well network is not represented.

5.4 Irrigation Water Requirements Program

The Irrigation Water Requirements Program (IWRP), similar to the CDHMP, 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

2019 Annual Report
Site C Clean Energy Project
Crop Damage Monitoring Program

BC Hydro and Power Authority

Blackbird Environmental Ltd.

Final Report - Rev. 1
Blackbird File No.: 19002

July 18, 2019

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Table of Revisions

Revision No.	Date	Reason/Type of Revision
R0	July 12, 2019	Original report issued
R1	July 18, 2019	Minor contextual and grammatical edits based on client review

1 Introduction

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 will be in service in 2024.

During the joint federal-provincial environmental assessment process, the Project's Environmental Impact Statement (EIS; BC Hydro. 2013) noted a potential for increased wildlife crop damage and identified reservoir induced changes to wildlife presence in agricultural areas as a key indicator (Table 20.3).

EIS 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*."

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*."

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 wildlife habitat use and related damage to agricultural crops for a 10 year period which includes the five years prior to reservoir filling and the first five years of operation.

In early 2019, BC Hydro and Power Authority (BC Hydro) retained Blackbird Environmental Ltd. ("Blackbird") to implement the Crop Damage Monitoring Program (CDMP) component of the AMAFP.

The annual report at hand covers the time period from **April 1, 2018** to **March 31, 2019** and focuses exclusively on the CDMP component of the AMAFP.

2 Methods

The CDMP focuses on parcels with agricultural production within a project area based on a five-kilometre buffer around the future Project reservoir.

- **Geospatial Analysis** - During the 2018/19 reporting year, the CDMP team utilized geographic information systems and recent orthoimagery of the project area to delineate and classify agriculturally used parcels (i.e. Crown and freehold parcels containing annual field crops or forage crops). Similarly, the project team utilized GIS technology and information from BC Hydro's properties team to identify agricultural producers in the project area in preparation of producer engagement activities.

- **Historical Data Collection** - The CDMP team has attained and continues to review historical Wildlife Accident Reporting System (WARS) records of vehicle-animal collisions along the segments of Highway 29 overlapping the CDMP area (i.e. from Fort St. John to Hudson's Hope). Similarly, the CDMP team requested and continues to analyse historical ungulate population inventory surveys from the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD; Thiessen 2009, Bridger 2016, Bridger 2018, Gagne-Delorme 2018). The CDMP team retained release forms through the BC Ministry of Agriculture (AGRI) required to access historical production insurance information on the extent and severity of past wildlife damage to crops and stored livestock feed.

- **Stakeholder Consultation & Producer Engagement** - The CDMP team initiated a landowner engagement and outreach program in March 2019 to increase awareness of the program and encourage program participation throughout the CDMP area. The initial engagement program is ongoing and expected to conclude in September 2019. Regional agricultural associations (e.g. Peace River Forage Association of BC, BC Grain Producers Association, Peace River Cattlemen's Association, Peace River Forage Seed Association) and provincial government representatives were invited to participate in a consultation meeting in Fort St. John to introduce the CDMP team and the CDMP in early April.

- **Field Methodology Development** - The CDMP team initiated consultation with stakeholders and knowledgeable third-parties (e.g. FLRNORD wildlife biologists, University of Northern BC, AGRI Agriculture Wildlife Program specialists) on the development of project-specific, scientifically sound methodologies to monitor wildlife habitat utilization and related crop damage for the purposes of fulfilling the requirements of Condition 31. Similarly, a literature review was initiated in early 2019 to evaluate standardized ungulate inventory and population monitoring techniques (e.g. BC RISC standards) for the purposes of the CDMP.

3 Results and Analysis

The CDMP team finalized data collection forms for the initial engagement of agricultural producer, as well as an annual follow-up at the end of the growing season (Appendix A).

Beyond the development of the data collection forms, limited results or analysis are available during the CDMP establishment phase.

As of March 31, 2019, the CDMP team is actively pursuing the engagement of agricultural producers and stakeholders, as well as the program communication and field methodology development components of the CDMP.

The 2020 CDMP report will provide a summary of results from the review of available historic information, producer engagement, the development of field methodologies, and the selection process of monitoring sites.

4 Next Steps

Field surveys and interviews will be completed over 10 years, commencing in late 2018 (5 years prior to reservoir filling) and ending 5 years after reservoir filling in accordance with Condition 31.

- Outreach and engagement activities will commence throughout the growing season of 2019, targeting identified producers within the program area.

- Work will continue to obtain and review available historical data from AGRI's Agriculture Wildlife Program for select CDMP participants.

- The identification and selection of long-term monitoring locations will be completed by July 15, 2019 based on the results of producer engagement and field truthing activities.

- Field methodology selection will be finalized and tested for replicated accuracy and precision in the 2019 growing season. The CDMP team will commence monitoring project locations for wildlife-related crop damage based on input by producers and the team's professional expertise and experience throughout the 2019 season.

- Efforts will be made to continue the successful collaboration with agricultural associations, producer groups and government agencies that may have data or local knowledge related to this monitoring plan.

5 Statement of Limitations

Services provided by Blackbird for this 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 the lead author at your convenience by email at matthias@blackbird.ca.

6 References

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

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Dated January 25, 2013; Amended August 2, 2013. Volume 3, Section 20 Agriculture. Subsection 20.3 Mitigation Measures.

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

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

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

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

Wildlife Accident and Reporting System (WARS). 2019. Highway 29: Fort St. John to Hudson's Hope. Ministry of Transport and Infrastructure, Victoria, BC.

Appendix A: Forms

BC Hydro Crop Damage Monitoring Program (CDMP)

Wildlife-related Crop Damage – Initial Producer Interview Form

Purpose: BC Hydro is required to engage farm operations located within 5 km of the Site C Clean Energy Project ("Site C") reservoir under Condition #31 of the Environmental Assessment Certificate E14-02 ("EAC") issued October 14, 2014 by the British Columbia Environmental Assessment Office ("EAO") for the purpose of constructing Site C. The information provided will inform the CDMP and will be summarised and reported annually to industry representatives, government, and program participants.

Confidentiality: Any crop or production information collected by BC Hydro as part of the CDMP will be held as strictly confidential and will be used exclusively for the purpose of fulfilling regulatory requirements directly associated with the CDMP. Information collected as part of the CDMP will not be disclosed to third persons outside the CDMP project team without the written permission of the producer, except where required under the provisions of the (BC) *Freedom of Information and Protection of Privac*y Act and associated regulations.

Authority: BC Hydro has statutory authority to collect personal information for the purpose of providing generation and distribution of electrical power in British Columbia under the Hydro and Power Authority Act. BC Hydro is bound by Condition #31 of the EAC by the EAO for the purpose of constructing Site C to establish a monitoring program to monitor effects on agriculture for a period beginning 5 years prior to reservoir filling and ending 5 years after reservoir filling. The monitoring program requires BC Hydro to engage with farming operations located within 5 km of the reservoir to collect data. The EAO is administered under the Environmental Assessment Act.

Contact: For more information please contact Ben Rauscher (BC Hydro); ben.rauscher@bchydro.com; BC Hydro, 9948 – 100th Avenue, Fort St John, BC V1J 1Y5

Date (day/month/year):

1 Farm Information

Farm Name		Contact	
Phone #		Email Address	

2 Description of Farm Operation (check all that apply)

☐ Annual Crops	☐ Cow-Calf	☐ Forage	☐ Forage Seed	☐ Horticulture
☐ No Till	☐ Crown Grazing	☐ Organic	☐ Certified Organic	☐ Other

Owned Land	ha/ac	Rented Land	ha/ac
Crown Land	ha/ac		

3 Types of Crops *(+ approx. yield averages)*

☐ Wheat ____	☐ Canola ____	☐ Peas ____	☐ Barley ____	☐ Oats ____
☐ Forage Seed ____	☐ Mixed Forage ____	☐ Vegetables	☐ Nursery	☐ Greenhouse

Other/Details:

4 Livestock *(+ approx. numbers)*

☐ Cows _____	☐ Bulls _____	☐ Yearlings _____	☐ Horses _____	☐ Bison _____
☐ Sheep _____	☐ Goats _____	☐ Meat Chicken ____	☐ Laying Hens ____	☐ Honeybees ____

Other:

5 Past Experiences with wildlife-related damage to crops

Have you participated in the *Agricultural Wildlife Program* with the Ministry of Agriculture in the past? ☐ Yes / ☐ No

Have you experienced wildlife-related loss of production last year? ☐ Yes / ☐ No ☐ NOL filed with AGRI

5.2 Timing of loss (rate in order of importance - 1 being most important, 5 being least, N/A for no damage)				
☐ Establishment ___	☐ Early Spring ___	☐ Standing Crop ___	☐ Swathed ___	☐ Storage ___
5.3 Species of wildlife primarily responsible for losses (1 being mostly responsible, 5 being least, N/A for no damage by species)				
☐ Deer ___	☐ Elk ___	☐ Moose ___	☐ Bear ___	☐ Wolves ___
5.4 Mitigation of wildlife damage to crops (e.g. crop choices/fencing/hunting check all that apply)?				
☐ Hunting	☐ Fencing	☐ Lure Crops	☐ Guardian animal	☐ Other_____
6 Technology utilized on your operations				
☐ Tractor GPS	☐ Combine GPS	☐ Sprayer GPS	☐ Yield Sensor	☐ Grain Cart/Scales
☐ Soil Samples	☐ Mapping	Other:		
7 Participation in the CDMP (we will contact you for a follow-up discussion with our team if you're interested)				
☐ Interested	☐ Not Interested			
7.1 Access Notes (gates, keys, vehicle restrictions, advance notice to landowner/occupant)				
8 Additional details or information you consider important for our program				

BC Hydro Crop Damage Monitoring Program (CDMP)

Wildlife-related Crop Damage – Annual Data Collection Form

Purpose: BC Hydro is required to engage farm operations located within 5 km of the Site C Clean Energy Project ("Site C") reservoir under Condition #31 of the Environmental Assessment Certificate E14-02 ("EAC") issued October 14, 2014 by the British Columbia Environmental Assessment Office ("EAO") for the purpose of constructing Site C. The information provided will inform the CDMP and will be summarised and reported annually to industry representatives, government, and program participants.

Confidentiality: Any crop or production information collected by BC Hydro as part of the CDMP will be held as strictly confidential and will be used exclusively for the purpose of fulfilling regulatory requirements directly associated with the CDMP. Information collected as part of the CDMP will not be disclosed to third persons outside the CDMP project team without the written permission of the producer, except where required under the provisions of the (BC) *Freedom of Information and Protection of Privac*y Act and associated regulations.

Authority: BC Hydro has statutory authority to collect personal information for the purpose of providing generation and distribution of electrical power in British Columbia under the Hydro and Power Authority Act. BC Hydro is bound by Condition #31 of the EAC by the EAO for the purpose of constructing Site C to establish a monitoring program to monitor effects on agriculture for a period beginning 5 years prior to reservoir filling and ending 5 years after reservoir filling. The monitoring program requires BC Hydro to engage with farming operations located within 5 km of the reservoir to collect data. The EAO is administered under the Environmental Assessment Act.

Contact: For more information please contact Ben Rauscher (BC Hydro); ben.rauscher@bchydro.com; BC Hydro, 9948 – 100th Avenue, Fort St John, BC V1J 1Y5

Date (day/month/year):

1 Farm Information

Farm Name		Contact No.	

Have there been significant changes to your operation's land base this year? ☐ Yes / ☐ No

If yes, please provide details:

2 This growing season's crops and approximate yields

☐ Wheat ____	☐ Canola ____	☐ Peas ____	☐ Barley ____	☐ Oats ____
☐ Forage Seed ____	☐ Mixed Forage ____	☐ Vegetables	☐ Nursery	☐ Greenhouse

Other:

3 Wildlife-related damage to crops

Have you participated in the *Agricultural Wildlife Program* with the Ministry of Agriculture this year? ☐ Yes / ☐ No

Have you experienced wildlife-related loss of production last year? ☐ Yes / ☐ No ☐ NOL filed with AGRI

Have you experienced significant changes to wildlife-related loss of production last year? ☐ Yes / ☐ No

If yes, please provide details:

3.1 *Severity and Extent of wildlife-related crop damage (check all that apply)*

☐ None	☐ Trace (< 10 % of crops)	☐ Low (10-25 %)	☐ Moderate (25-60 %)	☐ Severe (>60 % of crop)

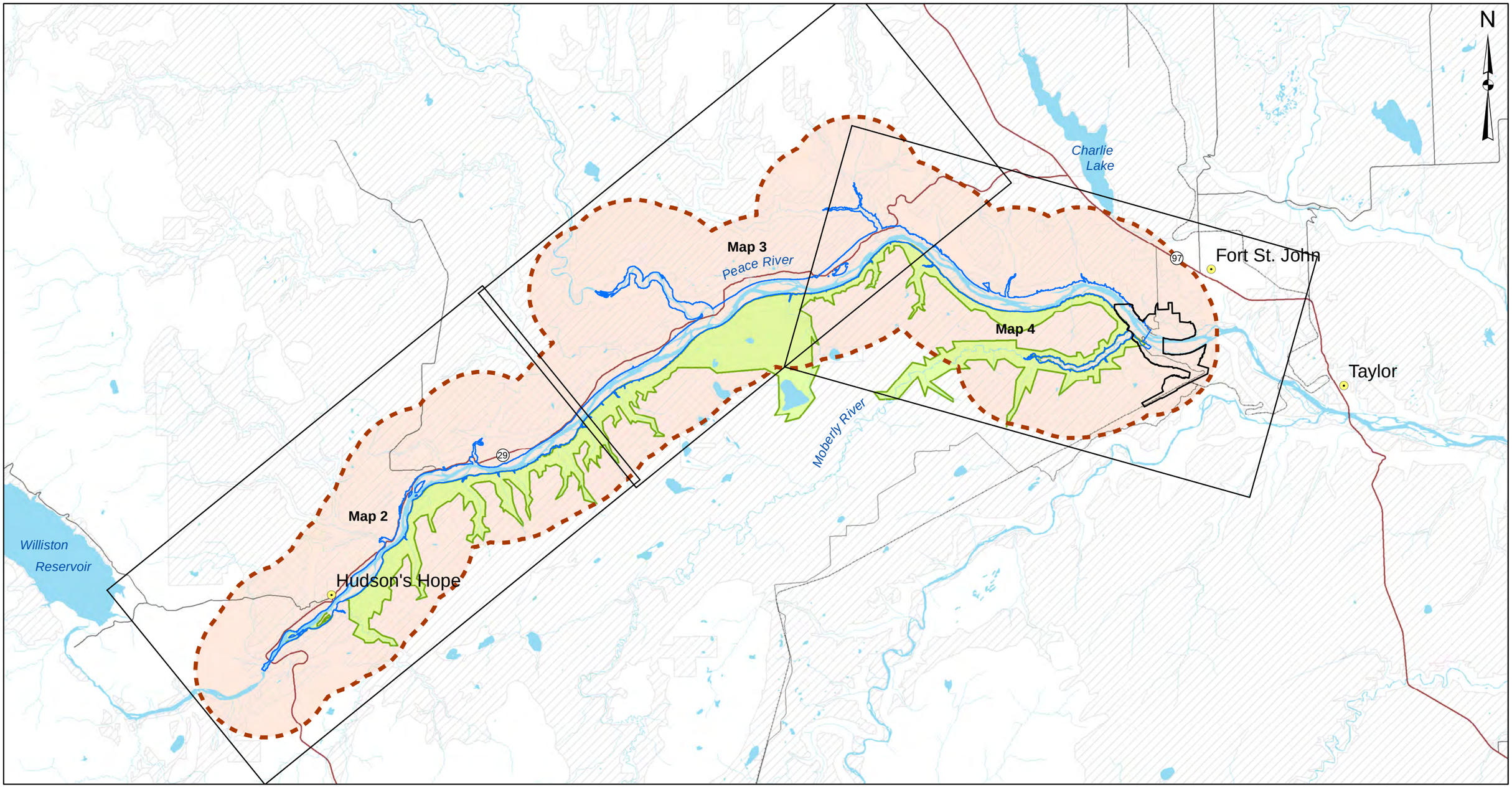
Total area with crop damage:	Proportion of stored feed damaged:

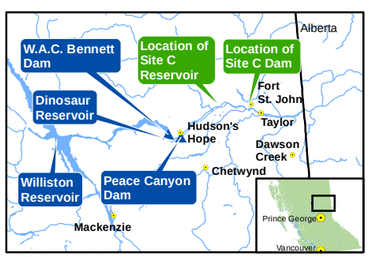
3.2 Timing of loss (rate in order of importance - 1 being most 5 being least)

☐ Establishment ___	☐ Early Spring ___	☐ Standing Crop ___	☐ Swathed ___	☐ Storage ___

Notes/Details:

3.3 Species of wildlife primarily responsible for losses (H for high losses, L for low losses)				
☐ Deer ___	☐ Elk ___	☐ Moose ___	☐ Bear ___	☐ Wolves ___
Notes/Details:				
3.4 Mitigation of wildlife damage to crops (check all that apply)				
☐ Hunting	☐ Fencing	☐ Lure Crops	☐ Guardian animal	☐ Other_____
Notes/Details:				





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:\ArcGIS\Projects\Environment\Agriculture\Ag_SkinReservoirBoundary_Overview_1016_C14_07343-1.mxd

Hudson's Hope

Peace River

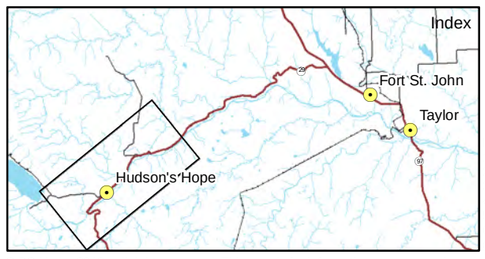
Lynx Creek

Dry Creek

Farrell Creek

Dinosaur Reservoir

N



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 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.

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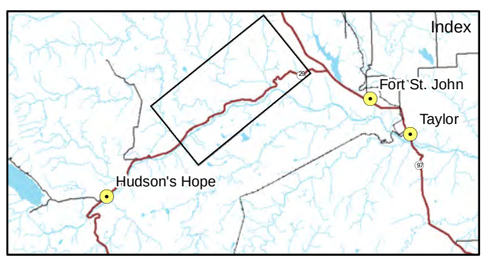

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos provided by ESRI
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

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 3 of 4

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.

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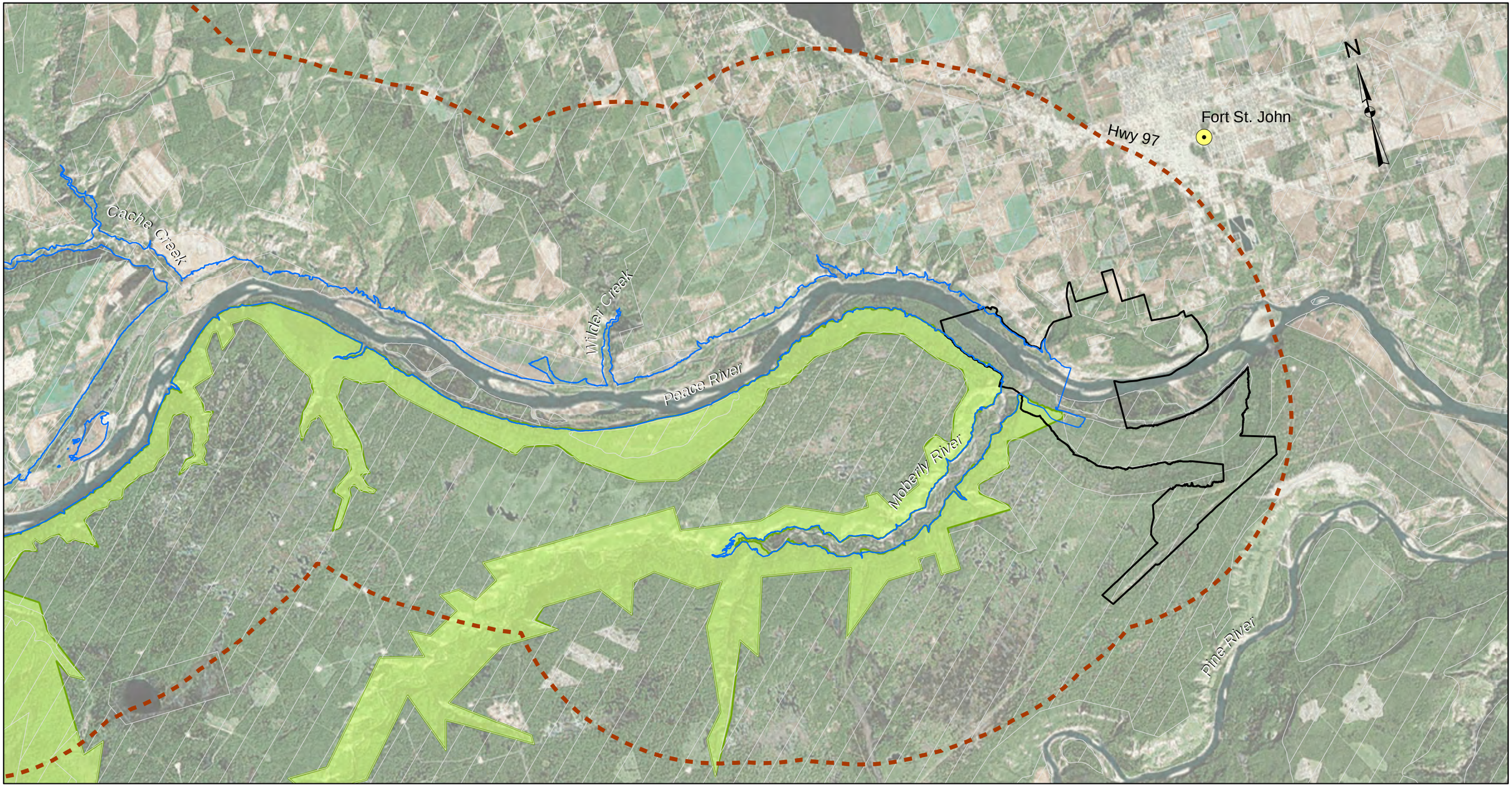

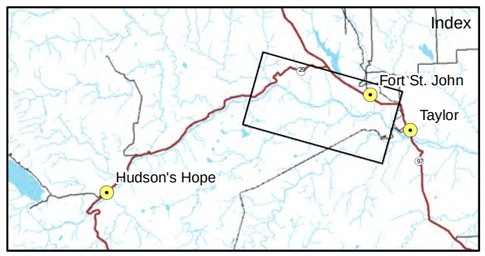

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos provided by ESRI
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

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.

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Appendix B – Crop Drying and Humidity Monitoring Program Report

Introduction

The Site C Clean Energy Project's Environmental Impact Statement (BC Hydro. 2013) ("EIS") identifies reservoir induced changes to microclimate on adjacent agricultural operations as a key indicator (EIS Section 10, Table 20.3). Changes which have an effect on crop drying is a reservoir induced change which 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."

EAC Condition 31 states: "The Agriculture Monitoring and Follow-up Program must include 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."

In accordance with EAC Condition 31, this study is intended to determine if there are reservoir induced changes to the microclimate on adjacent farms which result in a negative effect on crop drying.

Methods

Study location: The program includes the collection of climate data within 3 km of the reservoir to evaluate any changes and determine the effects on crop drying practices.

Activities: Activities have included mapping, initial work on historical data review, baseline data collection, climate station site planning, identification of farm operations within the project area, field survey locations, and initial consultation.

To support the establishment of this monitoring program, maps were created using a combination of aerial orthophotography and Agricultural Land Reserve (ALR) data. Maps produced include:

- Climate Stations Map (refer to Appendix E)
- Crop Drying Monitoring Area Identification (refer to Appendix B – Overview Maps 1 of 9)

Climate data was included in the EIS and baseline climate data continues to be collected using BC Hydro's Site C climate station network. Appendix E: Climate Station Information provides an overview of the climate stations relevant to the agriculture monitoring program.

There are currently nine climate stations located at the sites below (refer to Appendix E for complete details):

- Attachie Flat Upper Terrace,
- Attachie Plateau,
- Bear Flat,
- Farrell Creek,
- Site C North Camp,
- Old Fort,
- 85th Avenue,
- Tea Creek, and
- Taylor.

These stations are maintained and monitored by RWDI and data collection is ongoing and summarized annually in tabular format and by location. Complete details from 2014 to 2018 are available in the RWDI *Site C Climate & Air Quality Monitoring Annual Reports*.

The data collected from these stations to be used in the monitoring program 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.

Farm operator interviews will be undertaken with participating operators identified within the monitoring program area. Overlap with other agricultural monitoring programs may enable the program team to interview identified farm operators in coordination with the other programs.

Results and Analysis

During the program establishment phase, there are limited results or analysis required. In this phase, annual reports provide a summary of activities including baseline data review, selection of monitoring sites for field surveys and general program preparation. The climate stations are collecting information that will provide baseline information to support future analysis.

Next Steps

Baseline climate data continues to be collected and reviewed alongside the compiled historical data. The existing climate station network was upgraded to meet monitoring program requirements.

Coordination of outreach and engagement with other agricultural monitoring programs continues as it relates to farm operator interviews. Additionally, collaboration is planned with associations, producer groups and government agencies to share data or impart local knowledge.

Full program activities will be undertaken in 2019 in accordance with EAC Condition 31 requirements and the AMAFP implementation schedule. Full monitoring plan implementation will be undertaken over 10 years, commencing five years prior to reservoir filling and ending five years post reservoir filling.

References

British Columbia Ministry of Environment. 1983. Climatic Capability for Agriculture, Mapsheets 94A/SW and 94A/SE. Victoria, B.C

BC Grain Producers Association. 2015. “Peace- Agriculture Weather Monitoring and Decision Support Tools” Available at: http://www.bcgrain.com/Current_Projects.html. Accessed: December 2015.

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

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

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Dated January 25, 2013; Amended August 2, 2013. Volume 3, Section 20 Agriculture. Subsection 20.3 Mitigation Measures (20.3.7.2.2)

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Dated January 25, 2013; Amended August 2, 2013. Volume 3, Appendix D Agricultural Assessment Supporting Documentation. Appendix A. Climatic Moisture Deficit MD Calculations

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

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

RWDI Air 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 2019, Final. February 22, 2019.

Schnorbus, M., K. Bennett, A. Werner and A. Berland. 2011. Hydrological Impacts of Climate Change in the Peace, Campbell and Columbia Watersheds, British Columbia, Canada. Pacific Climate Impacts Consortium, University of Victoria. Victoria, B.C.

N

Charlie Lake

Map 8

Map 9

Peace River

Map 5

Map 4

Fort St. John

97

Map 6

Moberly River

Map 7

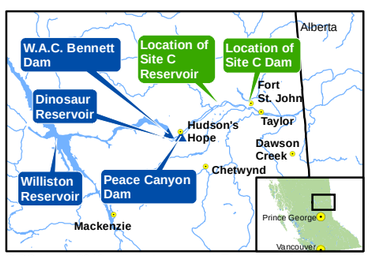
Taylor

Map 3

29

Hudson's Hope

Map 2



Map Notes:
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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 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.

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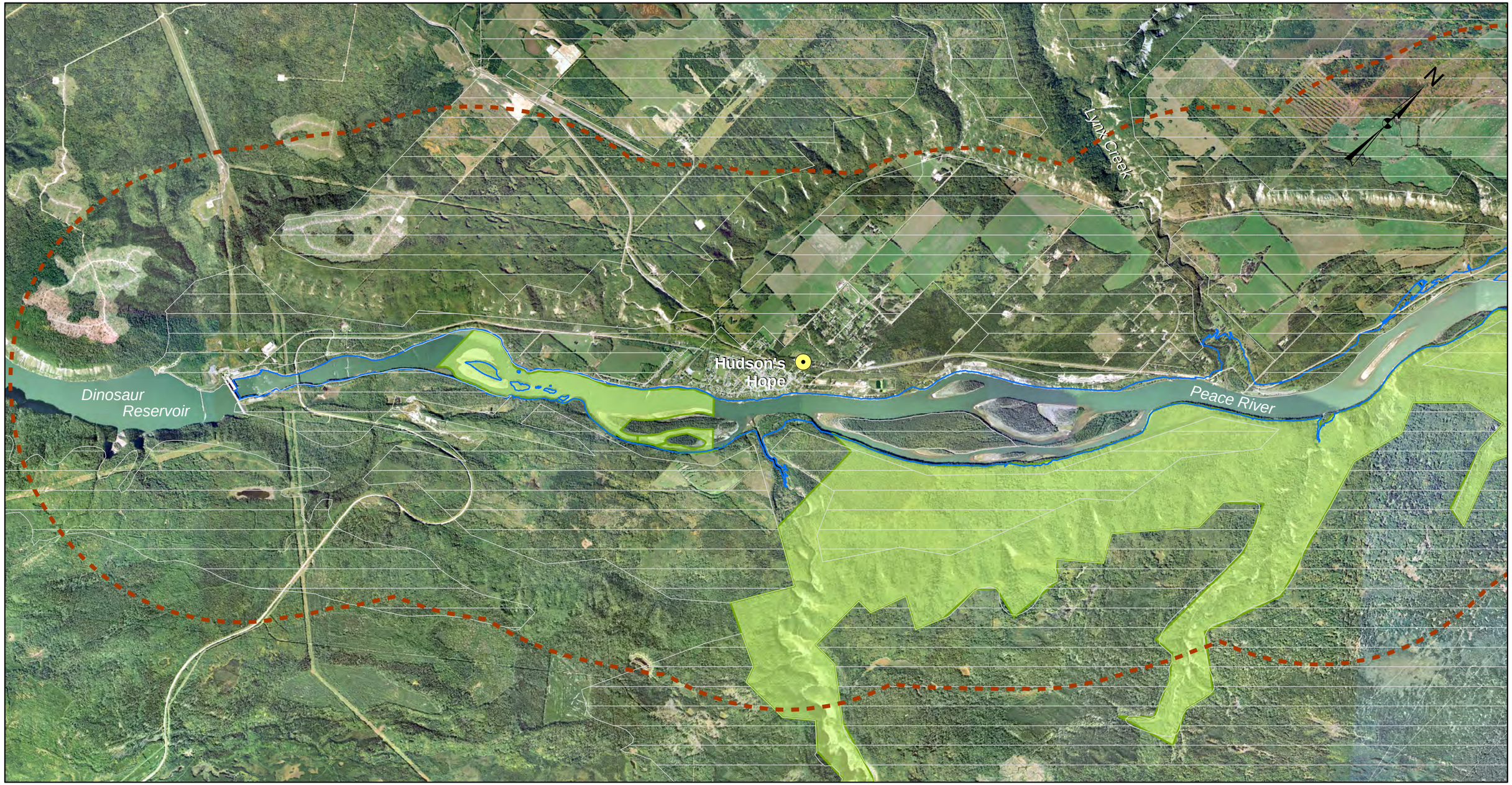

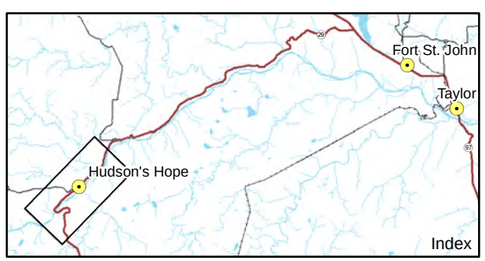

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3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August,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

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

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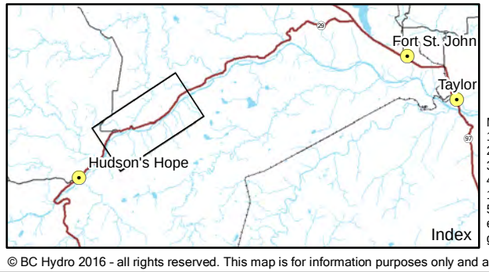
Dry Creek

Farrell Creek

Peace River

N



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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

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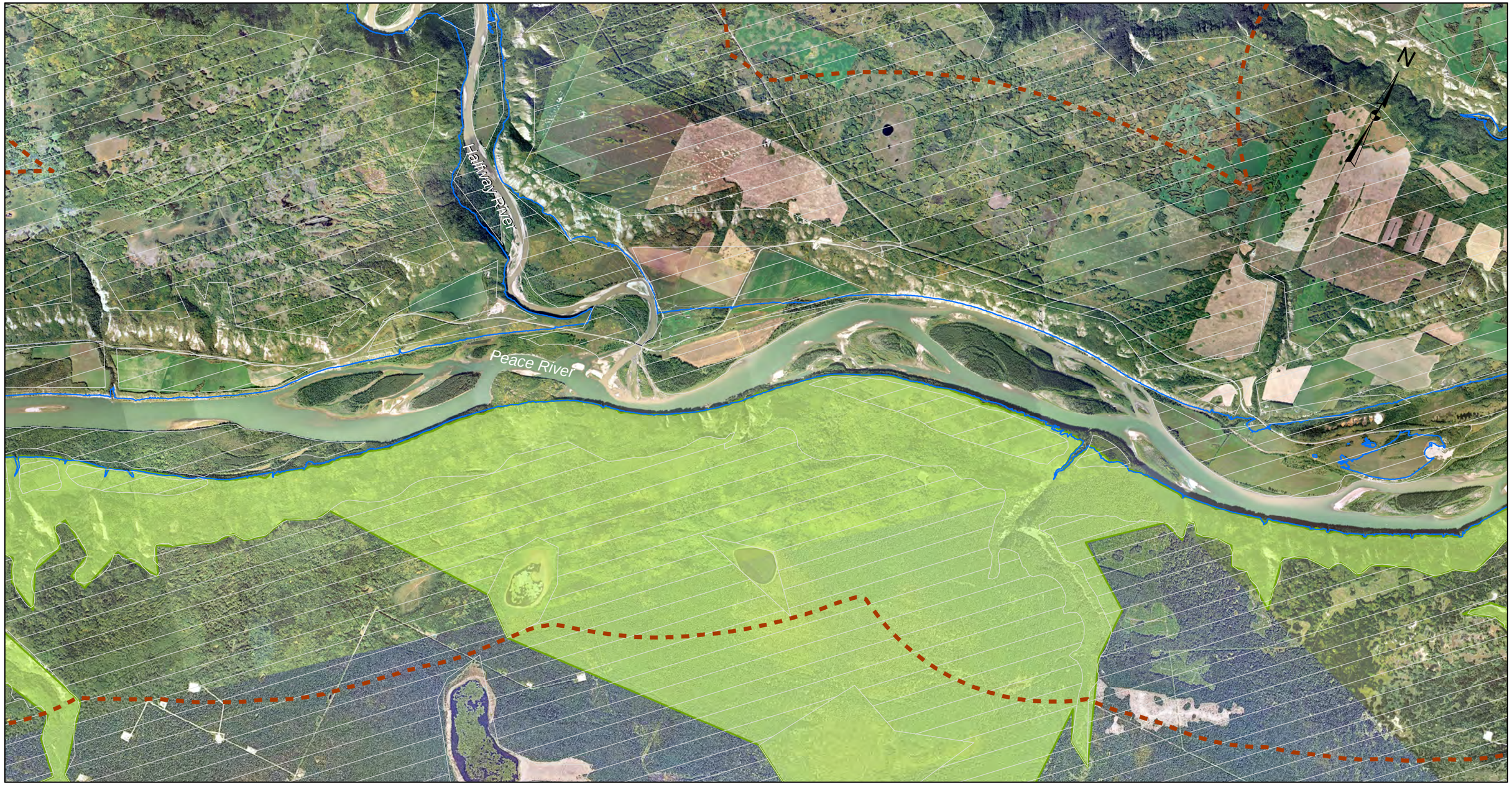

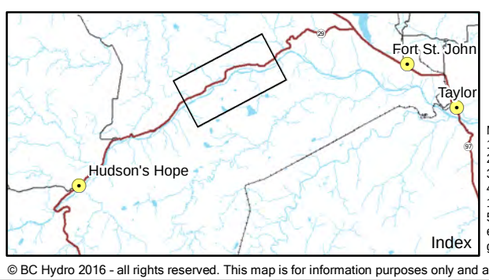

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5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

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.

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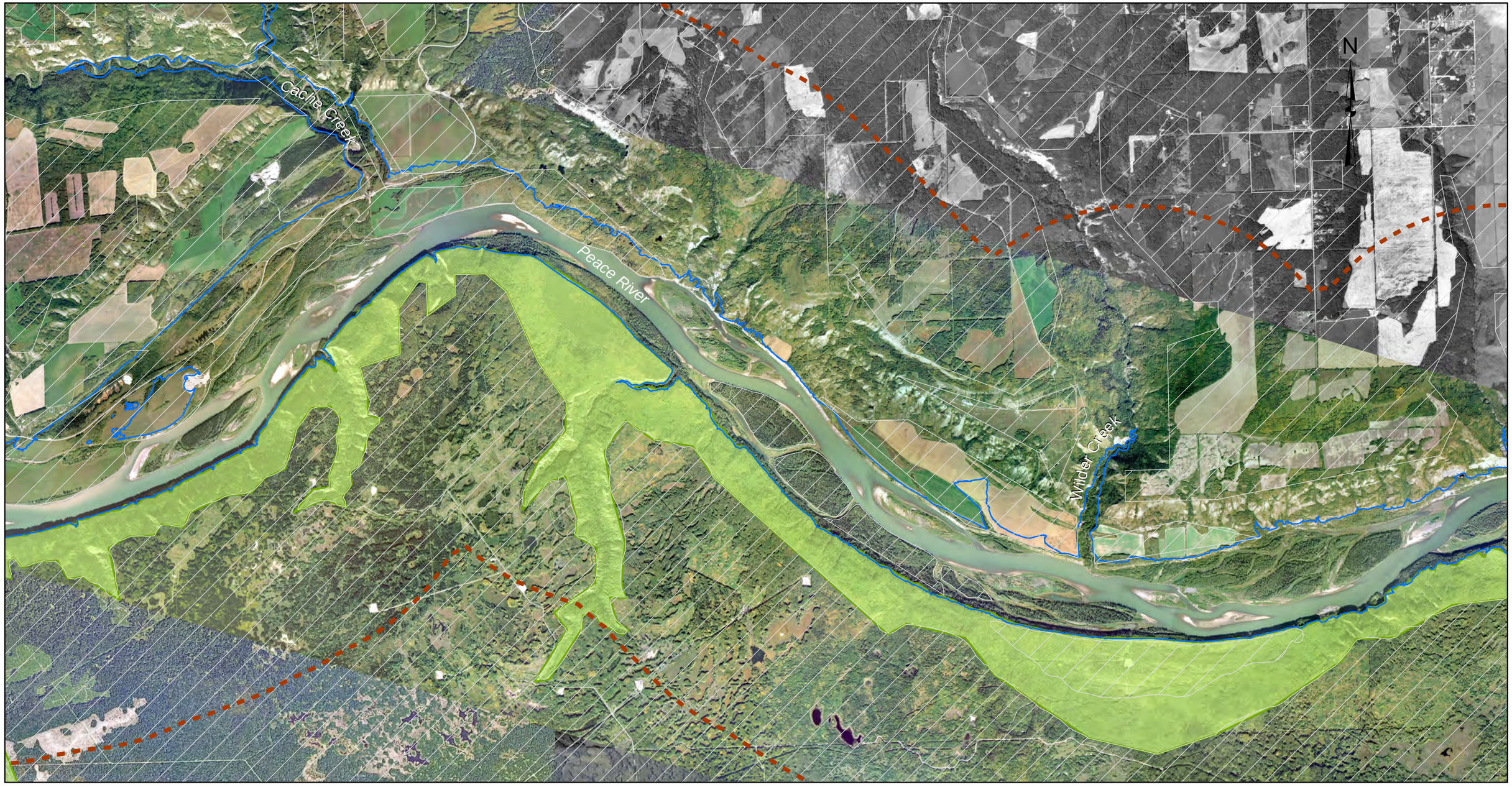

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5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

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

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

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Map Notes:
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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.

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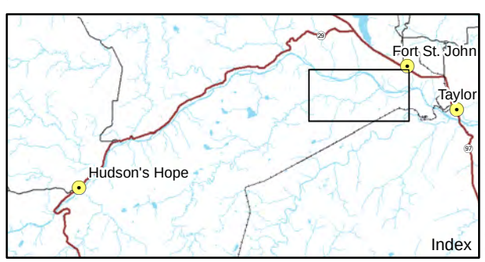
Widen

Peace River

Moberly River

Pine River

N



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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

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

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N

Halfway River

Peace River

Map Notes:
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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

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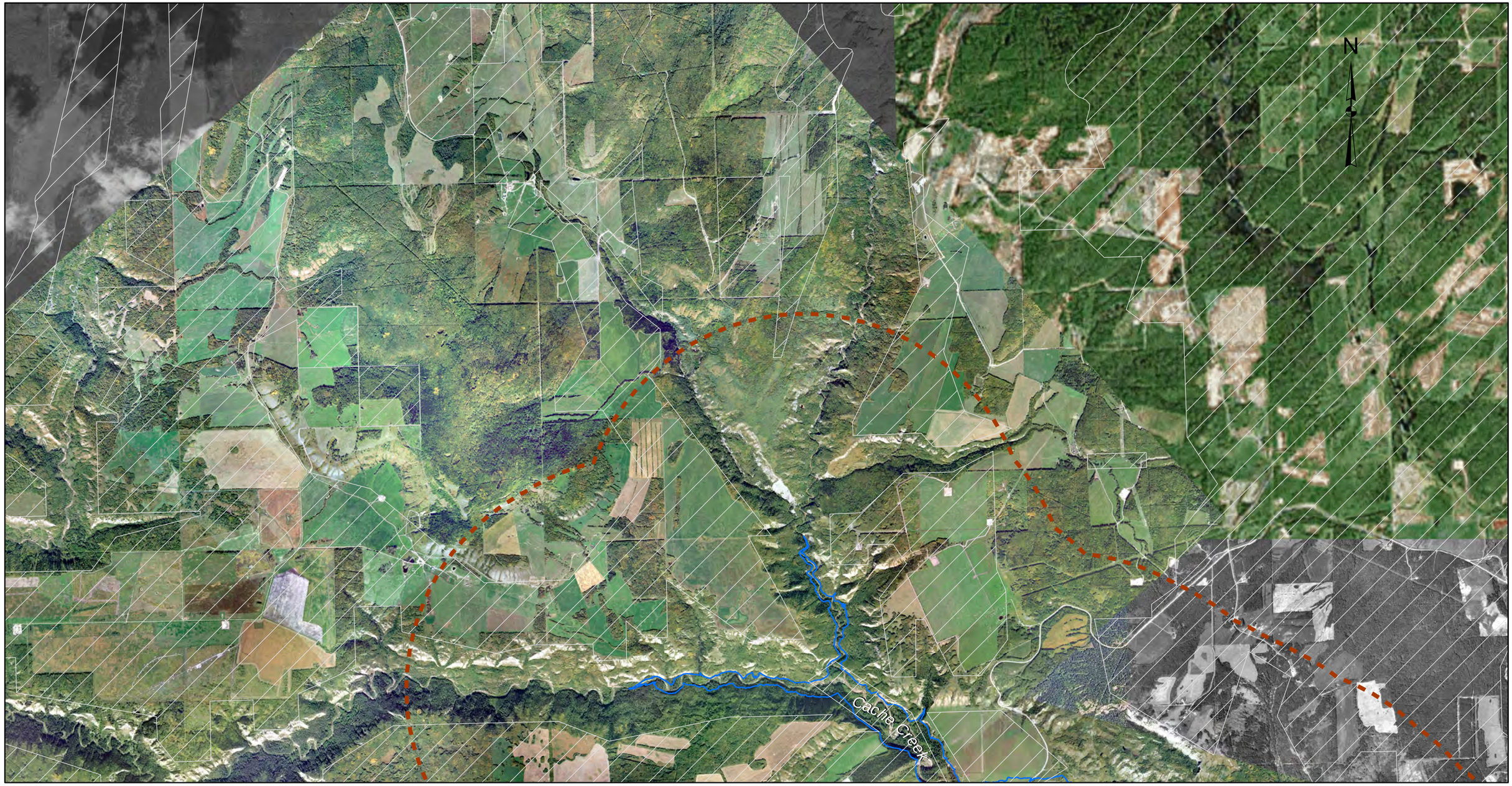

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5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

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.

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Appendix C – Crop Productivity and Groundwater Monitoring Program Report

Introduction

The Site C Clean Energy Project's Environmental Impact Statement (BC Hydro. 2013) ("EIS") identifies changes to local hydrology and groundwater as a key indicator for agriculture (EIS Section 20, Table 20.3).

EIS Section 20.3.2.2 (page 20-34, lines 7 to 19) 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."

EAC Condition 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."

In accordance with EAC Condition 31, this study is intended to determine if there are reservoir induced changes to groundwater elevations on adjacent agricultural land which results in a negative effect on crop production.

Data will be collected and evaluated to determine if crop productivity, including yield and limitations on cropping selection, in areas within 2 km of the reservoir which is within 2 metres of the reservoir level and will potentially be altered. The data to be collected will include:

- measured groundwater levels,
- observations of crop growth,
- measurements of soil moisture,
- climate data, and
- information obtained from farm operators interviews.

Methods

Study Location: The program includes monitoring of Project-induced changes to groundwater elevations in producing fields within 2 km of the reservoir. Cropped areas which are less than 2 metres above the reservoir full supply level have been identified and groundwater impacts in these areas will be monitored.

Activities: Activities have included mapping, initial work on historical data review, baseline data collection, fieldwork preparations (survey, interviews, etc.), and consultation. To support the establishment of this monitoring program, maps were created using a combination of aerial orthophotography and Agricultural Land Reserve (ALR) data.

Areas of potential groundwater effects have been identified using elevation mapping.

This program has identified both precipitation and soil moisture as key parameters. Baseline data collection and climate station management is described in Appendix B: Monitoring Potential Effects on Crop Drying Plan.

Coordination of outreach and engagement with other agricultural monitoring programs continues as it relates to farm operator interviews.

Results and Analysis

During the program establishment phase, there are limited results or analysis required. In this phase, annual reports provide a summary of activities including baseline data review, selection of monitoring sites for field surveys and general program preparation. The groundwater monitoring well network is collecting information that will provide baseline information to support future analysis.

Next Steps

The full monitoring plan implementation, including field work, interviews, and data interpretation will be completed over 10 years, commencing five years prior to reservoir filling and ending five years after reservoir filling.

Baseline data continues to be reviewed, including observations of crop growth and soil moisture conditions in potentially affected areas. Selection of monitoring sites for field surveys may include ground truthing. A data collection sheet will be developed to gather the following information:

- Drainage: qualitative information on growing conditions and variability,
- Crop and soil type, and
- Crop productivity (yield and variability).

Farm operations within the program area will be invited to participate in annual interviews, and assist in the determination of field survey locations.

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.

References

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

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Dated January 25, 2013; Amended August 2, 2013. Volume 3, Section 20 Agriculture. Subsection 20.3 Mitigation Measures.

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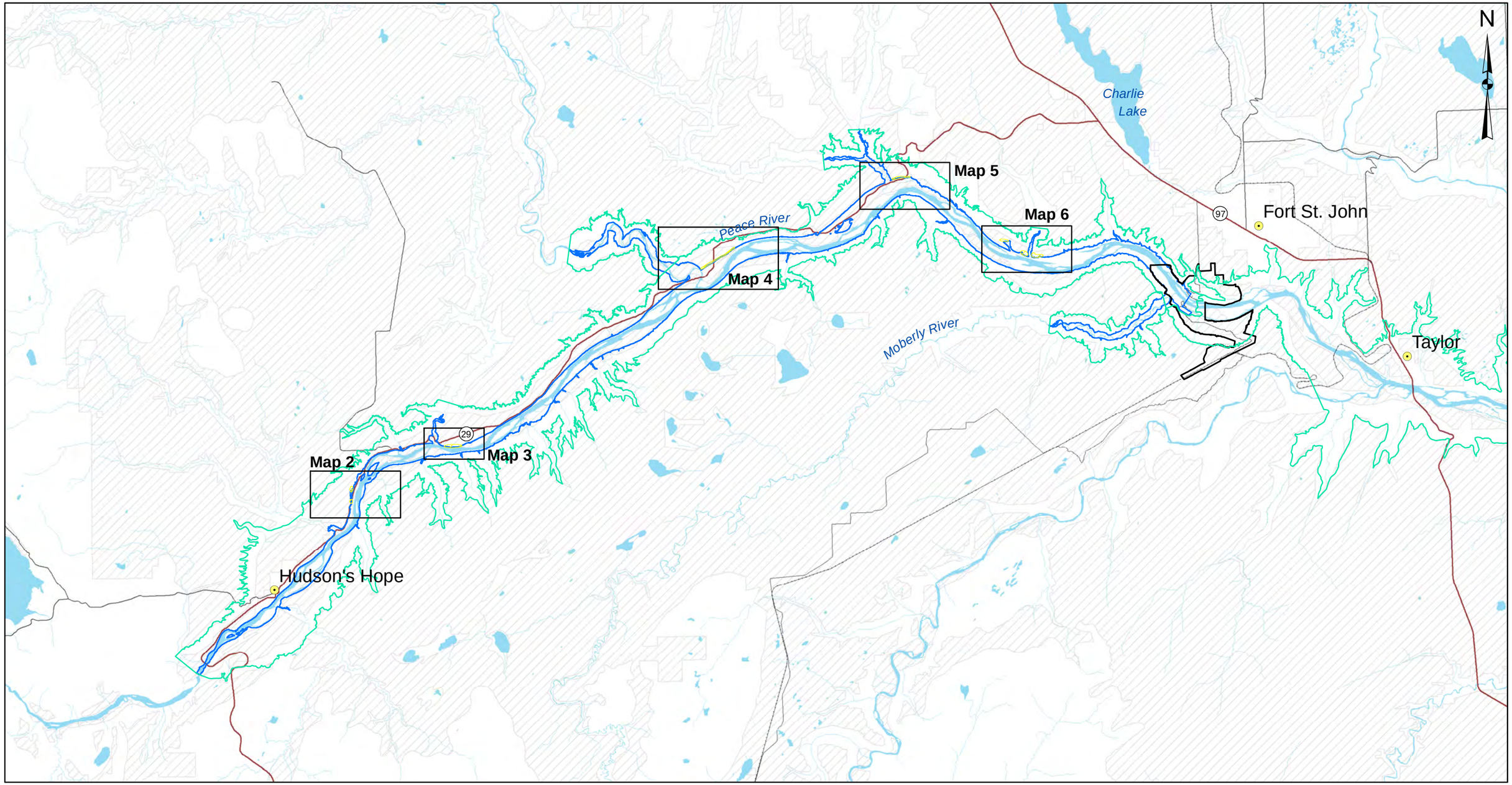
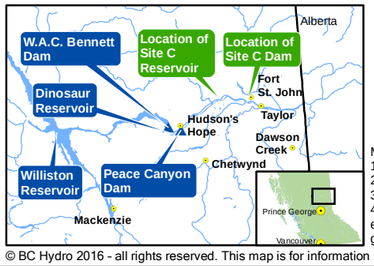
RWDI Inc. (2019), Site C Climate & Air Quality Monitoring Annual Report 2019, Final. February 22, 2019.





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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.

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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.

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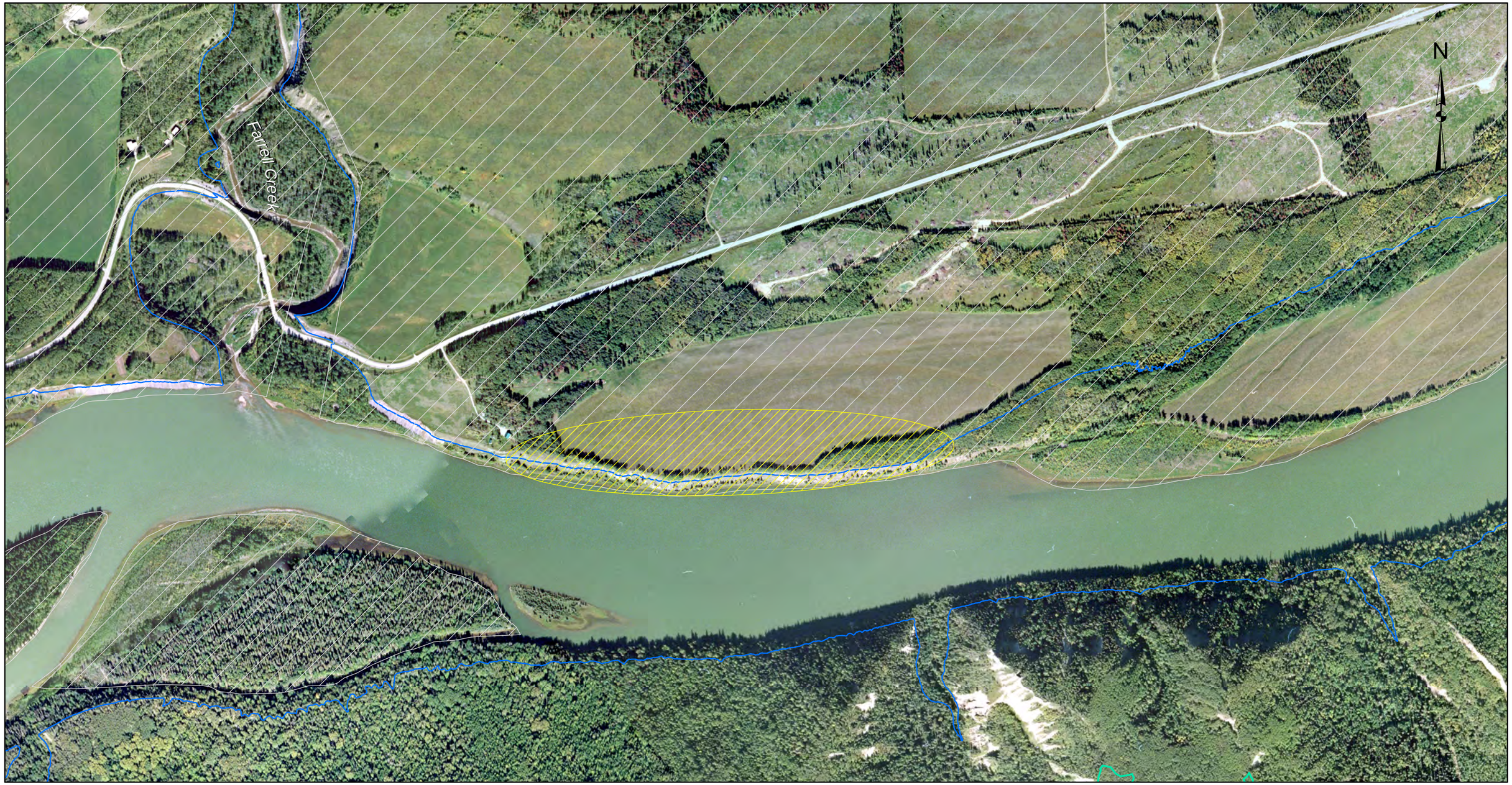

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4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

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.

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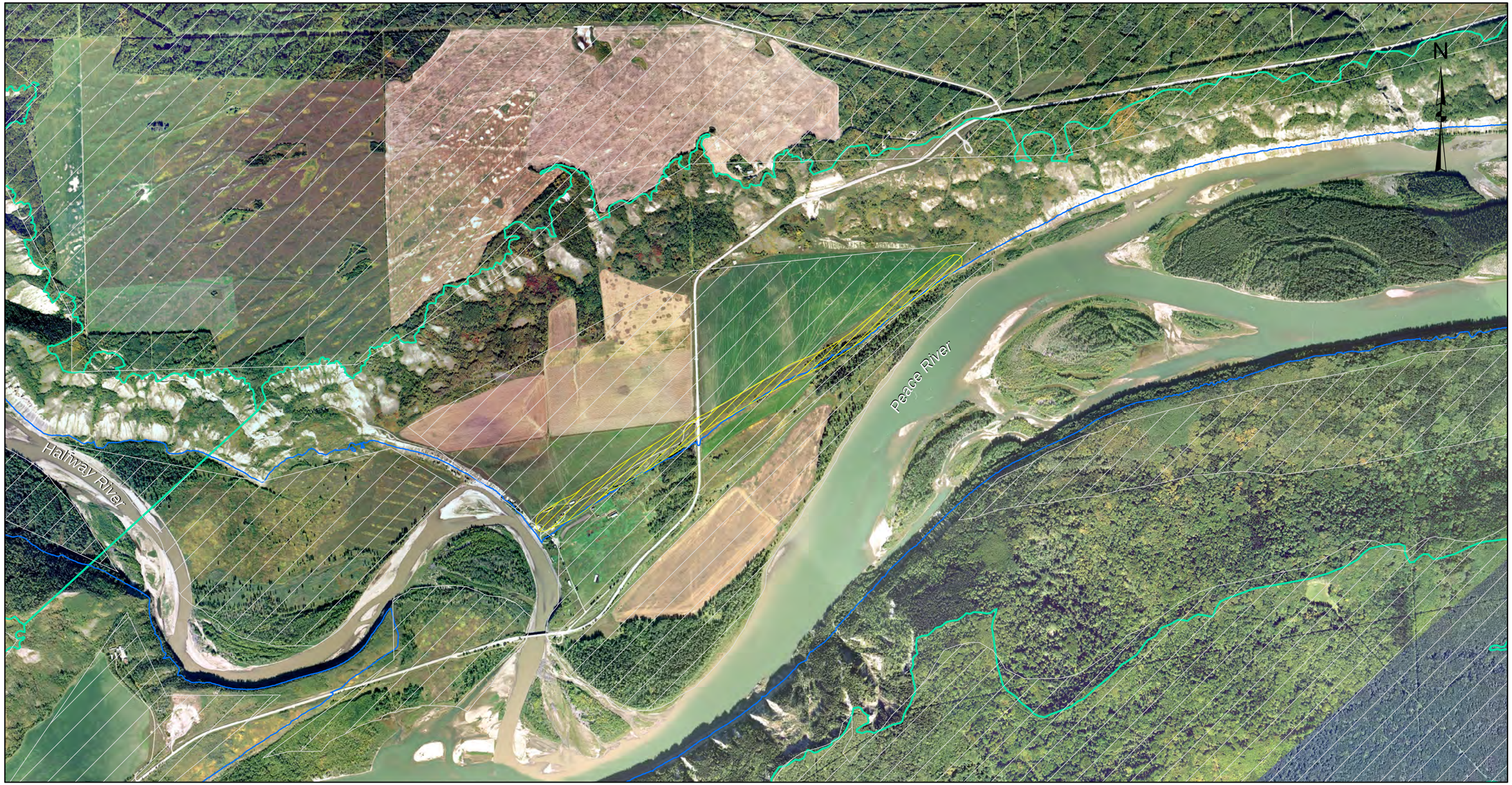

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4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

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.

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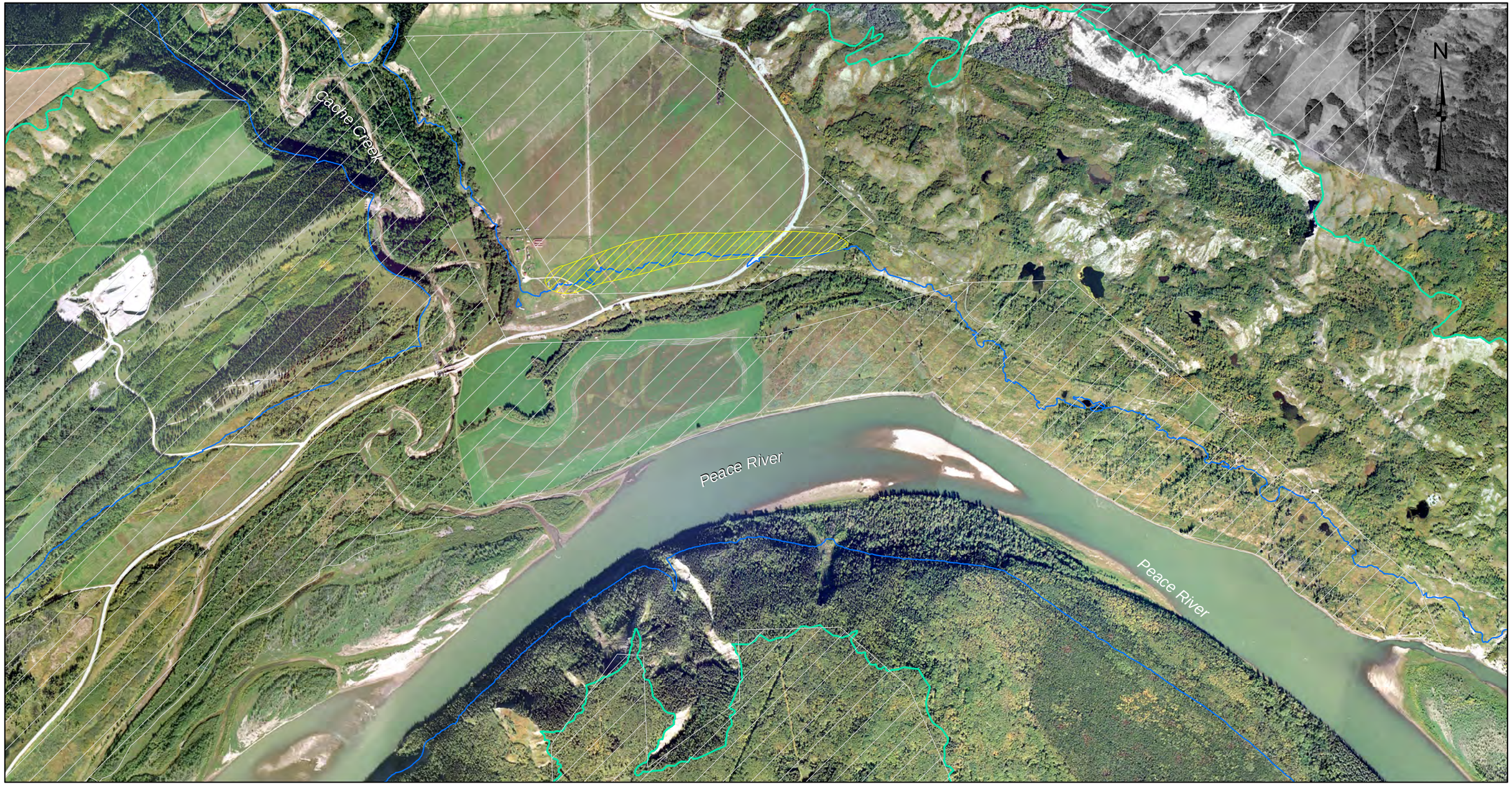

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3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August,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

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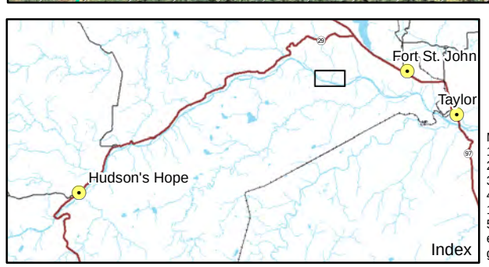

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007, TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August,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

Legend

- Groundwater Monitoring Area
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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

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

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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

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

Activities: 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, 2015, 2016, 2017, and 2018 *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:

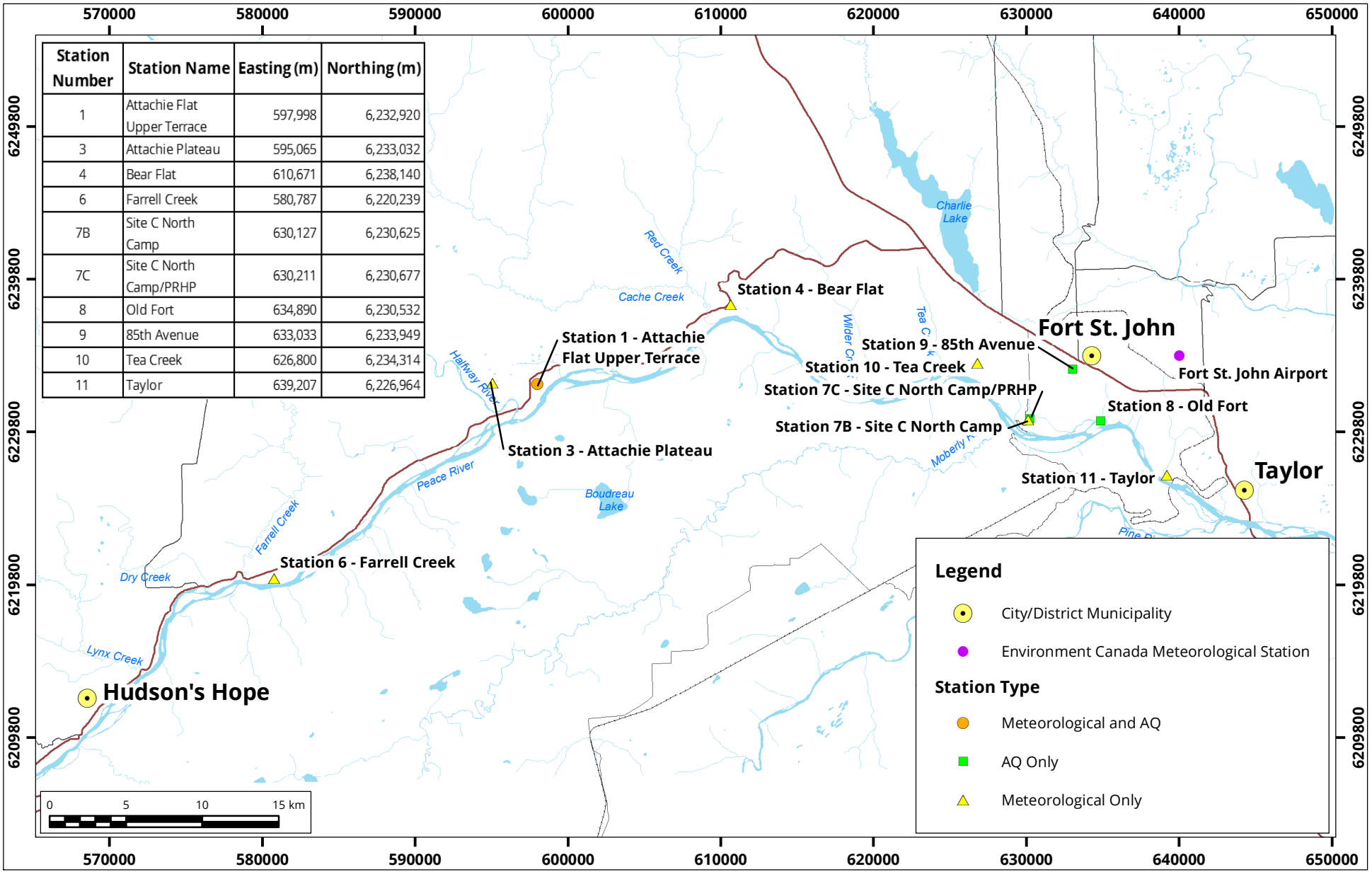
RWDI Inc. (2015), Site C Climate & Air Quality Monitoring Annual Report 2014, Final. August 26, 2015.

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 2019, Final. February 22, 2019.



Station Number	Station Name	Easting (m)	Northing (m)
1	Attachie Flat Upper Terrace	597,998	6,232,920
3	Attachie Plateau	595,065	6,233,032
4	Bear Flat	610,671	6,238,140
6	Farrell Creek	580,787	6,220,239
7B	Site C North Camp	630,127	6,230,625
7C	Site C North Camp/PRHP	630,211	6,230,677
8	Old Fort	634,890	6,230,532
9	85th Avenue	633,033	6,233,949
10	Tea Creek	626,800	6,234,314
11	Taylor	639,207	6,226,964

BC Hydro - Site C Meteorological and Air Quality Stations

True North

Drawn by: DJH | Figure: 2-1

Approx. Scale: 1:350,000

Date Revised: Sep 18, 2017

Map Projection: NAD 1983 UTM Zone 10N

Project #: 1601625