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SITE C CLEAN ENERGY PROJECT - AGRICULTURAL ASSESSMENT

Site C Clean Energy Project - Agricultural Assessment Supporting Documentation

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1.0 INTRODUCTION

This Agricultural Assessment Supporting Documentation report provides supplementary information and additional detail to support the agricultural assessment contained in Volume 3 Section 20 Agriculture. Volume 3 Section 20 Agriculture also contains an outline of the methodology used in the agricultural assessment.

This supporting documentation report includes descriptions of the following:

- The methodology used for determining land capability for agriculture
- The evaluation of climatic capability for agriculture, of the potential climate effects of the proposed reservoir on agriculture, and of the effects of predicted global climate change on agriculture
- The process used in interviewing farm operators or owners and a summary of agricultural operations in the Peace Agricultural Region
- The agricultural economies baseline information and of the methodology used in estimating economic returns from farming
- Regional food production and consumption baseline information and effects of anticipated changes in population, agricultural practices and climate on food self-reliance

2.0 LAND CAPABILITY FOR AGRICULTURE ASSESSMENT METHODOLOGY

This section describes methodology used in evaluating and updating and land capability for agriculture ratings for lands within the Local Assessment Area (LAA) and the remainder of the Peace River Valley between the Peace Canyon Dam and the Alberta border.

This section includes:

- A list of sources of existing information used
- A summary of existing soils and land capability for agriculture information
- A description of the land capability for agriculture classification system
- A description of the 2011 and 2012 soils field programs
- The methodology used in updating and evaluating land capability for agriculture ratings

2.1 Sources of Existing Information

Numerous sources of existing information on area soils and land capability for agriculture were reviewed and used to characterize the agricultural land base within the LAA and the remainder of the Peace River Valley between the Peace Canyon Dam and the Alberta border. These information sources included the following:

- Canada Land Inventory Land Capability for Agriculture maps (1:50,000 scale; these maps were produced from the early- to mid-1970s)
- *Peace River Site C Hydroelectric Development Agriculture Assessment* (CBRC 1979)
- Digital ortho-photographs 1:5,000 scale (2010)
- Digital ortho-photograph base 1:40,000 scale (2007)
- *Land Capability Classification for Agriculture in British Columbia* (Kenk and Cotic 1983)
- LiDAR Digital Elevation Model.
- *Soils of the Fort St. John – Dawson Creek Area, British Columbia* (Lord and Green 1986)
- *A Soil Mapping System for Canada: Revised* (Mapping Systems Working Group 1981)
- *Site C Project Environmental Resource Atlas* (Norecol Environmental Consultants Ltd. 1991a)
- *Manuscript Maps used for Determination of the Aerial Extent of Lands with Agricultural Capability Class 1 to 5 within the Proposed Site C Reservoir Area September 15, 1982* (Pottinger 1982a)
- *Site C Project. Determination of the Aerial Extent of Lands with Agricultural Capability Class 1 to 5 within the Proposed Site C Reservoir Area* (Pottinger 1982b)
- *The Canadian System of Soil Classification* (Soil Classification Working Group 1998)

2.2 Summary of Existing Information

2.2.1 Soils Information

The following summary description of soils of the LAA and remainder of the Peace River Valley between the Peace Canyon dam and the Alberta border is based on the *Soils of the Fort St John-Dawson Creek area, British Columbia* (Lord and Green 1986). Lord and Green described and mapped soils according to soil map units. Map units include a dominant soil and other minor soils. The map units are identified by the name of the dominant soil. The brief descriptions in this section are for the dominant soil in the map unit of the same name. Soil mapping from Lord and Green is shown in Figure 2.1, Maps 1 through 3.

The following summary soil descriptions provide an overview and perspective of the soils in the LAA and in the remainder of the Peace River Valley between the Peace Canyon dam and the Alberta border.

2.2.1.1 Soils within the Reservoir Area

Soils in the proposed reservoir area below the full supply level are almost entirely Bear Flat soils with very minor areas of Branham and Clayhurst. Since Branham and Clayhurst generally occur above the full supply level, they are described in the Section 2.2.1.2 below.

Bear Flat soils occur in the Peace River floodplain from the Peace Canyon Dam to the Alberta border. Bear Flat soils are the only soils mapped on the islands and occur to a lesser extent on land adjacent to the river. Two Bear Flat map units, Bear Flat 1 and Bear Flat 2, were identified.

Lord and Green (1986) reported that “The importance and extent of the Bear Flat soils were not known prior to stabilization of river flow by the damming in 1968.” Also, the deposition of sediment was reduced, or practically eliminated, resulting in vegetation establishment on many gravel bars.

Bear Flat 1 soils are dominantly well drained Cumulic Regosols on weakly calcareous deep fine sands, 1 to 3 m thick, over channel gravels. Topography is nearly level or gently undulating, often with incised channels. The surface horizons of Bear Flat 1 soils are sandy loam or silt loam in texture, while the lower horizons range from fine sandy loam to fine sand in texture.

The Bear Flat 1 soils have capability to produce a wide variety of crops. In the early 1980s “productive market gardens were developed on cleared lands adjoining the Peace River bridge at Taylor…” on Bear Flat 1 soils (Lord and Green 1986). Also, the capability was adequate to ripen corn crops on Bear Flat 1 soils near Taylor. Bear Flat 2 soils occur on abandoned back channels and cobble and gravel bars often thinly veneered with fine-loamy sediments. These areas of recent deposition have no distinctly formed soils. Lord and Green (1986) noted that Bear Flat 2 soils provide range for wild ungulates. No mention is made of agricultural potential of Bear Flat 2 soils.

Soils in the floodplain of the major tributaries, the Halfway River and the Moberly River, are mapped as Alluvial. These soils are Cumulic Regosols on sandy, silty, loamy, and often gravelly fluvial deposits. Soil texture and drainage varies greatly and so does agricultural capability of these general very small and difficult to access areas.

2.2.1.2 Soils of the River Valley Terraces above the Reservoir

Soils on the terraces above the full supply level of the proposed reservoir include Branham, Davis, Clayhurst, Lynx, Pingel, Sundance, and Taylor. These soils have formed on colluvial fan and terrace deposits, or on plains associated with the valley, between the elevations of the river floodplain and up to 750 m above sea level. All the soils are Brunisols or Luvisols, except Taylor. The range of agricultural crops which can be grown on these soils varies greatly and is indicated in the following descriptions.

Branham soils are well drained Orthic Eutric Brunisols on calcareous sandy and silt colluvial fan and terrace deposits. Branham soils occur below 600 m above sea level from the Peace Canyon Dam to the confluence of Cache Creek and the Peace River. Branham soils have slight limitations, due to relatively low moisture-holding capacity, that restrict the range of agricultural crops.

Clayhurst soils are well to rapidly drained Eluviated Eutric Brunisols on calcareous gravelly, sandy and silty colluvial fans and terraces. Clayhurst soils occur on terraces below 600 m above sea level. They have severe limitations due to stoniness, low moisture-holding capacity, and adverse topography that restrict the range of agricultural crops.

Davis soils are well to moderately well drained Orthic Gray Luvisols on variable, sandy, and silty strongly calcareous sediments and glaciofluvial materials. They occur below 700 m above sea level on plains associated with the river valley. Davis soils are rated as fair to fairly good agricultural soils. Limitations are due primarily to restricted drainage and topography. Davis soils are often associated with Coldstream soils, which are poorly drained Gleysols with restricted agricultural capability due to poor drainage.

Lynx soils are well drained Brunisolic Gray Luvisols on loamy glaciofluvial materials. The variable sandy and silty sediments from which Lynx soils are formed are strongly calcareous and variable in thickness. They occur mainly on the plains adjoining the Peace River Valley and most of its main tributaries. The Lynx soils occur below elevations of 750 m above sea level. Lynx soils generally have severe limitations due to topography that restrict the range of agricultural crops.

The Pingel soils are moderately well drained Eluviated Eutric Brunisols on clayey colluvial deposits in scattered areas along the south bank of the Peace River. They occur on terraces below an elevation of 500 m above sea level between the Kiskatinaw and Halfway rivers. Some Pingel soils are highly productive for a wide range of crops, however they often have limitations for crop production due to adverse topography and low subsoil permeability.

Sundance soils are well drained to rapidly drained Brunisolic Gray Luvisols on sandy glaciofluvial deposits often underlain by gravel. Sundance soils occur below elevations of 750 m above sea level. Sundance soils have severe limitations due to coarse texture, low water-holding capacity, and adverse topography that restrict the range of agricultural crops.

The Taylor map unit is dominated by well drained to moderately well drained Rego Black and Rego Dark Gray clayey soils on colluvial deposits. Taylor soils occur below an elevation of 500 m above sea level along the north side of the Peace River and on terraces scattered along the lower Pine and Halfway Rivers. They are on gently to moderately sloping clay-textured fans; underlying materials are variable in texture. Taylor soils are highly productive for a wide range of agricultural crops.

2.2.1.3 Soils of the River Valley Slopes above the Reservoir

The steep slopes above the terraces and fans of the Peace River Valley are mapped as Attachie and Septimus map units. The Attachie and Septimus map units are similar, except that Attachie soils generally have a south aspect and the Septimus soils generally have a north aspect. Therefore, Attachie soils are mapped on the north side of the Peace River and the Septimus soils on the south side of the river. Slopes of the Moberly River are mapped as Attachie soils on both sides of the river. Slopes of the Halfway River have Attachie soils on the east and Septimus soils on the west.

Both the Attachie and Septimus map units are dominantly Regosols and lithic phases of Brunisols on undifferentiated colluvial materials on steep and very steep slopes. The materials include loamy tills and shale and sandstone bedrock that may be mantled with combinations of glaciofluvial gravels, sands, silts, loess, and colluvium. Adverse topography, instability, and shallow rocky soils make the Attachie and Septimus soils unsuitable for cultivation, but some less steeply sloping areas are often used for livestock grazing.

2.2.2 Land Capability for Agriculture

The agricultural land capability within the proposed reservoir was assessed in 1979 and 1982 (CBRC 1979; Pottinger 1982a and 1982b). To Golder's knowledge, field investigations were conducted as part of the Canadian Bio Resources assessment, but not as part of the Pottinger assessments.

The Canadian Bio Resources Consultants study (CBRC 1979) largely relied upon existing 1:50,000 B.C. Land Inventory mapping, but reinterpreted some capability ratings and polygons, particularly for the alluvial soils within the reservoir area, which had been stabilized by the installation of the WAC Bennett Dam and the resulting regulated flow regime. The study used 1:15,840 aerial photographs and a program of field investigations to reinterpret these areas and mapped the reservoir area on 1:12,000 uncontrolled photomosaics. From the study report, it was not apparent how the capability polygons were digitized and whether complex polygon areas (which contain areas with two or three different capability ratings) were prorated between capability classes or assigned to the dominant capability class for each polygon. In addition to tabulating agricultural capability within the proposed reservoir area below elevation 1,515 feet (461.9 m), the study also tabulated capability within the Peace River Valley from the Peace Canyon Dam to the Alberta border, and from valley bottom to the "brink of the trench." The study also provided broader regional and provincial aggregates of capability data, drawn from BC Environment and Land Use Committee Secretariat (1976).

The Pottinger (1982a and 1982b) study was initiated to verify the agricultural capability mapping within the proposed reservoir area tabulated by Canadian Bio Resources Consultants in 1979 after the B.C. Ministry of Agriculture computed and presented substantially different figures. This study used available 1:12,000 topographic maps with 20 foot contour intervals prepared by the B.C. Surveys and Mapping Branch, as well as 1:31,680 aerial photographs. In areas where Canadian Bio Resources Consultants (1979) carried out new mapping, Canadian Bio Resources Consultants polygons were transferred to these base maps; in all other areas, capability polygons from the 1:50,000 B.C. Land Inventory maps were transferred to the base maps. Minor changes were made at the subclass level to align the classification to the then-accepted methodology, a few changes were made to capability boundaries (based on the more detailed topographic mapping used), and a few other capability ratings were reinterpreted. Because the base maps did not delineate a contour level at the proposed 1,515 foot (461.9 m) inundation level, digitized results included all lands below the 1,520 foot (463.4 m) contour shown on the base maps. Polygon areas were digitized using a planimeter and 30 dot per inch grid and were prorated between polygon classes.

The assessments varied somewhat in the approach and methodologies in refining the B.C. Land Inventory land capability for agriculture mapping, including:

- Complex ratings of two classes were assigned, if necessary, to map units by Canadian Bio Resources Consultants Ltd. and Pottinger (1982a and 1982b). The Site C Project Environmental Resource Atlas (Norecol Environmental Consultants Ltd. 1991a) reflects only the first or dominant capability rating class, and secondary ratings were not recorded in the data base
- The Site C Project Environmental Resource Atlas (Norecol Environmental Consultants Ltd. 1991a) and statistical summary of the extent of agricultural capability map units appear to include all or most of the recent, active alluvial deposits visible on the ortho-photograph base presented in the Atlas. Recent, active alluvial deposits were not classified in the Canadian Bio Resources Consultants, Pottinger or current analyses
- Limitations of the mapping techniques (scale, age and accuracy of base maps, and hand transfer of map units to paper print bases), combined with temporal changes in river geo-morphology have resulted in some obvious discrepancies where the mapping does not fit the landforms reflected on the recent orthophotography
- The Pottinger Manuscript Maps (Pottinger 1982a) use a Site C reservoir elevation of 463.3 m
- Canadian Bio Resources Consultants Ltd. (1979) used a Site C reservoir elevation of 461.9 m

It is also noted that subsequent to the Pottinger review (Pottinger 1982a), changes in the provincial agricultural capability classification methodology were made to some of the subclass designations (Kenk and Cotic 1983).

Prior to retaining Golder to carry out the agricultural assessment, BC Hydro conducted an in-house technical review and Geographic Information System (GIS) update of existing soil and agricultural land capability mapping for the proposed Site C reservoir at a full supply level of 461.8 m. This update of capability was required due to the limitations of the earlier mapping techniques, noted above, with respect to different map scale, age and accuracy of base maps, and hand transfer of map units to paper print bases. In addition, there have been changes in river geomorphology since the earlier mapping was conducted. The map units were updated using a combination of mapping and interpretive techniques, including the following:

- Slope derivative mapping based on the agricultural capability topographic (slope) classes generated from the LiDAR Digital Elevation Model (DEM). Topographic classes used are the simple slope classes from the *Land Capability Classification for Agriculture in British Columbia* (Kenk and Cotic 1983)
- Confirmation of landform interpretation using the LiDAR Bare Earth digital mapping to provide an accurate rendering of landforms, especially of the alluvial units
- Delineation of landforms by visual interpretation of the digital 2007 orthophotographs and the LiDAR to confirm the landform interpretation to reflect current river morphology

The BC Hydro technical review and GIS update produced an agricultural capability polygon attribute data set in ArcGIS for the reservoir area, including polygon identifier, Canada Land Inventory capability classes, capability subclasses, landform from BC Hydro terrain mapping, soil name, and generalized vegetative cover or land use. A draft Land Capability for Agriculture map folio on orthophotograph bases was prepared at a scale of 1:10,000. This GIS analysis and mapping update was used to provide interim land capability for agriculture statistics for the proposed reservoir area. This interim land capability information for areas within the reservoir was then verified in the field and revised as necessary.

Areas other than the proposed reservoir area and Peace River Valley slopes, which would be directly affected by the Project, include areas of:

- Permanent land loss at the dam site, re-aligned sections of Highway 29, and permanent access roads
- Temporary land loss such as for construction and worker housing areas, temporary access roads, transmission line access roads, borrow areas, and soil stockpile areas

For these areas, recent aerial photography, topographic mapping and existing 1:100,000 scale soil mapping (Lord and Green 1986) and 1:50,000 scale Canada Land Inventory Land Capability for Agriculture mapping which were prepared in the 1970s) was reviewed and field verification of land capability for agriculture was conducted as required.

2.3 Land Capability for Agriculture Classification

This section summarizes:

- The land capability for agriculture classification system
- The 2011 and 2012 soils field program
- Soil sampling and analyses
- The methodology for estimating available soil water storage capacity
- Soil capability mapping

2.3.1 Classification System

This assessment follows the methodology specified in Land Capability Classification for Agriculture in British Columbia (Kenk and Cotic 1983). The earlier version of this classification system was utilized for previous Site C capability assessments. Land capability for agriculture refers to the potential for agricultural crop production and is determined by both soil and climate conditions. Capability is rated as Class 1 through 7. A brief description of each Class is provided below:

- Class 1 land is capable of producing the widest range of crops. Soil and climate conditions are optimum, resulting in easy management

- Class 2 land is capable of producing a wide range of crops. Minor restrictions of soil or climate may reduce capability but pose no major difficulties in management
- Class 3 land is capable of producing a fairly wide range of crops under good management practices. Soil and or climate limitations are somewhat restrictive
- Class 4 land is capable of producing a restricted range of crops. Soil and climate conditions require special management considerations
- Class 5 land is capable of producing cultivated perennial forage crops and specially adapted crops. Soil and or climate conditions severely limit capability
- Class 6 land is important in its natural state as grazing land. These lands cannot be cultivated due to soil and or climate limitations
- Class 7 land has no capability for soil-bound agriculture

Land can be assigned both unimproved and improved ratings. Unimproved ratings apply to lands where no major improvements, including irrigation and drainage, have been carried out, whereas improved ratings apply to the land where improvements, such as irrigation and drainage, can improve the capability. The improved ratings reflect the assumption that the improvements are feasible at the farm level. If land cannot be improved, only an unimproved rating is assigned.

The land capability ratings consist of the Class symbol (1 through 7) and one or two subclass modifiers, which describe the nature of the limitation(s). For example 3P denotes a Class 3 soil due to stoniness limitation. Only Class 1 ratings do not have a subclass, or limitation, modifier.

All seven Classes occur in the reservoir area or the adjacent valley slopes. The subclass limitations to capability ratings for mineral soils in the Peace River Valley are depicted in Table 2.1.

Table 2.1: Land capability subclass limitations in the Peace River Valley

Symbol	Limitation	Symbol	Limitation
A	Soil moisture deficiency	I	Inundation
C	Adverse climate	P	Stoniness
D	Undesirable soil structure / low permeability	R	Proximity to bedrock
E	Erosion	T	Topography
F	Fertility	W	Excess water

The key factors which affect agricultural capability ratings for soils below the reservoir full supply level are climate, soil moisture deficiency, and topography. The key limitation for soils on the valley sides above the flood line is topography and, in the relatively level areas, climate and soil moisture deficiency.

Both unimproved and improved ratings have been assigned for lands within the Project activity zone. Classes 6 and 7 are generally not considered improvable. The improved ratings for Classes 2 through 4 include improvements such as drainage and irrigation.

Climatic influence is reflected in agricultural land capability classification by its impact on growing degree days[1], freeze free period and soil moisture deficits. Climatic capability for agriculture was added in by modelling at a later stage in the study. However, there is an interaction between climate and soil texture that results in variations to soil moisture deficiency subclass ratings. Therefore the collection of soil texture data was a key component of the field program.

2.3.2 Soils Field Program

The purpose of the soils field program was to verify, and modify as required, the existing agricultural land capability information. The draft Land Capability for Agriculture map folio at a scale of 1:10,000 on orthophotograph bases, prepared by BC Hydro, was used to plan field inspection locations and land access for the 2011 and 2012 field programs. Priority for potential field inspections sites was given to large or variable polygons, or to those with unique attributes. Additionally, locations were selected to achieve a good distribution of field sites throughout the proposed reservoir area.

Field verification of soil capability and land use was carried out on privately owned lands, BC Hydro lands which are leased and are being farmed, as well as selected Crown lands and other BC Hydro owned lands. In addition to the proposed reservoir area, field verification was also carried out for other components of the Project activity zone. Golder performed field work in the area below reservoir flood line between late May and early November 2011, inspecting 182 sites within the full supply level of the proposed reservoir. The inspection density of one site per 25 ha corresponds to Survey Intensity Level 2 (Mapping Systems Working Group 1981). Soil inspection sites were well distributed except in the Moberly River drainage, which had only two inspections due to restricted physical access.

An additional 12 inspections were completed in 2011 in the dam site area above the flood line. In July and August 2012, 135 inspections were completed within Project activity zone areas outside of the reservoir area. The field program included a total of 329 field inspection sites.

Soil data forms and a database were prepared specifically for the Project. Site descriptions (BC Ministry of Environment and BC Ministry of Forests 1998) and soil profile descriptions (Soil Classification Working Group 1998) emphasized soil properties which influence soil agricultural capability.

At each inspection site the UTM coordinates were recorded on the forms and marked with a Garmin GPS receiver. Field observations and data collection were made to determine the soil characteristics required to assign agricultural ratings according to Land Capability Classification for Agriculture in British Columbia (Kenk and Cotic 1983). Additional characteristics required to define soil taxonomy were not determined, and soil pits were dug or augured by hand to a depth sufficient to allow classification of agricultural capability as illustrated in Table 2.2. Most pits were dug to a depth of 50 cm.

[1] The accumulated difference between the mean daily temperature and the standard base temperature of 5°C on days when the mean daily temperature is above 5°C. The first or last day of any consecutive five-day period when the mean daily temperature is equal to or greater than 5°C is defined as the start or end of the period of accumulation.

Table 2.2: Soil observation depth requirements for agricultural capability classification

Agricultural Capability Subclass	Depth (cm)	Rationale
A (soil moisture deficiency)	50	Estimate AWSC of root zone
D (undesirable soil structure and or low perviousness)	25 to 75	Observe texture and depth to impermeable layers
F (fertility)	50	Assess fertility of root zone
I (inundation)	0 or more	Observe soil surface, vegetation, and buried horizons
N (salinity)	Up to 100	Observe depth and degree of salinity[a]
P (stoniness)	25	Estimate coarse fragment content of plough layer
R (depth to solid bedrock and or rockiness)	Up to 100	Observe depth to bedrock
T (topography)	0	A soil pit is not required for topography
W (excess water)	Up to 50	Observe water table depth and soil colour patterns

NOTES:
[a] Field observations and laboratory analyses did not indicate salinity or sodicity. Observations to 100 cm were made at only a few sites.
AWSC – available water storage capacity
SOURCE:
Modified from Kenk and Cotic (1983)

When all traverses and sites in a polygon were complete, the polygon was assigned a provisional soil agricultural capability rating. Soil aridity and topography are the most common agricultural capability limitations in the area included in the soils field program.

Soil texture provides a practical approximation of available water storage capacity (AWSC). The fluvial deposits of the Peace River and its tributaries vary in texture from loam to medium sand, resulting in AWSC that spans several soil moisture deficiency classes. Soil textures were estimated by hand at every soil pit. In the field, hand texturing was used to get an approximation of AWSC. Such an approximation in the field can easily result in misinterpretation of the AWSC and the resulting capability by one class. This potential for error was mitigated by sampling soils at one site in seven and conducting soil particle size analyses on these samples in the laboratory. The laboratory analyses included determination of the silt and clay fractions as well three sand fractions (fine, medium, and coarse). The laboratory soil particle size data were used to correct any inaccuracy in field estimates of soil texture. The field-determined soil texture, corrected as necessary, was then used to predict AWSC and soil moisture deficiency classes for individual soil polygons.

Many island and river bank sites are limited by topography. Old channels were frequently observed during transects, but in forested areas it was difficult to estimate the areal extent of channelled or undulating topography. The best estimate of land affected by topography limitations was determined by reviewing field notes in conjunction with careful examination of LiDAR imagery, which provides a clear detailed image of ground topography. The LiDAR imagery shows ground topography without the visual interference of the forest cover, as is the case with air photographs.

2.3.3 Soil Sampling and Analyses

Soil samples were collected at a total of 47 sites. Samples were analysed for particle size (soil texture) to confirm soil field hand texturing for interpretation of available water storage capacity (AWSC), undesirable soil structure and / or low perviousness subclasses. Soil texture also provides an indication of soil fertility for interpretation of the fertility subclass. Additional analyses were conducted on selected samples for pH, EC

(electrical conductivity to assess salinity), exchangeable cations and cation exchange capacity. Soil analyses were conducted by Pacific Soil Analysis Inc. in Richmond.

2.3.4 Estimation of Available Water Storage Capacity

Available Water Storage Capacity (AWSC) is a key factor in the determination of the soil capability for agriculture ratings. The AWSC chart in Kenk and Cotic 1983 is considered to lack sufficient detail for application in this assessment. Instead, a similar chart from the *BC Trickle Irrigation Manual* (IIABC and BCMAF 1999) produced by the Irrigation Industry Association of BC was used to construct a lookup table. Where this chart did not contain a value for a texture, a rationale was developed to estimate a value as shown in Table 2.3.

Table 2.3: Estimates of available water storage capacity

Texture	AWSC (cm water / m soil)	Rationale
C	20	N/A
CL	20	N/A
FS	10	FS = S + 1.7
FSL	14.2	N/A
L	17.5	N/A
LFS	11.7	LFS = LS + 1.7
LS	10	N/A
LVFS	12.7	LVFS = LS + 1.7 + 1
Organic	25	N/A
S	8.3	N/A
Si	20.8	Si = SiL
SiC	20	SiC = C
SiCL	20.8	SiCL= SiL
SiL	20.8	N/A
SL	12.5	N/A

NOTES:
AWSC – available water storage capacity
SOURCE:
Modified from IIABC and BCMAF (1999)

For each soil horizon between the zero and 50 cm depth, the contribution to AWSC was calculated from soil texture and coarse fragment content. Soil textures calculated from laboratory data were compared to the results of hand texturing done in the field. The AWSC was estimated on a corrected soil texture for each horizon. Adjustments were made for coarse fragment content, as particles larger than 2 mm diameter are considered to make no contribution to AWSC. Available water storage capacity for each soil horizon was then added and the sums were compared to the subclass definitions (Kenk and Cotic 1983).

2.3.5 Land Capability for Agriculture Maps~~Soil Capability Maps~~

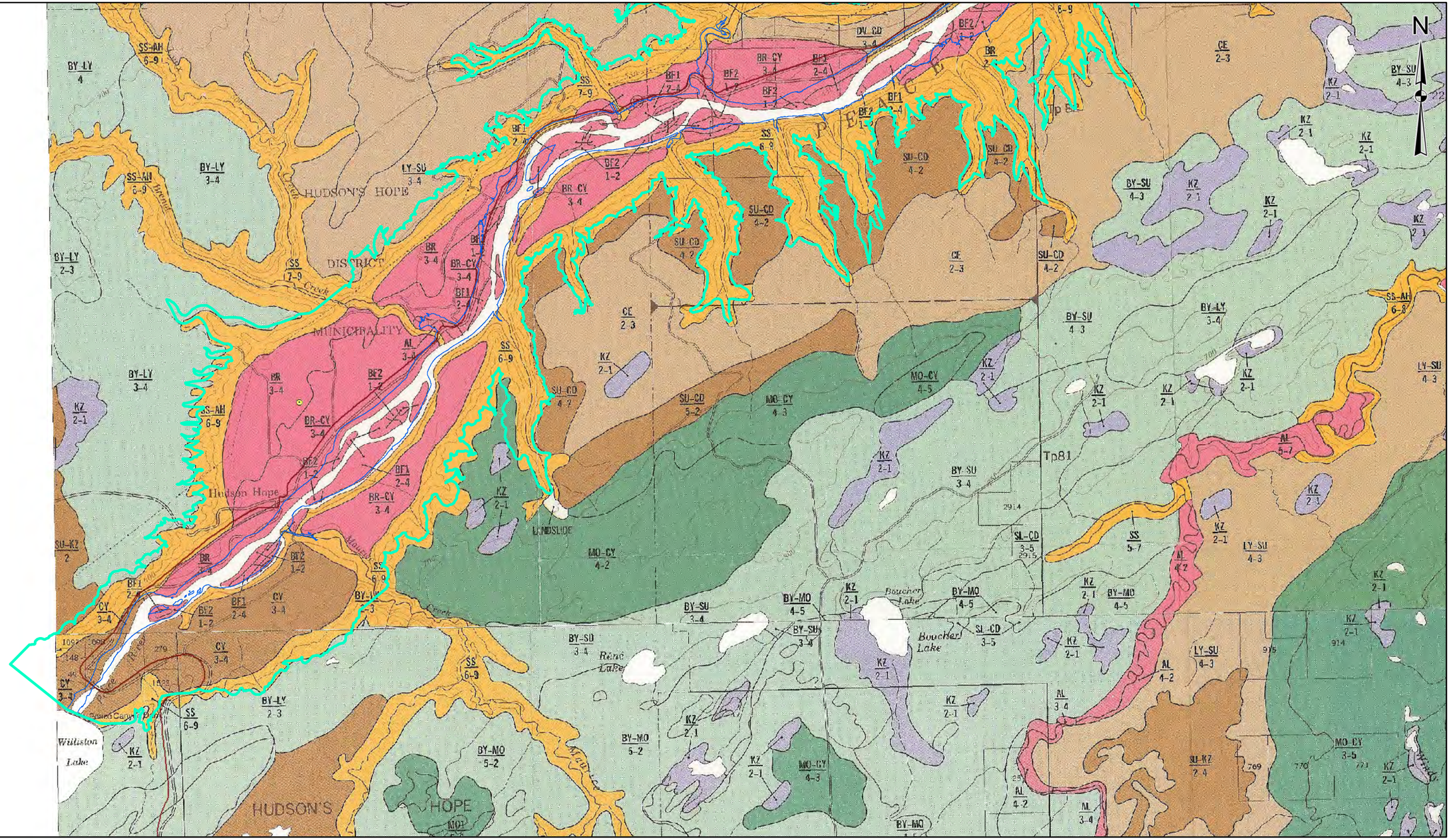
The draft agricultural land capability polygon boundaries and agricultural capability ratings provided by BC Hydro were revised, as necessary, based on the 2011 and 2012 field investigations and interpretation of LiDAR imagery and air photograph stereo pairs.

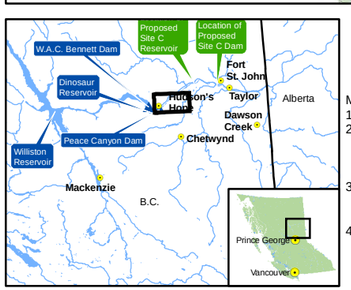
Mapping conventions in the labelling of polygons (map units) followed Land Capability Classification for Agriculture in British Columbia (Kenk and Cotic 1983):

- Arabic numerals denote the capability classes, and small capital letters after the class numerals denote the subclasses
- A subclass is only shown when the limitation it represents is equal to or one class less severe than the class level indicated. Only one of the less severe limitations is shown
- Limitations have no cumulative effect
- In map delineations comprising more than one class, small superscript Arabic numerals denote the proportion of each class present out of a total of 10. The classes are written in order of dominance with the most dominant class first. Up to three class symbols are allowed in delineations with three very contrasting soils; otherwise, one or two is preferable
- The improved (irrigated) rating for a map unit is identified in parentheses

Final AWSC estimates and agricultural capability ratings were assigned to each polygon after review of field and laboratory data as well as LiDAR imagery.

The resulting land capability for agriculture maps are contained in Chapter 20 Agriculture.





Map Notes:
1. Datum/Projection: NAD83/UTM Zone 10N
2. Proposed Reservoir Area (461.8 m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August 2006.
3. Base Data: Agriculture Canada, Soil Survey Report No. 42 (Map Sheets: 93P/NE1 93P/NW, 94A/SE, 94A/SW).
4. Peace River Valley Definition (based on recent, more accurate data and may not match the map contours), Proposed Reservoir and Dam Site Area provided by BC Hydro .

Legend

Soil Type

- AH — ATTACHIE - Variable undifferentiated materials that may include colluvial, morainal, fluvial, lacustrine, aeolian deposits, and bedrock; steep, inclined; modified by erosion, avalanche, and failing processes
- AL — ALLUVIAL - Sandy and loamy, often gravelly, fluvial; terraced, level
- BF1 — BEAR FLAT - Sandy and loamy fluvial, weakly calcareous; 1-3 m thick over gravel; terraced, level; elevation range is 400-500 m
- BF2 — BEAR FLAT - Gravely and stony fluvial river bars; level; elevation range is 400-500 m
- BR — BRANHAM - Sandy fluvial, weakly calcareous; terraced, level; elevations < 600 m
- BR-CY — BRANHAM-CLAYHURST - Sandy fluvial, weakly calcareous (Branham) and gravelly sandy glaciofluvial (Clayhurst); terraced, level; elevations < 600 m
- CY — CLAYHURST - Gravelly sandy glaciofluvial; terraced, level; elevations < 600 m
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- LY-SU — LYNX-SUNDANCE - Loamy glaciofluvial (Lynx) and sandy glaciofluvial (Sundance); calcareous; hummocky; elevations < 750 m
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TOPOGRAPHIC PHASE (SLOPE)

	Percent	Degrees
level	0-0.5	0
nearly level	0.5-2.5	0.3-1.5
very gentle slopes	2-5	1-3
gentle slopes	6-9	3.5-5
moderate slopes	10-15	6-8.5
strong slopes	16-30	9-17
very strong - steep slopes	31-70	17-35
very steep - extreme slopes	71->100	35->45

- Proposed Reservoir
- Peace River and Tributary Valleys Definition
- Dam Site Area
- Existing Road
- Existing Highway
- Existing Railway

1:100,000

0 — 4 km

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SITE C CLEAN ENERGY PROJECT

Figure 2.1
Soil maps
Map 1 of 3

Date	Dec. 11, 2012	DWG NO	1016-C14-B4991-1	R 0

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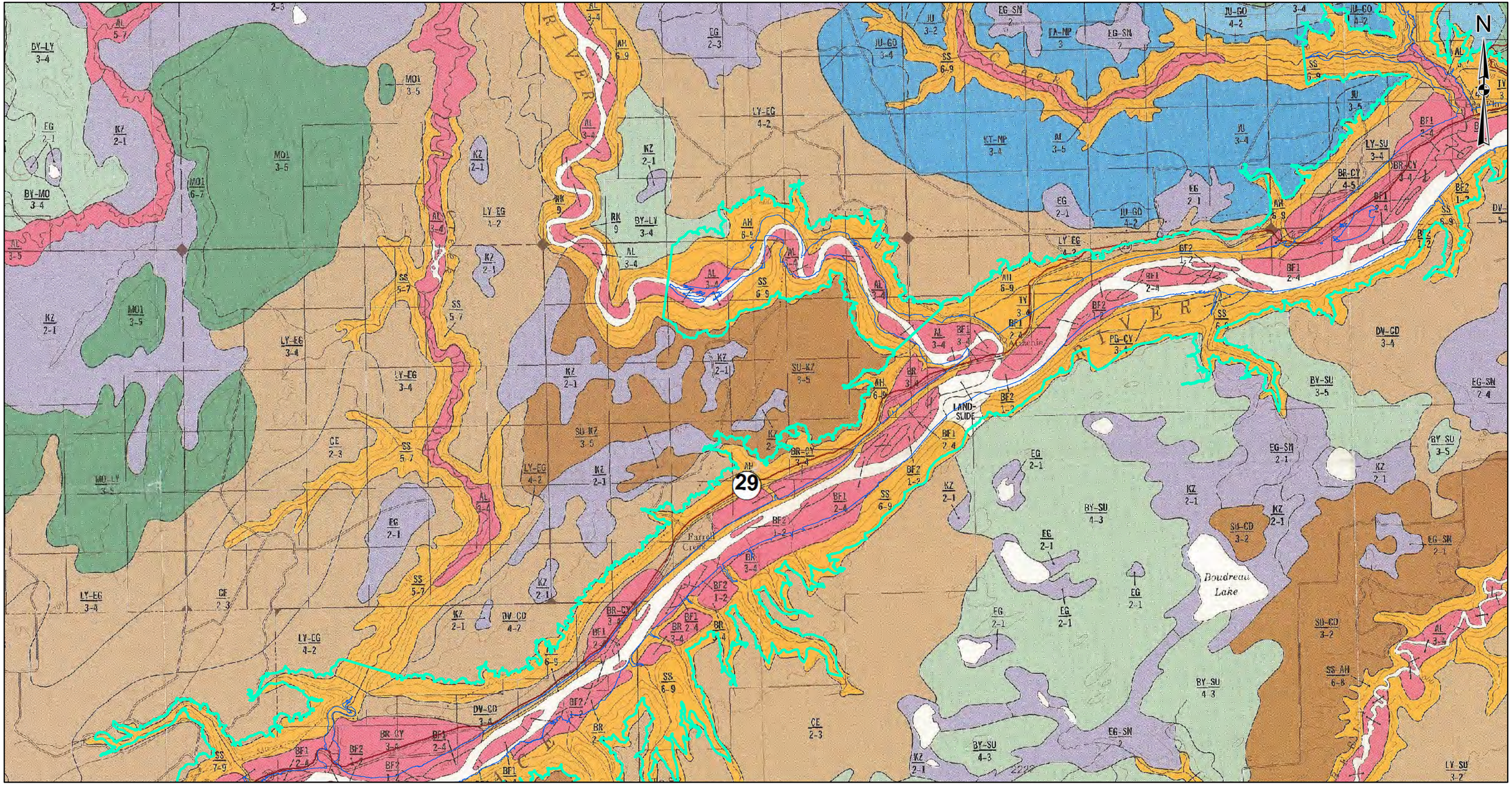

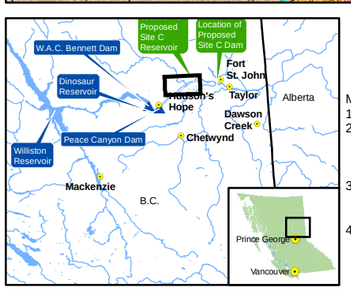

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1:100,000 — 0 — 4 km

SITE C CLEAN ENERGY PROJECT

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Figure 2.1
Soil maps
Map 2 of 3

Date	Dec. 11, 2012	DWG NO	1016-C14-B4991-1	R 0

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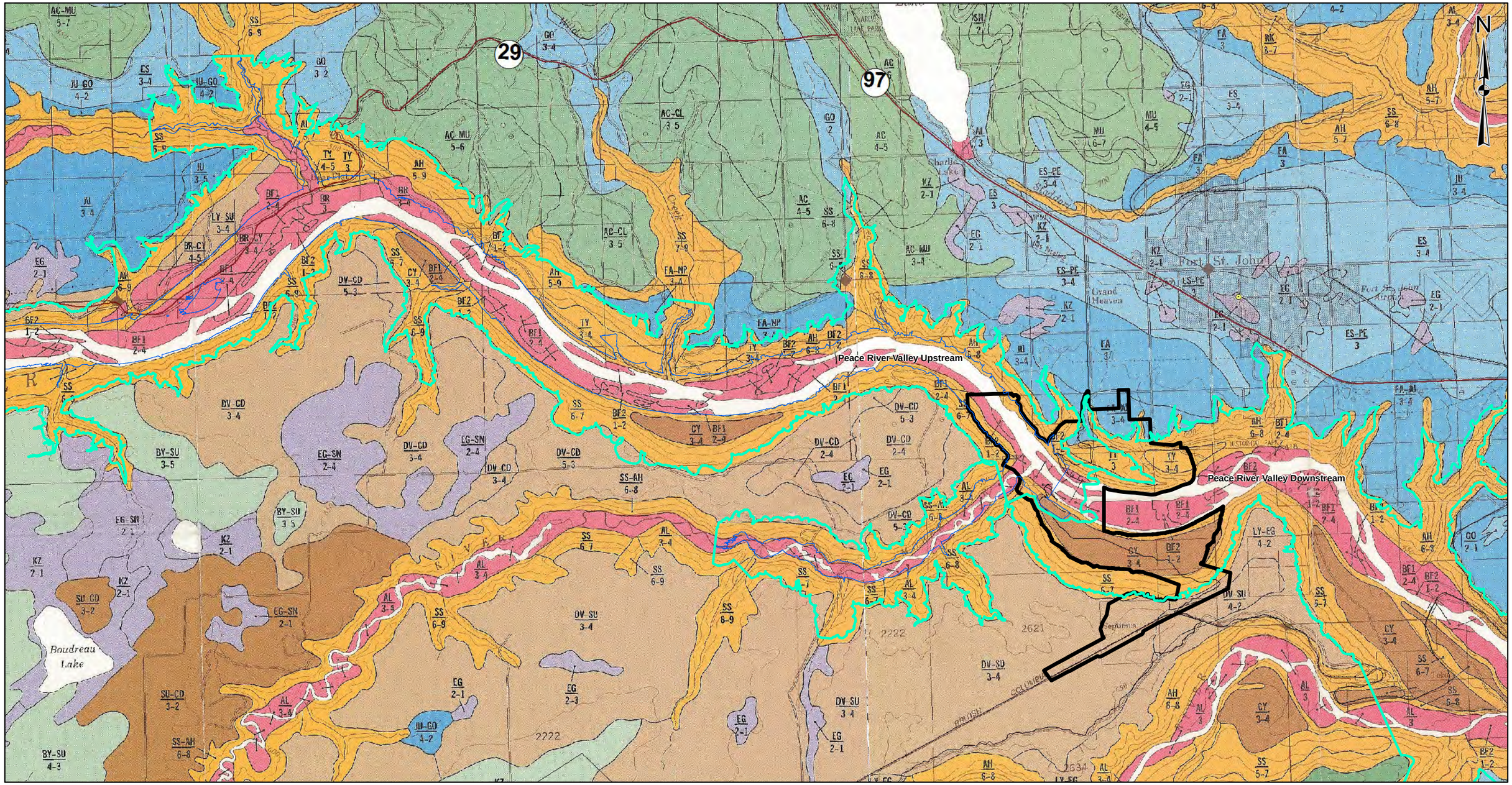

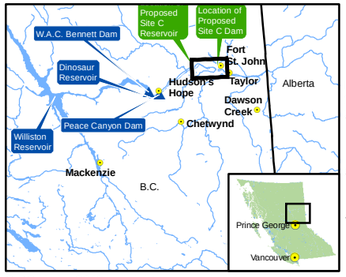

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1:100,000 0 4 km

SITE C CLEAN ENERGY PROJECT

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Figure 2.1
Soil maps
Map 3 of 3

Date	Dec. 11, 2012	DWG NO	1016-C14-B4991-1	R 0

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3.0 AGRICULTURE AND CLIMATE

This section summarizes the assessment of the following:

- The current climatic capability for agriculture within the LAA
- Potential climatic effects to agriculture of the proposed reservoir
- Potential effects to agriculture of predicted global climate change

3.1 Climatic Capability for Agriculture

The following describes the assessment of the climatic capability for agriculture, including:

- Historical climatic capability for agriculture mapping
- The use of data from BC Hydro climate stations
- Climatic capability based on 1971 through 2000 climate normal
- The comparison of thermal parameters
- Estimates of climatic moisture deficits

3.1.1 Historical Climatic Capability for Agriculture Mapping

Most agricultural regions of B.C. were mapped for their climatic capability for agriculture (CCA) by the B.C. Ministry of Environment (BCMOE) during the period from 1968 to 1983. The classification system to rate CCA is outlined in *Climatic Capability Classification for Agriculture in British Columbia* (BCMOE 1981). CCA maps were generally produced at a scale of 1:100,000 and were based on an analysis of climate data from topoclimate scale observation stations operated for a two- to three-year period. Data from these relatively short-term observation stations were then compared to a longer-term record of climate data at a regional scale climate station, allowing interpretation of the climatology as influenced by physiographic and topographic characteristics such as elevation, slope, aspect, and landform.

The CCA for the Peace River region of B.C. was mapped by the provincial government in 1983 (BC Ministry of Environment 1983) based on 1951 through 1980 climate normals and on a network of weather stations operated from 1977 through 1980.

3.1.2 BC Hydro Climate Data

BC Hydro established a number of climate stations in the Peace River Valley, which were operated in 2011. Table 3.1 outlines the name, elevation and location of each of the stations used in this analysis. The location of each station is also shown in Figure 20.2 in Volume 3 Section 20 Agriculture. Comparison of data from these stations with the longer-term record at the Environment Canada climate station located at the Fort St. John Airport allows estimation of longer-term climatic parameters at the short-term observation stations.

Table 3.1: BC Hydro climate station locations

Station	Elevation (m)	Latitude	Longitude
Station 1 Attachie Mid	480	56° 13' 52.382" N	121° 25' 9.983" W
Station 2 Attachie Low	440	56° 13' 18.918" N	121° 25' 26.573" W
Station 3 Attachie Flat	654	56° 13' 57.522" N	121° 27' 59.189" W
Station 4 Bear Flat	470	56° 16' 30.367" N	121° 12' 45.835" W
Station 5 Hudson Hope	510	56° 3' 34.908" N	121° 51' 59.757" W
Station 7 Site C	600	56° 12' 17.809" N	120° 54' 43.609" W

Estimation of long-term climatic normals from a short-term record assumes that comparison between the short-term station and the long-term station is based on a sufficient period of record to establish an average relationship, and is not unduly influenced by abnormal weather conditions during the period of observations at the short-term stations. Data from the BC Hydro stations was only available for 2011 for the purposes of this analysis. Monthly mean temperatures recorded at the Fort St. John Airport in 2011 were compared to the 1971 to 2000 normals for that station and are presented in Table 3.2. During the growing season[2] in 2011, the Peace River region had higher than normal precipitation during the spring and early summer, and then experienced lower precipitation during the later summer months. In 2011, May to September precipitation at the ~~Fort St. John~~ North Peace Regional Airport was 128 percent of normal, and was warmer ~~slightly cooler~~ by ~~-0.2~~ 0.6 degrees Celsius.

Table 3.2: Comparison of 2011 mean temperature and precipitation to 1971 – 2000 normals at the Fort St. John Airport

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Normal T_{mean} (°C)	-14.2	-10.5	-4.4	4.0	10.0	13.8	15.7	14.6	9.9	3.9	-6.7	-12.1
2011 T_{mean} (°C)	-11.8	-11.7	-10.5	2.4	11.3	13.4	15.1	15.2	12.4	5.2	-7.5	-3.4
Difference (°C)	2.4	-1.2	-6.1	-1.6	1.3	-0.4	-0.6	0.6	2.5	1.3	-0.8	8.7
Normal Precipitation (mm)	26.0	21.9	21.4	18.8	39.7	71.4	83.2	56.9	45.7	25.8	28.5	26.5
2011 Precipitation (mm)	58.9	31.0	47.4	47.3	12.8	176.5	144.9	19.7	26.1	9.4	51.4	13.4
Ratio (%)	227	142	221	252	32	247	174	35	57	36	180	51

[2] The CCA classification defines the growing season as the period from May to September.

3.1.3 Climatic Capability for Agriculture Based on 1971 through 2000 Climate Normals

Climatic capability for agriculture, based on the data from the six BC Hydro climate stations and the Fort St. John Airport, normalized to 1971 through 2000, is presented in Table 3.3. Improved CCA ratings range from Class 3F at the Hudson Hope site to Class 1G at the Site C site. Improved CCA ratings are generally more limited by growing degree days than the frost-free period, with the Hudson Hope site being an exception. Much of the agricultural land in the vicinity of the proposed reservoir has an improved CCA rating Class 2G. Unimproved CCA ratings range from Class 3A to Class 4A, indicating that irrigation would be necessary to achieve full agricultural capability potential except where groundwater is locally available within the rooting zone of common crops.

Table 3.3: Climatic capability parameters at the BC Hydro and Fort St. John Airport climate stations

Station	GDD	FFP	CMD	CCA
Station 1 Attachie Mid	1,251	93	-245	2G(4A)
Station 2 Attachie Low	1,230	75	-220	2GF(4A)
Station 3 Attachie Flat	1,204	93	-148	2G(3A)
Station 4 Bear Flat	1,241	91	-132	2G(3A)
Station 5 Hudson Hope	1,173	67	-142	3F(3A)
Station 7 Site C	1,359	125	-156	1G(3A)
Fort St. John Airport	1,248	125	-124	2G(3A)

NOTES:
GGD – growing degree days
FFP – frost-free period
CMD – climatic moisture deficit
CCA – climatic capability for agriculture

Frost-free period and growing degree days for the BC Hydro stations were calculated as 1971 through 2000 normals based on a comparison of 2011 data to the 1971 through 2000 normals from the Fort St. John Airport.

The frost-free period analysis was undertaken by utilizing radiational cooling nights in both spring and fall. The appropriate radiational cooling nights used were clear to mostly clear and winds were less than 7 km per hour. After isolating the nights, the next step was to derive the average temperature deviations from the long-term Fort St. John Airport base station. This permitted calculation of estimates of the last spring frost and the first fall frost for each year of the thirty-year, 1971 through 2000, database.

Growing degree days for the short-term BC Hydro climate stations were calculated as the ratio of 2011 growing degree days between these short-term stations and the Fort St. John Airport, multiplied by the mean growing degree days at the Fort St. John Airport for the period 1971 through 2000.

3.1.4 Comparison of Thermal Parameters

The previous climatic capability for agriculture ratings were based on the thirty-year period of 1951 through 1980. To assess if there have been changes in climate that would warrant updating climatic capability for agriculture mapping, data from this period was compared to the most recent 30-year period (1981 through 2010) of data collected at the Fort St. John Airport. The Fort St. John Airport was the only station with the length of record that permitted this comparison. Thermal parameters for the two thirty-year periods that were compared included the following:

- Frost-free period, corresponding to the period between the average last spring frost date and the average first fall frost date
- Growing degree days, corresponding to the accumulated difference between the mean daily temperature and five degrees Celsius on days when the mean daily temperature is above five degrees Celsius. Growing degree days start on the first day of any consecutive five-day period when the mean daily temperature is equal or greater than five degrees Celsius, and end on the last day of the last five-day period when the mean daily temperature is equal or greater than five degrees Celsius

The results of the analysis of thermal parameters showed that has been some change in these thermal parameters due to climate trends. There has been an increase in growing degree days (65 degree days or approximately 0.5%) and an increase in the length of the frost-free period (10 days). Figure 3.1 shows that there has been about a 0.2 to 0.3 degrees Celsius increase in mean growing season temperature during the period from 1943 to 2011 at Fort St. John.

Data from the six BC Hydro climatological stations were compared with the climatic capability for agriculture maps produced by the BCMOE in 1983 (Kenk and Cotic 1983). Based on this review, it was concluded that any changes to growing degree days and frost-free period were not large enough to justify updating the climatic capability for agriculture mapping of thermal parameters.

3.1.5 Climatic Moisture Deficit

Climatic moisture deficit was calculated as May to September potential evapotranspiration minus precipitation. Estimates of long-term growing season climatic moisture deficit were made using data collected at the Fort St. John Airport and at the BC Hydro climate stations. Daily potential evapotranspiration from May through September 2011 was calculated for each of the six BC Hydro climatological stations for which temperature, precipitation, and radiation data had been collected, using the Priestley and Taylor method (Priestley and Taylor 1972). Long-term average potential evapotranspiration for the May to September period was estimated for the six BC Hydro climatological station locations by comparing the 2011 evapotranspiration data to average evapotranspiration estimates calculated from solar radiation estimates available for Fort St. John (see Appendix A).

This approach has been shown to accurately estimate potential evapotranspiration from a forage crop in the Peace River region of B.C. (Davis and Davies 1981; Davis 1978). Estimates at the various stations ranged from 124 mm to 245 mm as shown in Table 3.3. The median value of climatic moisture deficit at the six BC Hydro stations and the Fort St. John Airport is 148 mm.

Previous climatic capability for agriculture mapping from 1983 was based on an estimated climatic moisture deficit of 34 mm at the Fort St. John Airport, which used potential evapotranspiration calculated using Baier and Robertson's Equation 1 (Baier and Robertson 1965), and was estimated for the 1951 through 1980 period. The Priestly and Taylor method, which generated a median value of 148 mm and has been shown to provide more accurate estimates of climatic moisture deficit than the method that produced the estimate of 34 mm, was used to estimate climatic moisture deficit values for the 1971 through 2000 period. Figure 3.2 shows how climatic moisture deficit over the growing season has varied from 1953 through 2005 at the Fort St. John Airport (Note: a negative value in this chart denotes a seasonal water surplus.) An overall growing season drying trend (starting in 1975) can be observed in this graph. Mean climatic moisture deficit for the period from 1951 to 1980 is 101 mm, and is 113 mm for the period from 1971 through 2000, which is a 12 percent increase. Using the higher climatic moisture deficit estimate of 148 mm reflects updated methodology, as well as this drying trend, and results in changes to climatic capability assumptions which were used in earlier land capability for agriculture ratings. This results in a reduction in capability when considering unimproved ratings. The higher estimate of climatic moisture deficit does not influence improved ratings, as improved ratings assume that irrigation is provided to compensate for the moisture deficit.

3.2 Analysis of the Potential Effects of the Proposed Reservoir

RWDI Air Inc. (RWDI) conducted a microclimate modelling study to evaluate the effect of how the proposed Site C reservoir might influence the local climate (Volume 2 Chapter 11.10 Microclimate). An analysis was conducted on the effects that the proposed Site C reservoir would have on climatic capability for agriculture for areas adjacent to the reservoir based on an analysis of the results of this microclimate study.

Potential effects included changes to the following:

- Climatic capability for agriculture (frost-free period, growing degree days and climatic moisture deficit)
- Crop drying
- Potential evapotranspiration
- Soil trafficability
- Overwintering perennial crops
- Winter wind chill effects on livestock

Effects of the reservoir on frost-free period with the proposed reservoir in place were calculated by linearly adjusting minimum temperatures for each station by the values in the RWDI report, then recalculating the last day of frost in the spring and the first day of frost in the fall, similar to the procedure used for calculating frost-free period in Section 3.1.3. Effects on growing degree days were similarly calculated by adjusting mean temperatures at each station, then recalculating growing degree days similar to the procedure in Section 3.1.3.

The results of this analysis suggest that the reservoir could have a small but statistically significant growing season warming effect on temperatures for stations closely adjacent to the reservoir. The date of last spring frost is expected to be earlier, and the first date of fall frost should be later (Table 3.4).

Table 3.4: Dates of first spring and last fall frost

Station	No Reservoir			With Reservoir		
	Spring	Fall	FFP	Spring	Fall	FFP
Station 1 Attachie Mid	May 30	Aug. 31	93	May 25	Sept. 14	112
Station 2 Attachie Low	June 10	Aug. 24	75	May 28	Sept. 06	101
Station 3 Attachie Flat	May 25	Aug. 26	93	May 17	Aug. 31	106
Station 4 Bear Flat	May 31	Aug. 30	91	May 12	Sept. 30	116
Station 55 Hudson Hope	June 14	Aug. 20	67	June 08	Aug. 27	80
Station 7 Site C	May 14	Sept. 16	125	May 02	Sept. 26	147

NOTES:
FFP – frost-free period

This effect is due to warmer fall minimum temperatures resulting from proximity to the relatively warmer reservoir as predicted by the RWDI model. The effect of the reservoir on growing degree days is minimal (Table 3.5).

Overall, the reservoir is expected to have a minimal effect on the improved climatic capability for agriculture ratings, except for a change of the frost rating at the Attachie Low station from a Class 2GF to Class 2G, and a change at the Hudson Hope station from a Class 3F to 2G (Table 3.5). Unimproved ratings were not assessed in the analysis, largely because detailed data to accurately calculate potential evapotranspiration was not available from the RWDI model results. However, given that this model did not predict statistically significant changes to growing season precipitation, then climatic moisture deficit, and therefore the unimproved CCA rating, is not expected to be affected.

Table 3.5: Effect of Site C Reservoir on improved climatic capability for agriculture

Station	Frost-Free Period (Days)			Growing Degree Days			Climatic Capability for Agriculture	
	No Reservoir	With Reservoir	Difference	No Reservoir	With Reservoir	Difference	No Reservoir	With Reservoir
Station 1 Attachie Mid	93	112	19	1,251	1,250	-1	2G	2G
Station 2 Attachie Low	75	101	26	1,230	1,204	-26	2GF	2G
Station 3 Attachie Flat	93	106	13	1,204	1,262	58	2G	2G
Station 4 Bear Flat	91	116	25	1,241	1,238	-3	2G	2G
Station 5 Hudson Hope	67	80	13	1,173	1,188	15	3F	2G
Station 7 Site C	125	147	22	1,359	1,431	72	1G	1G

Predicting the effect that the reservoir might have on crop drying is made more 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 percent 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 percent or less over the year. However, due to the increased humidity, the reservoir could potentially have a small, likely minor, effect on crop drying during summer and early fall in the Peace River Valley in areas adjacent to the reservoir.

No effect on potential evapotranspiration[3] or on growing season precipitation is expected as a result of the RWDI model analysis, and therefore there should be no change to irrigation water requirements, overwintering of perennial crops, or trafficability. The RWDI model predicts there is no statistically relevant change to winter precipitation or winter minimum temperature as a result of a reservoir, so there should not be an effect on overwintering of perennial crops. Similarly, winter wind chill effects to livestock should not be affected. The RWDI model predicts extreme winter minimum temperatures to be about 2.5 degrees Celsius cooler; however, changes in wind speed in the winter are not expected to be statistically significant.

3.3 Analysis of the Effects of Predicted Global Climate Change

The effect of potential climate change on future climatic capability for agriculture using the IPCC B1 and A2 emission scenarios[4] was assessed using temperature and precipitation anomalies calculated by the Pacific Climate Impacts Consortium (PCIC) at the University of Victoria (Schnorbus, et al. 2011) for 2050 and 2080. The data provided by PCIC are shown in Tables 3.6 and 3.7. The PCIC model predicts warmer conditions in 2050 in all seasons of the years for each emission scenario, and similarly wetter conditions except during the summer months for the A1B scenario. For 2080 the model predicts warmer and wetter conditions for all seasons for all emission scenarios.

Table 3.6: Mean 2050 temperature and precipitation anomolies for the Peace River Valley Region of B.C.

Mean Temperature (degC)					
Emission Scenario	**Winter**	**Spring**	**Summer**	**Fall**	**Annual**
B1	2.7	1.5	1.8	1.6	1.8
A1B	3.7	2.4	2.7	2.6	2.5
A2	3.1	2	2.6	2.1	2.4
Precipitation (%)					
B1	17%	15%	6%	13%	12%
A1B	25%	19%	-2%	24%	9%
A2	18%	16%	1%	18%	10%

SOURCE:
Modified from Pacific Climate Impacts Consortium, University of Victoria (Schnorbus, et al. 2011)

[3] Potential evapotranspiration is the amount of evaporation plus transpiration that would occur if sufficient water were available

[4] The IPCC B1 emission scenario assumes that greenhouse gas emissions will eventually decrease, while the IPCC A2 emission scenario assumes emissions continuously increase (IPCC 2000).

Table 3.7: Mean 2080 temperature and precipitation anomalies for the Peace River Valley Region of B.C.

Emission Scenario	Winter	Spring	Summer	Fall	Annual
Mean Temperature (degC)					
B1	3.2	2.3	2.3	2.4	2.5
A1B	4.9	3.4	3.5	3.1	3.6
A2	5.2	3.5	4.1	3.7	3.9
Precipitation (%)					
B1	23%	19%	7%	25%	13%
A1B	24%	25%	5%	34%	17%
A2	38%	34%	2%	41%	16%

SOURCE:
Modified from Pacific Climate Impacts Consortium, University of Victoria (Schnorbus, et al. 2011)

Growing degree days and frost-free period were calculated for each of the BC Hydro climate station locations by applying the monthly temperature anomoly data as a linear correction, using the same methods used in Section 3.1.3. The results of this analysis for emission scenarios B1 and A2 are shown in Tables 3.8 and 3.9.

Table 3.8: Effect of greenhouse gas emissions on improved climatic capability for agriculture ratings for 2050

	Frost Free Period			Growing Degree Days			Climatic Capability for Agriculture (Improved Rating)		
Station	**1971 – 2000 Normal**	**2050 Emission Scenario B1**	**2050 Emission Scenario A2**	**1971 – 2000 Normal**	**2050 Emission Scenario B1**	**2050 Emission Scenario A2**	**1971 – 2000 Normal**	**2050 Emission Scenario B1**	**2050 Emission Scenario A2**
Station 1 Attachie Mid	92	106	119	1,251	1,531	1,645	2G	1F	1F
Station 2 Attachie Low	76	99	106	1,230	1,523	1,627	2GF	1F	1F
Station 3 Attachie Flat	94	109	122	1,204	1,650	1,763	2G	1F	1aGF
Station 4 Bear Flat	92	108	115	1,241	1,515	1,627	2G	1F	1F
Station 5 Hudson Hope	68	97	102	1,173	1,440	1,538	3F	1GF	1F
Station 7 Site C	125	144	152	1,359	1,644	1,799	1G	1aGF	1aG

Table 3.9: Effect of greenhouse gas emissions on improved climatic capability for agriculture ratings for 2080

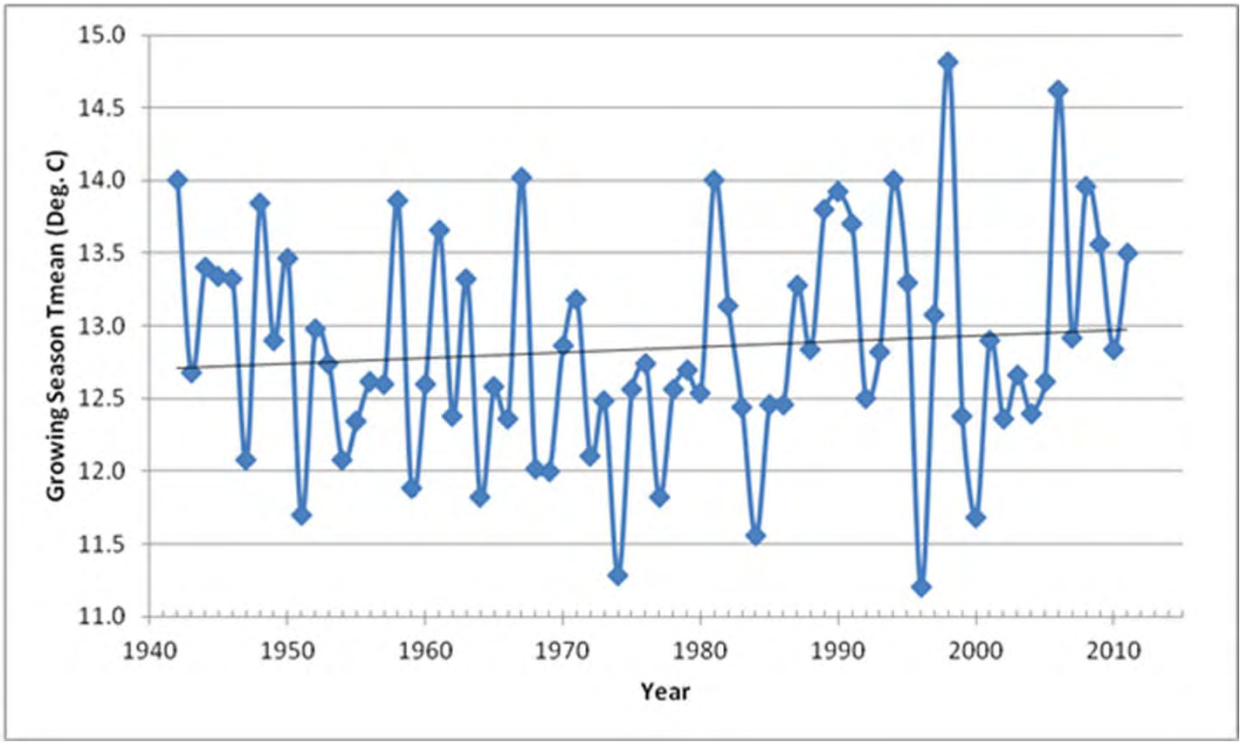
	Frost Free Period			Growing Degree Days			Climatic Capability for Agriculture (Improved Rating)		
Station	**1971 – 2000 Normal**	**2080 Emission Scenario B1**	**2080 Emission Scenario A2**	**1971 – 2000 Normal**	**2080 Emission Scenario B1**	**2080 Emission Scenario A2**	**1971 – 2000 Normal**	**2080 Emission Scenario B1**	**2080 Emission Scenario A2**
Station 1 Attachie Mid	92	117	132	1,251	1570	1897	2G	1F	1aF
Station 2 Attachie Low	76	107	120	1,230	1549	1872	2GF	1F	1aF
Station 3 Attachie Flat	94	119	136	1,204	1681	2036	2G	1F	1aF
Station 4 Bear Flat	92	114	132	1,241	1553	1881	2G	1F	1aF
Station 5 Hudson Hope	68	101	115	1,173	1482	1790	3F	1GF	1F
Station 7 Site C	125	150	164	1,359	1757	2032	1G	1aGF	1a

Applying the PCIC model temperature anomaly projections, statistically significant changes to growing degree days and frost-free period are expected and, as a result, an improvement in climatic capability for agriculture is predicted.

Using the 2050 predictions for emission scenario B1 the CCA at Stations 1, 2, 3, and 4 is projected to improve from Class 2 to Class 1; at Station 5 CCA improves from Class 3 to Class 1; and at Station 7, the improvement is from Class 1 to Class 1a. For emission scenario A2 the CCA improves to Class 1 at Stations 1, 2, 4 and 5, and to Class 1a at Stations 3 and 7.

For the 2080 predictions for emission scenario B1 the CCA improves to Class 1 at all stations except Station 7 where the CCA improves to Class 1a. For the 2080 predictions for emission scenario A2 the CCA improves to Class 1 at Station 5 and to Class 1a at the other stations.

The PCIC data also predicts warmer conditions throughout the Peace Agricultural Region in 2050 and 2080, indicating that climatic capability, and hence land capability for agriculture, would improve throughout the Peace Agricultural Region. With an increase in climate capability throughout the region it is expected that the proportion of high capability land within the Project activity zone relative to the total within the region will not increase with climate change and the proportion may decrease.

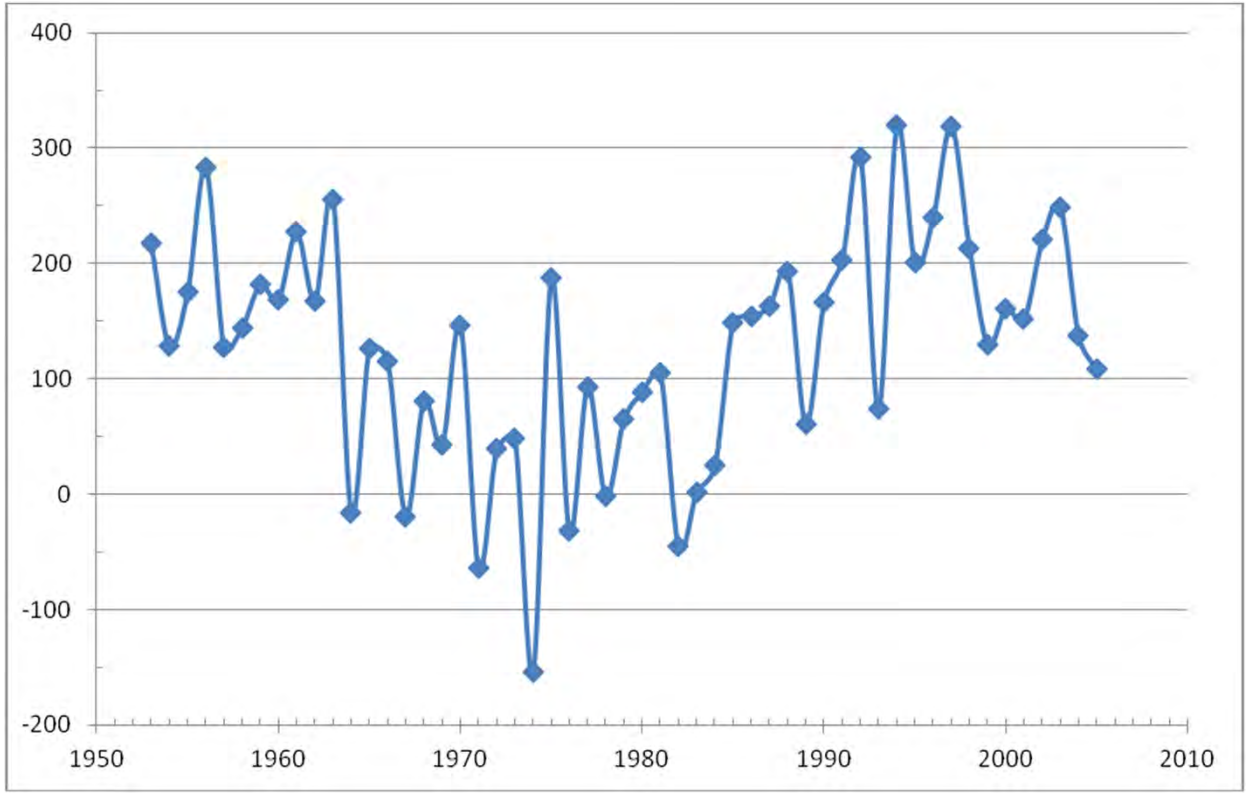


BC hydro

SITE C CLEAN ENERGY PROJECT

Figure 3.1 Mean growing season temperature at Fort St. John for the period 1943 – 2011

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification



BC hydro

SITE C CLEAN ENERGY PROJECT

Figure 3.2 Seasonal climatic moisture deficit (mm) at the Fort St. John airport 1953 - 2005

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification

4.0 AGRICULTURAL OPERATIONS AND PRACTICES

This section describes interview process for collecting information from farm operators and or owners within the LAA and summarizes information on farm operations in the Peace Agricultural Region obtained from Statistics Canada.

4.1 Owner and or Operator Interviews

The following summarizes the objectives, people interviewed, interview procedures, and interview documentation for the farm operation owner or operator interviews which were conducted as part of the agricultural assessment. A copy of the question guide used during the interviews is contained in Appendix B.

4.1.1 Interview Objectives

Interviews were conducted in 2011 and 2012 with the owners and operators of agricultural operations located in the LAA. These interviews were focused on the collection of information related to current and future agricultural activities and information required to define and evaluate on-farm effects.

Information sought during the interviews with owners and operators included the following:

- Current and future land use
- Soil and crop management practices, including crop rotation practices
- Crop yields and farm gate prices
- Livestock use, movements, and production
- Farm infrastructure and improvements and other investments that have been made or might be considered
- Historical and potential trends in agricultural land use
- Motivating factors in land use decision making
- Non-farm infrastructure used by farm operations
- Projected changes to land use if the Project proceeds
- Marketing and distribution channels used, including access and transportation needs
- Agricultural inputs acquisition channels
- Short- and long-term concerns related to potential effects of the Project on agricultural operations
- Avoidance and mitigation options
- Regional compensation and enhancement opportunities

4.1.2 List of Farm Operation Interviewees

There were 34 farm operations identified where a portion of the operation would be within the Project activity zone. The owners or operators of 22 of these farm operations were interviewed in person or by phone as part of the agricultural assessment. The owners or operators of the other farm operations were not interviewed because they declined or because they could not be contacted.

4.1.3 Interview Procedures

BC Hydro contacted owners and operators prior to the interview to explain the purpose of the interview and arrange a time and place for the interview.

The interviews were conducted by a BC Hydro representative and one or two members of the agricultural assessment team. During the interviews the BC Hydro representative:

- Provided an overview of the agricultural assessment
- Explained the purpose of the interview
- Explained that financial information collected during the interview would not be linked to individuals and that this information would only be reported only in aggregate
- Noted that the interviewee was not obligated to answer some or all of the questions posed during the interview

The agricultural team then conducted the interview using a question guide, which is appended to this report. The interviewees were given a copy of the question guide and maps showing the boundaries of their agricultural holdings.

4.1.4 Interview Documentation

Answers to interview questions were recorded in the question guide and on maps of the agricultural holdings. The completed question guides and accompanying maps were forwarded to the interviewees for comment and, if comments were returned, the answers were amended.

Copies of the completed question guides, excluding answers to financial questions in Section C of the guide, and accompanying maps were submitted to BC Hydro as a Record of Contact and for possible future reference. Answers to the financial questions of Section C of the guide are securely stored with the agricultural consultants.

4.2 Statistics Canada Data

This section summarizes baseline information on agricultural operations collected from Statistics Canada, including information on:

- Agricultural land and farm characteristics of the Peace Agricultural Region

- Agricultural sector characteristics
- Cropping operations
- Livestock operations

The Peace Agricultural Region, represented by Peace River Census Division 55 and the Northern Rockies Census Division 59,[5] comprises about 22% of B.C.'s land area and contains 32% of the province's Agricultural Land Reserve land or 1,522,145 ha (ALC 2010). About 7.4% of the Peace Agricultural Region is in the Agricultural Land Reserve. Farms in the Peace Agricultural Region comprise 32% (831,566 ha) of the total land on Census farms in B.C. (2,611,383 ha) according to the 2011 Census of Agriculture (Statistics Canada 2012a).

Table 4.1 details the use of lands on Census farm in the Peace Agricultural Region, as reported in the 2011 Census of Agriculture. About 41% of these lands consists of natural land for pasture (rangeland, including woodland used as pasture). Of the remainder, 32.6% is cropped, and tame and seeded pasture accounts for a further 12%. Woodlands and wetlands comprise 9.8% of the total and all other land, including idle land, areas occupied by farm buildings, barnyards, and lanes, represents 2.6% of the total. Approximately 1.9% of the land on Census farms was reported to have been summer fallowed in 2011.

Table 4.1: Breakout of farmland uses in the Peace Agricultural Region

Land Use (2011)[a]	Ha	Percent of Total
Natural land for pasture[b]	341,136	41.1%
Crops[c]	270,506	32.6%
Tame and seeded pasture[d]	100,406	12.1%
Woodlands and wetlands[e]	81,590	9.8%
All other land[6]	21,802	2.6%
Summer fallow	16,097	1.9%
Christmas trees	28	<0.1%
Total	**831,566**	**100.0%**

NOTES:
[a]Statistics Canada Census Divisions 55 and 59 correspond to the Peace River Regional District and the Northern Rockies Regional Municipality, respectively. The Peace River Regional District accounts for 99% of the currently farmed area in the Peace Agricultural Region
[b]Includes woodland used as pasture
[c]Includes field crops, hay, vegetables, sod, nursery products, fruits, berries, and nuts
[d]Does not include areas to be harvested for hay, silage, or seed
[e]Includes woodlots, sugarbush, tree windbreaks, bush, ponds, bogs, marshes, and sloughs
[f]Includes idle land and land on which farm buildings, barnyards, lanes, home gardens, greenhouses and mushroom houses are located
SOURCE:
Modified from Statistics Canada (2012a)

[5] Census Division 55 and Census Division 59 correspond to the Peace River Regional District and the Northern Rockies Regional Municipality, respectively. The farm area in Census Division 55 represented 99.03% of the area of farms in the Peace Agricultural Region in 2011

Table 4.2 presents farm indicators of Peace Agricultural Region agriculture in relation to agriculture in B.C. as a whole. While the Peace Agricultural Region encompasses slightly less than a third of the total area on Census farms in the province, its farms are about four times larger than the provincial average and comprise only 8% of the number of farms in B.C.. The cultivated land in crops, tame and seeded pasture, and summer fallow in the Peace Agricultural Region is 46% of the cultivated area of the province. The total cultivated area has declined in the Peace Agricultural Region and the province since 2001.

Table 4.2: Breakout of key farming indicators – Peace Agricultural Region vs. B.C., 2011

Farm Indicator	Peace Region	BC	Peace Region as Percent of BC in 2011	Change in Peace Region Since 2001	Change in BC Since 2001
Area of farms (ha)	831,565	2,611,383	32%	-4%	+1%
Number of farms	1,560	19,759	8%	-12%	-3%
Average farm size (ha)	533	132	400%	+9%	+4%
Cultivated area in crop, tame and seeded pasture and summer fallow (ha)	387,009	843,808	46%	-4%	-5%

SOURCES:
Modified from Statistics Canada (2012a, 2012b)

4.2.1 Agricultural Sector Characteristics

The Peace River agricultural sector has developed as predominantly mixed farming based on cow-calf operations, with grain, forage, and seed production for own use or for sale. Cash crops, such as wheat, barley, oats, canola, fescue seed, and field peas have provided opportunities to augment farm incomes in response to run-ups in global market prices.

Table 4.3 indicates the predominant types of farms in the Peace Agricultural Region compared to B.C. as a whole in 2011. The Peace Agricultural Region is dominated by 77% of farm operations that derive the majority of gross farm receipts from hay, beef, horses, and livestock combinations. About 11% of Peace Agricultural Region farms are of oilseed, wheat, and other grain farm types.

In comparison, B.C. as a whole is composed of 49% of farms that derive a majority of gross farm receipts from hay, beef, horses, and livestock combinations. Oilseed, wheat, and other grain farm types represent about 1.2% of B.C. farm types.

Table 4.3: Key farm types – Peace Agricultural Region vs. B.C., 2010

Selected Farm Type[a]	Peace Agricultural Region		BC	
	Number of Farms	Percent of Farms	Number of Farms	Percent of Farms
Hay farm	668	43%	3,426	17%
Beef farm	239	16%	2,579	13%
Horse farm	182	12%	2,782	14%
Livestock combination	100	6%	941	5%

Selected Farm Type[a]	Peace Agricultural Region		BC	
	Number of Farms	Percent of Farms	Number of Farms	Percent of Farms
Oilseed farm	80	5%	85	0.4%
Other grain farm	76	5%	122	0.6%
Wheat farm	19	1%	49	0.2%
All other miscellaneous animals farm	17	1%	203	1%
Ornamental nurseries	14	0.9%	1,263	6%
Sheep farms	12	0.8%	457	2.3%
Apiculture farms	11	0.7%	234	1%
Fruit, berry and nut farms	6	0.4%	3,367	17%
All types of poultry and egg farms	6	0.4%	1,144	6%
Fruit and vegetable farms	3	0.2%	235	1%
Vegetable farms	2	0.1%	785	4%
Potato farms	2	0.1%	127	0.6%
All other farming (incl. forage seed)	133	9%	2,398	12%
Total Farms	**1,560**	**100%**	**19,759**	**100%**

NOTES:
[a]A farm is classified as a particular farm type if >50% of its gross farm receipts are attributable to the category. Farm type based on gross farm receipts reported for 2010 in the 2011 Agriculture Census
SOURCE:
Modified from Statistics Canada (2012a, 2012b)

Table 4.4 compares the presence of farm types in the Peace Agricultural Region to farm types in the province as a whole in 2010. The Peace Agricultural Region supports 94% of B.C.'s canola farms, 62% of other grain farms, and 39% of wheat farms. The Peace Agricultural Region also contains 20% of B.C.'s hay farms and 10% of beef farms. Overall, the number of farms dropped 12% in the Peace Agricultural Region between 2000 and 2010 compared to a decline of about 3% in B.C. as a whole.

In the dominant farm types, Peace Agricultural Region farms shifted out of beef, sheep, wheat, and other grains in favour of oilseed, hay, and livestock combinations between 2000 and 2010. Declining beef and increasing hay farm types also occurred at the provincial level. Increasing horse farm types has been more of a provincial trend.

In the less dominant farm types, the presence of apiculture farms, fruit and berry farms, fruit and vegetable farms, and nurseries increased in the Peace Agricultural Region between 2000 and 2010, while the presence of potato and vegetable farms declined. At the provincial level, apiculture, fruit and berry, fruit and vegetable, and vegetable farm numbers increased in the period.

Table 4.4: Change in farm types – Peace Agricultural Region vs. B.C., 2000 – 2010

Selected Farm Type[a]	Peace Region Farms as Percent of BC Farms in 2010	Change in Peace Region Farm Types 2000 to 2010	Change in BC Farm types 2000 to 2010
	Percent Change		
Hay farm	20%	+51%	+59%
Beef farm	10%	-57%	-47%
Horse farm	7%	-1%	+15%
Livestock combination	11%	+12%	0%
Oilseed farm	94%	+433%	+400%
Other grain farm	62%	-37%	-30%
Wheat farm	39%	-57%	-35%
All other miscellaneous animals farm	8%	-66%	-50%
Ornamental nurseries	1%	+27%	+8%
Sheep farms	3%	-46%	-1%
Apiculture farms	5%	+22%	+38%
Fruit, berry and nut farms	0.2%	+200%	+14%
All types of poultry and egg farms	0.5%	-40%	+4%
Fruit and vegetable farms	1%	+50%	+58%
Vegetable farms	0.3%	-67%	+52%
Potato farms	2%	-60%	-12%
All other farming (incl. forage seed)	23%	-39%	-19%
All Farms	8%	-12%	-3%

NOTES:
[a]A farm is classified as a particular farm type if >50% of its gross farm receipts are attributable to the category. Farm type based on gross farm receipts reported for 2000 in the 2001 Agriculture Census and for 2010 in the 2011 Agriculture Census
SOURCE:
Modified from Statistics Canada (2012a, 2012b)

4.2.2 Cropping Operations

Table 4.5 indicates the area and relative size of the various hay and field crop production sectors in the Peace Agricultural Region. Hay crops in the Peace Agricultural Region account for 51% of the land in crops, followed by all cereal crops (29%), canola (12%) and forage seed (5%). Fruits and berries, vegetables, and potatoes are grown on less than 0.1% of the land in crops in the Peace Agricultural Region.

In B.C. as whole, hay crops dominate the land in crops with 64% of the area, followed by all cereal crops (17%) and canola (6%). Fruits and berries, vegetables, and potatoes are produced on about 5.5% of the land in crops in the province.

Table 4.5: Agricultural Field Production – Peace Agricultural Region vs. B.C., 2011

Selected Crops	Peace Agricultural Region		BC	
	Ha	Percent of Total	Ha	Percent of Total
Alfalfa and alfalfa mixtures	93,673	35%	217,898	36%
Other tame hay and fodder crops	45,412	17%	166,417	28%
Canola	33,593	12%	35,838	6%
Wheat	30,487	11%	34,875	6%
Oats	29,568	11%	35,164	6%
Barley	15,985	6%	26,479	4%
Forage seed	14,577	5%	17,041	3%
Dry field peas	3,905	1.4%	4,144	0.7%
Mixed grains	1,632	0.6%	4,004	0.7%
Rye	688	0.3%	2,010	0.3%
Nursery products	36	<0.1%	4,571	0.8%
Fruit, berries and nuts	18	<0.1%	23,494	4%
Vegetables	16	<0.1%	6,591	1%
Potatoes	12	<0.1%	2,887	0.5%
Corn for silage	11	<0.1%	13,840	2%
All other field crops	893	0.3%	1,557	0.6%
Total	**270,506**	**100%**	**599,674**	**100%**

SOURCE:
Modified from Statistics Canada (2012a)

4.2.2.1 Forages

Forages, represented by alfalfa and alfalfa mixtures, and by other tame hay and fodder crops, dominate the land in crops in the Peace Agricultural Region, accounting for a combined 51% of cropped area in 2011. Between 2001 and 2011, the area of alfalfa production has increased 23% while the area of other tame hay has decreased 35%. The total area devoted to forage crops is dependent on the economics of livestock production, changes in the size of the regional beef cattle herd, and regional markets for hay.

4.2.2.2 Grains and Oilseeds

Canola, wheat, oats, and barley represented 40.5% of the cropped area in 2011, with canola area slightly higher than oats and wheat. Among these major field crops between 2001 and 2011, canola area has increased 49%, wheat and oats areas rose 16% and 20% respectively, while barley area dropped 25%. The improved market conditions for canola, wheat, and oats has resulted in increased areas planted to these crops since 2000 and diverted lands out of forage and forage seed production. Declining barley area is correlated with reduced feed needs due to downsizing of the regional beef herd (Section 4.2.3).

A regional biofuels market now exists, allowing feed grains and lower quality oilseeds to be diverted for the production of ethanol and biodiesel (Pratt 2011).

4.2.2.3 Forage Seeds

Forage seed production area, represented by creeping red fescue, comprised about 5.5% of the land in crops in the Peace Agricultural Region in 2011. Since the 1940s, fescue seed has been grown as a cash crop for export out of the Peace Agricultural Region for turf purposes, first for landing strips in World War II and thereafter for sporting and recreational facilities, as well as recreational, institutional, commercial, and residential lawns, and for conservation purposes. The combined Alberta Peace and Peace Agricultural Region has harvested between 32,400 and 48,600 ha of creeping red fescue seed annually (Alberta Agriculture and Rural Development 2012a). The combined Peace Agricultural Region is the largest producing area of creeping red fescue in the world.

Production in the Peace Agricultural Region, consisting predominantly of common seed, averages 15,900 to 18,200 tonnes annually, of which 95% is destined for export (over 40% of that to the US) and 5% is used in the Canadian domestic market (Alberta Agriculture and Rural Development 2012b). About 10 to 20% of total production has been certified fescue that is generally exported to Europe.

Forage seed crops like creeping red fescue and alfalfa, while important in the 1970s to 1990s, have more recently declined in area. Between 2001 and 2011, the area of production of fescue seed in the Peace Agricultural Region fell 60%. Unless prices increase dramatically, the area devoted to this crop will continue to be restrained. The end market for turf grass, e.g., institutional, recreational, and residential lawns and turf, has suffered since the latest economic downturn that started in 2007. Legume (alfalfa) seed plantings in the combined Peace Agricultural Region have remained in the 1,200 to 1,400 ha range.

4.2.2.4 Dry Field Peas

Dry field pea is a relatively new pulse cash crop in the Peace Agricultural Region and accounted for 1.4% of the land in crops in 2011. Area planted increased 32% between 2001 and 2011. Field peas are sold primarily into export markets for human food and livestock feed. Feeding studies indicate that feed pea, used alone or combined with canola meal, makes an excellent swine ration (Saskatchewan Agriculture 2012).

4.2.2.5 Other Crops

Other crops, such as potatoes, vegetables, fruits and berries, other field crops and nursery crops represent about 0.4% of the land in crops in the Peace Agricultural Region in 2011. The total combined area of potatoes, vegetables, and fruits was reported to be less than 50 ha, down from a high of 130 reported in the 2001 Census.[6] Areas of potato and vegetable crops decreased while fruit and berries increased, mainly due to increased plantings of saskatoon berries.

[6] The 1991 and 1996 Censuses of Agriculture indicate a combined area in the Peace Region of potatoes, vegetables, and fruit and berries of 55 and 84 hectares, respectively (Statistics Canada 1992, 1997).

Table 4.6 compares the area of crops in the Peace Agricultural Region to B.C. as a whole and the change in crop areas between 2001 and 2011. The Peace Agricultural Region contains the majority of the provincial area in canola (94%), dry field peas (94%), wheat (87%), forage seed (86%), oats (84%), and barley (60%). Between 2001 and 2011 in the Peace Agricultural Region, the major crops of canola, wheat, oats, and alfalfa crops have increased, while the areas of forage seed, other tame hay, and barley have declined. In the minor crops, the Peace Agricultural Region area of fruits and berries has increased dramatically (due to saskatoon berry plantings), and areas of vegetables and potatoes have dropped. In B.C. as whole, changes in crop areas show similar trends to the Peace Agricultural Region.

Table 4.6: Change in area of crops – Peace Agricultural Region vs. B.C., 2001 – 2011

Selected Farm Type[a]	Peace Region Land in Crops as Percent of BC in 2011	Change in Peace Region Crop Area 2001 to 2011	Change in BC Crop Area 2001 to 2011
	Percent		
Alfalfa and alfalfa mixtures	43%	+23%	+11%
Other tame hay and fodder crops	27%	-35%	-19%
Canola	94%	+49%	+52%
Wheat	87%	+16%	+12%
Oats	84%	+20%	+8%
Barley	60%	-25%	-23%
Forage seed	86%	-60%	-55%
Dry field peas	94%	+32%	+28%
Mixed grains	41%	+99%	+42%
Rye	34%	-8%	+23%
Nursery products	0.8%	-29%	+9%
Fruit, berries and nuts	0.1%	+350%	+25%
Vegetables	0.2%	-33%	-9%
Potatoes	0.4%	-88%	-18%
All land in crops	45%	-3%	-3%

NOTES:
[a]A farm is classified as a particular farm type if >50% of its gross farm receipts are attributable to the category. Farm type based on gross farm receipts reported for 2000 in the 2001 Agriculture Census and for 2010 in the 2011 Agriculture Census
SOURCE:
Modified from Statistics Canada (2012a, 2012b)

4.2.3 Livestock Operations

While many types of livestock are raised, the Peace Agricultural Region has larger concentrations of B.C.'s beef cattle and bison than other livestock. A few fledgling livestock operations representing other well-known Canadian livestock sectors are also present in the Peace River Region. Table 4.7 indicates the relative size of the various livestock production sectors in the Peace Agricultural Region and compares them to livestock in B.C. as a whole.

Table 4.7: Livestock populations – Peace Agricultural Region vs. B.C., 2011

Selected Livestock Indicators	Peace Region	BC	Peace Region as Percent of BC
	Head		
Bison	7,765	9,206	84%
Beef cows and replacement heifers	51,506	229,268	23%
Horses	8,108	45,791	18%
Ewes	4,387	26,513	17%
All cattle and calves	100,537	620,638	16%
Sows and gilts	659	8,706	8%
Goats	976	14,649	7%
Honey bee hives[a]	1,605	33,603	5%
Dairy cows and replacement heifers	562	109,731	0.5%
Laying hens and pullets	9,529	3,604,752	0.3%
Turkeys	2,668	937,128	0.3%
Broiler chickens	33,709	14,433,236	0.2%

NOTES:
[a]Number of hives
SOURCE:
Modified from Statistics Canada (2012a)

4.2.3.1 Beef

The primary focus of the beef cattle sector is cow-calf production in the Peace Agricultural Region. While some operators may overwinter cattle if calf-yearling price differentials are favourable, the bulk of the annual calf crop is auctioned off in the fall to be finished in feedlots outside the region. Some ranchers or farmers may purchase yearlings in the spring to pasture out in the summer for sale in the fall. The Peace Agricultural Region contained 51,506 head of cows and replacement heifers in 2011.

In the last decade, major events have affected the beef cattle market. The regional beef herd declined by 35% between 2007 and 2012 in the aftermath of the 2004 discovery of bovine spongiform encephalopathy (BSE) in Canada. A prolonged period of poor returns in the sector has led many farmers to leave the sector or substantially downsize.

4.2.3.2 Bison

In 2011, 7,765 head, or about 84% of B.C.'s farmed bison, were raised in the Peace Agricultural Region. Specialty livestock producers, such as bison ranchers, have been faced with low prices in recent years, resulting in a drop in herd numbers between 2001 and 2006, followed by modest recovery to 2011.

4.2.3.3 Hogs, Sheep and Goats

Other livestock categories in the Peace Agricultural Region with a provincial presence include sheep, hogs, and goats. These include the following:

- Sheep, represented by ewes, accounting for 17% of the provincial reproductive flock
- Hogs, consisting of sows and gilts, comprising 8% of the provincial reproductive herd
- Goats, accounting for 7% of the provincial population

The sizes of these sectors are constrained by the relatively small regional market and the high costs of marketing production outside the region. The impact of BSE has also spilled over into the regulation of the sheep and goat trade and affected development of those sectors.

4.2.3.4 Honeybees

The Peace Agricultural Region apiary is reported to be distinctive in terms of the quality of honey produced and the higher yield per hive. While producers of honey continue to operate in the Peace River Region, the number of colonies has dropped 60% since 2000. In 2011, Peace Agricultural Region honey hives represented 5% of the provincial total.

4.2.3.5 Horses

Horses are raised in the Peace Agricultural Region to supply outfitters for bucking, rodeo, and recreational purposes. In 2011, horses in the Peace Agricultural Region represented 18% of the total number in the province.

4.2.3.6 Poultry and Dairy

The dairy and poultry components of the Peace Agricultural Region livestock sector are small. Reported poultry inventories shows slow and steady growth in the 2001 to 2011 period. Conversely, the dairy presence in the Peace Agricultural Region is declining.

Table 4.8 compares livestock numbers in the Peace Agricultural Region to B.C. as a whole and the change in numbers between 2001 and 2011. Animal inventories of meat chickens, hogs and bison have increased in the Peace Agricultural Region while all other livestock categories have declined. For the province as a whole, turkey and honeybee hive numbers have shown the largest increase, while the livestock populations in the meat chicken, bison, and dairy sectors have increased marginally. Livestock numbers in all other categories decreased in the province between 2001 and 2011.

Table 4.8: Livestock trends – Peace Agricultural Region vs. B.C., 2011

Selected Livestock Indicators	Peace Region	BC
	Percent Change 2001 – 2011	
Bison	+14%	+3%
Beef cows and replacement heifers	-30%	-32%
Horses	-17%	-14%
Ewes	-28%	-28%
Sows and gilts	14%	-52%
Goats	-20%	-22%
Honey bee hives[a]	-59%	+17%
Dairy cows and replacement heifers	-35%	+2%
Laying hens and pullets	-48%	-26%
Turkeys	-60%	+14%
Broiler chickens	+130%	+3%

NOTES:
[a]Number of hives.
SOURCE:
Statistics Canada (2012a, 2012b)

5.0 AGRICULTURAL ECONOMIC ACTIVITY BASELINE

This section describes the agricultural sector characteristics of the Peace Agricultural Region in terms of:

- Market orientation and channels
- Farm gate marketing
- Input suppliers and services
- Regional food retail marketing
- Agricultural population and employment
- Economic returns from farming

5.1 Market Orientation and Channels

The bulk of Peace Agricultural Region agriculture is oriented to the export of products out of the region, predominantly as harvested field crops or livestock. As such, agricultural support industry and infrastructure is geared toward bringing inputs in and transporting harvested products to markets outside the region, including other provinces (predominantly Alberta), the US, and Asia.

A very small proportion of Peace Agricultural Region agriculture is oriented to the local market. The Peace Agricultural Region grows small areas of potatoes, vegetables, and fruits and berries for domestic consumption, local retailers, and local farmers' markets. Several livestock operations sell livestock for local slaughter to meet domestic needs and for specialty processing of bison, sheep, and deer.

5.1.1 Farm Gate Crop Marketing

Cash grain sales are marketed to regional grain dealers primarily for transport to the ports of Prince Rupert or Vancouver by rail for export, largely to Asian markets. Cereal and oilseed dealers serving the region include the following:

- Louis Dreyfus Canada Ltd. (Dawson Creek)
- Viterra (Dawson Creek and Fort St. John)
- Parrish & Heimbecker Limited, Dawson Creek Siding Grain Elevator
- Cargill with trucking to facilities in Rycroft, Alberta
- AgroSource, Dawson Creek, a grain buyer of oats, barley, wheat, canola, peas and rye, agent to the Canadian Wheat Board
- North Pine Farmers Institute, which in 2009 obtained a loan from Northern Development through the Economic Diversification Infrastructure program to acquire the Fort St. John rail head and elevator and make improvements and upgrades to the facility

In addition, some feed grains are sold directly to feed lots and livestock yards out of province.

In March 2012, Viterra was purchased by the Swiss multinational Glencore International PLC., a company specializing in the global production, sourcing, processing, refining, transporting, storage, and supply of metals and minerals, energy products, and agricultural products. Glencore has indicated that it will sell off some of Viterra's retail agri-products business to Agrium[7] and some grain-handling facilities to Richardson International. Richardson, a Winnipeg-based company, has agricultural business centres across the prairies and in the Alberta Peace Region.

Forage seeds are marketed to dealers such as Pickseed Canada Inc. in Dawson Creek, and Brett-Young Seeds (Rycroft) Ltd. in Grande Prairie, Alberta. The bulk of common forage seed makes its way to the US export market and about 10% is sold to interprovincial markets.

Farmers tend to plan herd size and manage forage area to be able to produce a slight surplus of hay on their farms annually. This allows a safety margin in case of weather-related yield declines and leads to the sale of surplus hay into local and regional markets in most years. Hay also has been occasionally sold into the Prince George region.

5.1.2 Crop Input Suppliers and Services

Consolidation in the input supply sector of the agricultural industry has also intensified over the last few decades. The grains and oilseeds sector of the Peace Region is now largely served by Viterra, with agricultural retail sales at Dawson Creek and Fort St. John. Other input suppliers include Agro Source Ltd. (Dawson Creek) and Cargill (Fort St. John).

There are two farmer-owned seed cleaning plants in the Peace Agricultural Region. The Fort St. John Seed Cleaning Co-op is a farmer-owned facility that cleans grass and legume seeds for producers. The South Peace Grain Cleaning Co-op (Dawson Creek) is a facility owned by about 200 farmers that cleans wild oat and weed seeds from wheat, barley, oats, rye, peas, and canola. This latter co-op also specializes in cleaning wheat that is used as feed in marine fish farms, malt barley for beer, pony oats for racehorses, and organic oats and rye.

The main granular urea and ammonia fertilizer storage and distribution facility in the region is Canadian Fertilizers Ltd., a company jointly owned by Viterra and CF Industries Holdings Inc., with a terminal located in Rycroft, Alberta in the adjacent Alberta Peace Region and a fertilizer plant in Medicine Hat, Alberta. Following the sale of Viterra to Glencore International in 2012, CF Industries Holdings Inc. has acquired Viterra's minority stake in Canadian Fertilizers Ltd. distribution facilities and fertilizer complex.

[7] An agreement has now been reached to purchase the fertilizer holdings with CF Industries Holdings Inc., a US-based fertilizer manufacturer serving the northern US corn belt states and western Canadian markets. The company owns 66% of Canadian Fertilizers Ltd.

5.1.3 Farm Gate Livestock Marketing

Livestock sales occur through Vold, Jones & Vold Auction Co. Ltd. regionally at the auction in Dawson Creek, at points in Alberta (e.g., Ponoka and Stavely, Alberta), and through internet bidding. Other, smaller, auction houses that handle livestock in the Peace Agricultural Region include Patterson's Auction Mart Ltd.

Other livestock raised in the Peace Agricultural Region, such as bison, deer, hogs, and sheep, tend to be butchered locally and packed or processed into livestock products that are sold locally or exported regionally.

5.1.4 Meat Product Marketing

The large retail chains market meats procured from major suppliers outside of the Peace Agricultural Region. Other retail meat outlets include IGA and the Dawson Cooperative Union. While meat sales in the region are dominated by the large retail food chains, the Peace Agricultural Region is also served by several provincially licensed abattoirs in the area (BCMOH 2012). These include the following:

- Gate to Plate Food Services Inc., Fort St. John, with fixed red meat plant and mobile facilities, offering halal and organic services for slaughtering beef, swine, sheep, lamb, bison, and deer
- Peace Country Poultry, Farmington, a poultry facility operated by the local Hutterite Colony offering halal and uncertified organic slaughter of chicken, turkey, geese, ducks, and pheasant
- South Peace Colony Meats, Farmington, a red meat facility operated by the South Peace Hutterite Colony
- South Peace Colony Poultry Farm, Dawson Creek, a poultry facility operated by the South Peace Hutterite Colony
- Lawrence Meat Packing Co., Dawson Creek (BCMOH 2012; Lawrence 2008), a red meat facility (cattle, bison, goats, sheep, and swine) and certified organic handler/packer with Butcher Block retail outlets in Fort St. John and Dawson Creek

New federal and provincial food safety protocols adopted since 2008 have created hardship in areas such as the Peace Agricultural Region where federal or provincial slaughter and meat inspection facilities are not conveniently available. With changes to B.C.'s Food Safety Act, more stringent meat processing regulations limited slaughter and processing of meats for sale to provincially and federally licensed abattoirs (BCMOH 2012), requiring pre-existing processing facilities to meet new provincial standards and creating financial costs beyond the reach of small scale processors.

In 2010, amendments to the B.C. *Meat Inspection Regulation* were made to allow Class D[8] and Class E[9] licenses that permit limited on-farm slaughter for producers who cannot access a licensed facility to meet their slaughter needs.

[8] Class D facilities are allowed on-farm slaughter of 1 to 25 animals annually. The meat can be sold to restaurants and retail outlets in the regional district where the meat was produced, and directly to local consumers. Class D license holders may slaughter their own or other people's animals. These licenses are only available in the designated areas.

The Canadian Food Inspection Agency, which previously inspected meats at its own expense, will cease to provide provincial meat inspection services in B.C.'s provincially licensed plants on January 1, 2014. As a result, the cost of meat inspection will default to the province, which is examining ways of cost sharing with facility users.

5.2 Regional Food Retail Marketing

The bulk of the produce and meat food products marketed in the Peace Agricultural Region are by large retail chains with branches throughout B.C. and Canada. These stores source stock from centralized procurement locations. The larger chains, such as PriceSmart, IGA, Supervalu, Real Canadian, and Canada Safeway, are present in the all of the larger centres of the Peace Agricultural Region, e.g., Fort St. John, Dawson Creek and Chetwynd. Other outlets marketing food products include the Dawson Cooperative Union.

Local producers have challenges accessing chain food retailers due to a number of factors including the following:

- Small production volumes
- Problems with reliability of supply
- Ability to supply only during a short production season
- High costs of production leading to higher asking prices
- Inconsistent quality

While some retailers may make efforts to buy produce locally in the Peace Agricultural Region, the large chains are involved in wholesaling operations as well and the bulk of their produce buying is through centralized distribution centers across Canada and the US (USDA Foreign Agriculture Service 2012).

Farmers' markets selling local honey, fruits, and vegetables are in operation in Chetwynd, Dawson Creek, and Fort St. John, involving 50 local vendors from May through October each year. Some vendors also sell processed food products such as baking and preserves.

In 2011, 22 farmers produced organic products in the Peace Agricultural Region, mainly hay crops and organic animals or animal products (Statistics Canada 2012a).

[9] Class E facilities are allowed on-farm slaughter of 1 to 10 animal units annually for direct sale to consumers. Sales are restricted to the regional district in which the meat was produced, and operators are only permitted to slaughter their own animals.

5.3 Agricultural Population and Employment

In 2010, agriculture in the Peace Agricultural Region comprised 1,560 farms, of which all but 28 farms were in the Peace River Regional District that includes Fort St. John and Dawson Creek. These farms were operated by 2,325 farm operators (Statistics Canada 2012a).

Two Hutterite colonies own and farm large tracts of land in the Peace Agricultural Region: the South Peace Colony and Peace View Colony, both near Farmington, B.C. (approximately 25 km north of Dawson Creek). A German Mennonite settlement at Prespatou, B.C., 84 km north of Fort St. John, moved into the area in the early 1960s and continues to farm in the area.

Agriculture employed about 3% of the region's workforce (WorkBC No Date), or about 1,200 person-years, in 2011. In addition, the 1,560 farms in the Peace Agricultural Region had 2,325 farm operators. It was estimated in 2006 that about 9% (5,127 persons) of the regional population was involved in agricultural production (BCMA 2008).

Twenty percent of the farms pay wages and salaries, either to family members or other persons. About 80% of the farms do not pay formal wages and salaries. In 2010, agricultural operators paid about $8.596 million in total agriculture-related wages and salaries. Of the farms using paid labour, 73% utilize seasonal or temporary labour and 46% employ farm workers full-time. The total weeks of annual paid employment represent about 312 person-years of employment.[10] The number of farms using paid labour and the number of weeks of employment have dropped 28% and 30%, respectively, since 2005.

About 57% (894 farms) of Peace Agricultural Region farms were sole proprietorships, 30% (470) were formal or informal partnerships, and 10% (162 farms) were family corporations in 2011.

About 55% of the land in farms in the Peace Agricultural Region was privately owned in 2011, with a further 29% leased from governments, and 10% farmed through private rental and lease arrangements.

5.4 Economic Returns from Farming

Table 4.9 shows economic characteristics of farms in the Peace Agricultural Region in comparison to B.C. as a whole. In 2010, Peace Agricultural Region farmers generated about $145 million, or 4.9% of the gross farm receipts generated in B.C.. Between 2000 and 2010, total gross farm receipts have increased slightly more rapidly in B.C. as a whole than in the Peace Agricultural Region. During the same period, the average contribution margin[11] declined in the Peace Agricultural Region while increasing 44% in B.C. as a whole. In 2010, the provincial average contribution margin from farming as a proportion of farm gross receipts was about twice that of the contribution margin as a proportion of farm gross receipts generated in of the Peace Agricultural Region.

[10] This calculation is based on an estimate of 49 weeks of employment per year per full-time worker.

[11] Contribution margin is defined as the excess of total revenue over variable costs and does not include depreciation or returns to equity or management.

Total farm capital value increased 61% in the Peace Agricultural Region compared to an increase of 119% in B.C. as a whole. In the same period, livestock and poultry inventory value declined by 51% in the Peace Agricultural Region between 2001 and 2011, compared to a decrease of 41% in B.C. as a whole.

About 83% of the farm capital of Peace Agricultural Region farm operations is composed of land and building value. In B.C. as a whole, land and building value accounted for about 93% of farm capital. Between 2001 and 2011, land and building value increased farm capital value by more than 100% in the Peace Agricultural Region and by almost 150% in B.C. as a whole, more than offsetting declining livestock and poultry inventory values.

Table 5.1: Farm economic characteristics – Peace Agricultural Region vs. B.C., 2000 – 2010

Farm Economic Indicator	Peace Region	BC	Peace Region as Percent of BC in 2011	Change in Peace Region since 2001	Change in BC since 2001
	Dollars		Percent Change		
Gross farm receipts[a] (2010)	$144,940,291	$2,935,906,056	4.9%	+22%	+27%
Contribution margin (2010)	$7,774,551	$315,191,066	2.5%	-2%	+44%
Contribution margin as a proportion of farm cash receipts (2010)	5.4%	10.7%			
Total farm capital (2011)	$1,870,795,296	$34,701,682,716	5.4%	+64%	+119%
Machinery and equipment (2011)	$230,846,441	$1,834,254,460	4.4%	+13%	+14%
Livestock and poultry inventory (2011)	$87,020,200	$683,459,156	12.7%	-51%	-41%
Land and buildings (2011)	$1,552,928,655	$32,183,969,100	4.8%	+104%	+146%
Land and buildings as a proportion of total farm capital (2011)	83%	92.7%	N/A	N/A	N/A

NOTES:
[a] Gross farm receipts are reported for 2000 in the 2001 Census of Agriculture and for 2010 in the 2011 Census of Agriculture
SOURCE:
Statistics Canada (2012a, 2012b)

Table 5.2 examines the distribution of farm size and gross farm receipts in the Peace Agricultural Region. It provides a glimpse of the proportion of agricultural operators that are predominantly employed in the sector. Over half (56%) of farming operations gross less than $25,000 annually, and only about 18% gross more than $100,000 annually. In comparison, family income in the Peace Agricultural Region averaged $86,150 in 2005 (BC Stats 2011).

Approximately 31% of the Census reporting farms are a quarter section (65 ha or 160 acres) or less in size, and 23% of farms have less than 26 ha (60 acres) in crops or summer fallow.

One important measure of economic value is the net return associated with agricultural activity. Estimates of this value are best arrived at by using whole farm analysis of representative farms. A Peace Agricultural Region enterprise budget for a grains and oilseeds operation indicated a contribution margin[12] of about 23% in 2008.[13] A 2007 Peace Agricultural Region budget for a 200 cow operation indicated a contribution margin of 52% and net farm income of 19% of gross farm receipts, not including return to management (BCMA 2007).

The average contribution margin of all farms across all farm types in the Peace Agricultural Region is reported to have been 5.4% in 2010 (Statistics Canada 2012a). This indicates that there is a wide variation in net returns to farming in the Peace Agricultural Region. Higher gross margins are being achieved by larger farms and low or negative gross margins by smaller farms. Given the distribution of gross receipts and farm sizes in the Peace Agricultural Region, many farm operators relied on off-farm income in addition to revenues produced from farming. There is also strong demand in the region for rural acreage for hobby farming.

Table 5.2: Distribution of Peace Agricultural Region farms by category

Gross Farm Receipts Category (2010)	No. of Farms	Percent	Farm Size Category (2011)	No. of Farms	Percent	Area in Crops and Summer fallow (2011)	No. of Farms	Percent
Under $10,000	543	34.8%	Under 10 acres	20	1.3%	No area in crops	161	10.3%
$10,000 – $23,999	336	21.5%	10 – 59 acres	71	4.6%	Under 10 acres	22	1.4%
$25,000 – $49,999	222	14.2%	70 – 129 acres	73	4.7%	10 – 59 acres	188	12.1%
$50,000 – $99,999	185	11.9%	130 – 179 acres	320	20.5%	70 – 129 acres	256	16.4%
$100,000 – $239,999	157	10.1%	180 – 239 acres	32	2.1%	130 – 179 acres	149	9.6%
$250,000 – $499,999	67	4.3%	230 – 399 acres	222	14.2%	180 – 239 acres	108	6.9%
$500,000 – $999,999	31	2.0%	400 – 559 acres	137	8.8%	230 – 399 acres	205	13.1%
$1,000,000 – $1,999,999	15	1.0%	560 – 759 acres	123	7.9%	400 – 559 acres	129	8.3%

[12] Contribution margin is defined as the excess of total revenue over variable costs and does not include depreciation or returns to equity or management.

[13] The BC Ministry of Agriculture's *Planning for Profit: 2,500 Acre Grains and Oilseed Operation: Full Production* notes net income after indirect costs was -27% of gross farm receipts (BCMA 2008).

Gross Farm Receipts Category (2010)	No. of Farms	Percent	Farm Size Category (2011)	No. of Farms	Percent	Area in Crops and Summer fallow (2011)	No. of Farms	Percent
$2,000,000 & over	4	0.3%	760 – 1,119 acres	139	8.9%	560 – 759 acres	103	6.6%
			1,120 – 1,599 acres	126	8.1%	760 – 1,119 acres	95	6.1%
			1,600 – 2,239 acres	89	5.7%	1,120 – 1,999 acres	73	4.7%
			2,230 – 2,879 acres	57	3.7%	2,000 – 3,499 acres	46	2.9%
			2,880 – 3,519 acres	38	2.4%	3,500 acres & over	25	1.6%
			3,520 & over	112	7.2%	N/A	N/A	N/A
Total	**1,560**	**100.0%**	**Total**	**1,560**	**100.0%**	**Total**	**1,560**	**100.0%**

SOURCE:
Statistics Canada (2012a)

6.0 AGRICULTURAL ECONOMIC VALUATION METHODOLOGY

The value of the future agricultural activity in the Project activity zone area that is forecast to be displaced by the proposed Project is calculated in this section of the report. The approach used largely follows a valuation methodology first used in the 1981 review of the BC Hydro Peace River Site C Hydroelectric Development Agriculture Assessment (CBRC 1979) by the BC Ministry of Agriculture Blue Paper (BCMAF 1982). Adjustments have been made to address changes since that time.

The valuation methodology process, described below, consisted of the following:

- Estimated values from agricultural production are based on expected per acre net economic returns from key crop types. For this purpose, crop budgets of revenues and costs applicable to the Peace Agricultural Region have been applied to calculate the net returns associated with the crop types.
- Crop budget information, representing average production attained by representative farm operators, is typically generated periodically by government agencies. As such, crop budgets may be available for different years and be based on revenues and costs associated with those years. In order to bring these estimates to current values, farm indices have been used to update the values.
- Forage, pasture, and grazing budgets have been used to represent returns to land for beef enterprises in place of a beef cattle budget.

6.1 Developing Crop Budgets

Previous evaluation of Site C agricultural effects focused heavily on the social cost of the foregone opportunity to expand vegetable crop production. At that time, a vegetable industry study was commissioned specifically to examine the potential for developing a vegetable industry in the Peace River Valley to meet anticipated increases in regional demand. Other crop enterprises included forage, forage seed, grain production, and pasture.

The crop mix has changed since that time as farmers have responded to market factors by adjusting their cropping patterns. Cereal grain production and oilseeds (canola) figure more prominently in Peace Agricultural Region, although forages and range and pasture still predominate. While vegetable production has not increased in the last 30 years, vegetables still remain a potential high value use of the land into the future and have been included as part of the future crop mix. The sections below indicate the methodology that was used to develop crop budgets for each of the key crop types.

6.1.1 Field Crops

The current assessment uses recent crop budgets prepared for the Peace Region of B.C. by BC Ministry of Agriculture (BCMA 2008) as well as current crop budgets prepared for the Alberta Peace (Alberta Agriculture and Rural Development 2012). Where necessary, these budgets have been updated to 2011 terms by applying Statistics Canada's farm input price indices (Statistics Canada 2012d) and farm product price indices (Statistics Canada 2012c) for western Canada and then extrapolating to 2013 dollars based on average historical rates of change in these indices.

6.1.2 Vegetables

Total vegetable production in the entire Peace Agricultural Region in 2011 is reported at 2841 ha, including potato production. The only vegetable budgets created for the Peace Agricultural Region are the budgets from the 1979 Agricultural Assessment (CBRC 1979) and the 1981 and 1982 Blue Paper reviews (BCMAF 1981 and 1982) undertaken specifically for the earlier Site C assessment. Vegetable enterprises in southern B.C. and southern Alberta rely extensively on irrigation, and those budgets are not particularly relevant to the Project activity zone.

The 1981 vegetable budgets have been updated to 2013 dollars in a similar manner to that carried out for the field crop budgets. The individual crop budgets have been stripped of any foreign exchange benefit and subsidy payments that were estimated for 1981 Blue Paper. The more recent literature on foreign exchange benefits in Canada indicates that such benefits are much more minor at present, leaving any possible adjustment for them well within the range of possible error on other key budget assumptions. The specific subsidy adjustment made in the Blue Paper for potatoes and the general adjustments made to all vegetable models for the effects of the federal gasoline excise tax rebate and the provincial Partial Interest Reimbursement Program were removed due to the discontinuance of these subsidy programs.

The average weighted vegetable budget[14] adopted in the Blue Paper analysis has been used as the base case for calculations of possible losses associated with displaced vegetable production.

6.1.3 Beef

Forage, pasture, and grazing budgets have been used to represent returns to land for beef enterprises in place of a beef cattle budget.

6.2 Calculating Returns to Land

The concept of social return to land from farming addresses the following elements:

- Consideration of the true economic returns by accounting, as appropriate, for distortions in product and input prices caused by subsidies, taxes, foreign exchange, and other market imperfections
- Using a time horizon for economic returns that reflects the period of agricultural impact
- Applying social discount rates to discount future returns to the present.

[14] The Blue Paper average weighted vegetable budget is based on a vegetable crop production mix based on per capita demand as follows: cabbage- 6.9%; turnips – 2.61%; sweet corn – 2.25%; potatoes – 76.64%; cucumbers – 1.87% and lettuce – 9.73%.

The methodology utilized to estimate the foregone social return to land from farming that would be displaced in the Project activity zone consists of the following components:

1) Cropping scenarios:

- The area of land available for cultivated crops including pasture in the Project activity zone has been determined by the area of Class 1 to 5 lands with high to moderate utility, as identified in the agricultural capability review carried out for the current agricultural assessment
- The area of land available for range in the Project activity zone has been determined as all of the Class 1 to 5 lands with low to nil utility, plus 50% of the area of Class 6 and 7 lands identified in the capability review
- All cropping scenarios start with the current cropping pattern documented in the Project activity zone
- The three scenarios of cropping examined all assume full utilization of the agricultural land base (as defined) of the Project activity zone within a base analytical period of 100 years after the Project has been implemented, with crop expansion occurring at a constant rate over this period:
  - Scenario 1, shown in Table 6.1, is based on expansion of the current cropping mix, with no new crop types added
  - Scenario 2, shown in Table 6.2, is identical to Scenario 1, except that a growing amount of vegetable cropping, amounting to 100 ha by Year 100, is assumed to supplant an equal area of other crops
  - Scenario 3, shown in Table 6.3, is identical to Scenario 2, except that vegetable cropping reaches 200 ha by Year 100, supplanting an equal area of other crops

Table 6.1: Agricultural land use forecast under development scenario 1 (ha)

Crop	Year 1	Year 5	Year 10	Year 15	Year 20	Year 25	Year 50	Year 100
Vegetables	0	0	0	0	0	0	0	0
Canola	117	129	141	153	166	178	239	360
Grain	90	99	109	119	127	137	184	277
Forage	251	277	303	329	355	381	512	773
Pasture	83	92	101	109	118	126	169	256
Range	1,183	1,298	1,412	1,527	1,642	1,757	2,330	3,477
Idle	3,419	3,248	3,077	2,906	2,735	2,564	1,709	0
Subtotal Ha	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**
Non-agricultural use	1,326	1,326	1,326	1,326	1,326	1,326	1,326	1,326
Total Ha	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**

Table 6.2: Agricultural land use forecast under development scenario 2 (ha)

Crop	Year 1	Year 5	Year 10	Year 15	Year 20	Year 25	Year 50	Year 100
Vegetables	0	5	10	15	20	25	50	100
Canola	117	128	139	150	161	172	228	339
Grain	90	98	107	116	124	133	175	261
Forage	251	275	299	322	347	370	489	727
Pasture	83	91	99	107	114	122	162	240
Range	1,183	1,298	1,412	1,527	1,642	1,757	2,330	3,477
Idle	3,419	3,248	3,077	2,906	2,735	2,564	1,709	0
Subtotal Ha	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**
Non-agricultural use	1,326	1,326	1,326	1,326	1,326	1,326	1,326	1,326
Total Ha	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**

Table 6.3: Agricultural land use forecast under development scenario 3 (ha)

Crop	Year 1	Year 5	Year 10	Year 15	Year 20	Year 25	Year 50	Year 100
Vegetables	0	10	20	30	40	50	100	200
Canola	117	127	137	147	157	167	217	317
Grain	90	98	105	113	121	129	167	244
Forage	251	272	295	316	337	358	466	680
Pasture	83	90	97	104	111	118	154	225
Range	1,183	1,298	1,412	1,527	1,642	1,757	2,330	3,477
Idle	3,419	3,248	3,077	2,906	2,735	2,564	1,709	0
Subtotal Ha	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**	**5,143**
Non-agriculutral use	1,326	1,326	1,326	1,326	1,326	1,326	1,326	1,326
Total Ha	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**	**6,469**

2) Net returns from forage production:

- Livestock production is projected to increase in lock step with any forecast increase in forage production in the Project activity zone, as outlined in the above three crop development scenarios
- The values of forage, pasture and range production indicated in Table 6.4 are used as a proxies for livestock value:
  - Forage prices in 2011 are based on price expectations outlined in crop enterprise budgets for the B.C. Peace Region and Alberta Peace
  - Prices have been projected to 2013 dollars based on recent trends in FPPI for crops in western Canada

- After 2013, as shown in Tables 6.5, 6.6 and 6.7, a real increase in all agricultural prices and hence, the value of gross forage, pasture and range returns, of 0.5% per year for the next 99 years has been assumed, reflecting an optimistic scenario of improving terms of trade for agricultural products

3) Net returns from grazing:

- Grazing capacity was set based on consultation with the regional Range Agrologist for the Peace region
  - Average carrying capacity 1 animal unit month (AUM) per 4.66 ha (0.21 AUM/ha)[15]
  - Average value per AUM is based on Alberta Agriculture industry advisories[16]

4) Net returns from pasture:

- Net return to land:
  - Average value per AUM is based on Alberta Agriculture industry advisories[17]
  - Yields and 1981 costs of production are based on the 1981 enterprise budgets, as modified by the BC Ministry of Agriculture Supplement to Blue Paper No. 1
  - Prices and gross revenues adjusted to 2011 dollars using the Farm Product Price Index (FPPI) for western Canada and then projected to 2013 dollars using recent trends in the same index
  - Production costs adjusted to 2011 dollars using the Farm Input Price Index (FIPI) for western Canada, and then projected to 2013 dollars using recent trends in the same index
  - Net return to land is calculated as gross revenue minus costs of production

Table 6.4: Year 1 Net returns to land from pasture and grazing utilization (Year 1 dollars)

Parameter	Mixed Hay	Alfalfa Hay	Forage Average	Pasture	Range
	Per Hectare				
Expected yield – tonnes or AUMs[a]	4.3	4.9	4.6	12.4	0.21
Expected market price per tonne or AUM[a]	96.83	111.30	104.07	30.00	30.00
Revenues	418.56	549.83	481.96	370.50	6.44
Direct expenses	204.07	218.17	211.12	70.37	3.46
Contribution margin	214.49	331.66	270.84	300.13	2.99
Interest on Investment	11.12	11.12	11.12	11.12	0.00
Management	44.46	44.46	44.46	22.23	0.00
Depreciation	38.29	38.29	38.29	38.29	0.00
Net return to land	**120.63**	**237.80**	**176.98**	**228.50**	**2.99**

NOTES:
[a] Animal Unit per Month (AUM) per hectare is a measure of animal carrying capacity applied to pasture and range

[15] Range agrologist, Dawson Creek, BC indicated that range grazing productivity in the Peace Region is 8 to 15 ha per AUM (Morhart 2012 pers. comm.).

[16] Pasture rates are relatively insensitive to markets as animals must eat regardless of profitability. The historical range is $25 to $35 per AUM (Alberta Agriculture and Rural Development ___).

[17] Pasture rates are relatively insensitive to markets as animals must eat regardless of profitability. The historical range is $25 to $35 per AUM (Alberta Agriculture and Rural Development ___).

Table 6.5: Forage returns to land, Year 1 to Year 100 (Year 1 dollars)

Forage								
Per Hectare	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**	**Year 50**	**Year 100**
Revenue	481.96	494.13	506.61	519.40	532.51	545.96	618.46	793.63
Direct Expenses	211.12	211.12	211.12	211.12	211.12	211.12	211.12	211.12
Contribution margin	270.84	283.01	295.49	308.28	321.39	334.84	407.34	582.51
Interest on investment	11.12	11.12	11.12	11.12	11.12	11.12	11.12	11.12
Management	44.46	44.46	44.46	44.46	44.46	44.46	44.46	44.46
Depreciation	38.29	38.29	38.29	38.29	38.29	38.29	38.29	38.29
Return to land	**176.98**	**189.15**	**201.63**	**214.42**	**227.53**	**240.98**	**313.48**	**488.65**

Table 6.6: Pasture returns to land, Year 1 to Year 100 (Year 1 dollars)

Pasture								
Per Hectare	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**	**Year 50**	**Year 100**
Revenue	370.50	379.86	389.45	399.28	409.36	419.70	475.44	610.09
Direct Expenses	70.37	70.37	70.37	70.37	70.37	70.37	70.37	70.37
Contribution margin	300.13	309.48	319.07	328.91	338.99	349.33	405.06	539.72
Interest on investment	11.12	11.12	11.12	11.12	11.12	11.12	11.12	11.12
Management	22.23	22.23	22.23	22.23	22.23	22.23	22.23	22.23
Depreciation	38.29	38.29	38.29	38.29	38.29	38.29	38.29	38.29
Return to land	**228.50**	**237.85**	**247.44**	**257.28**	**267.36**	**277.70**	**333.43**	**468.09**

Table 6.7: Grazing returns to land, Year 1 to Year 100 (Year 1 dollars)

Range								
Per Hectare	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**	**Year 50**	**Year 100**
Revenue	6.44	6.61	6.77	6.94	7.12	7.30	8.27	10.61
Direct Expenses	3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46
Contribution margin	2.99	3.15	3.31	3.49	3.66	3.84	4.81	7.15
Interest on investment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Return to land	**2.99**	**3.15**	**3.31**	**3.49**	**3.66**	**3.84**	**4.81**	**7.15**

5) Net returns from cereal grains and canola:

- Target yields of cereal grains and canola indicated in Table 6.8 are identical to those used in recent crop enterprise budgets for the B.C. Peace Region and Alberta Peace
- Prices of cereal grains and canola in 2011 shown in Table 6.8 are based on a 10 year average of historical prices from 2002 to 2011 (Statistics Canada 2012g), with all prices in the period of record converted to 2011 terms using FPPI for crops in western Canada prior to averaging
  - Prices have been projected to 2013 dollars based on recent trends in FPPI for crops in western Canada
  - After 2013, as shown in Tables 6.9 and 6.10, a real increase in all agricultural prices, and hence the value of gross cereal grains and canola revenues, of 0.5% per year for the next 99 years has been assumed, reflecting an optimistic scenario of improving terms of trade for agricultural products

Table 6.8: 2013 Net returns to land from cereal grains and canola production (Year 1 Dollars)

Parameter	Wheat	Barley	Oats	Canola	Cereal Grain Average
	Per Hectare				
Expected yield –tonnes	3.70	4.30	3.81	2.24	3.94
Expected market price per tonne	223.66	172.61	299.27	572.72	231.85
Revenues	826.93	742.62	1,139.99	1,283.34	912.60
Direct expenses	518.62	444.34	371.96	593.79	444.98
Contribution margin	308.30	298.27	768.03	689.56	467.63
Interest on Investment	17.91	17.91	17.91	17.91	17.91
Management	44.46	44.46	44.46	44.46	44.46
Depreciation	62.99	62.99	62.99	62.99	62.99
Net return to land	**182.95**	**172.92**	**642.67**	**564.20**	**342.28**

Table 6.9: Average cereal grain returns to land, Year 1 to Year 100 (Year 1 Dollars)

Cereal Grains								
Per Hectare	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**	**Year 50**	**Year 100**
Revenue	912.60	935.65	959.27	983.50	1,008.33	1,033.79	1,171.08	1,502.75
Direct Expenses	444.98	444.98	444.98	444.98	444.98	444.98	444.98	444.98
Contribution margin	467.63	490.67	514.30	538.52	563.36	588.82	726.10	1,057.78
Interest on investment	17.91	17.91	17.91	17.91	17.91	17.91	17.91	17.91
Management	44.46	44.46	44.46	44.46	44.46	44.46	44.46	44.46
Depreciation	62.99	62.99	62.99	62.99	62.99	62.99	62.99	62.99
Return to land	**342.28**	**365.32**	**388.95**	**413.17**	**438.00**	**463.46**	**600.75**	**932.43**

Table 6.10: Canola returns to land, 2013 Year 1 to Year 100 (Year 1 dollars)

	Canola							
Per Hectare	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**	**Year 50**	**Year 100**
Revenue	1,283.34	1,315.75	1,348.97	1,383.03	1,417.96	1,453.76	1,646.82	2,113.24
Direct Expenses	593.79	593.79	593.79	593.79	593.79	593.79	593.79	593.79
Contribution margin	689.56	721.96	755.19	789.25	824.17	859.98	1,053.03	1,519.45
Interest on investment	17.91	17.91	17.91	17.91	17.91	17.91	17.91	17.91
Management	44.46	44.46	44.46	44.46	44.46	44.46	44.46	44.46
Depreciation	62.99	62.99	62.99	62.99	62.99	62.99	62.99	62.99
Return to land	**564.20**	**596.61**	**629.83**	**663.90**	**698.82**	**734.62**	**927.68**	**1,394.10**

6) Net returns from vegetables:

- Based on the 1981 vegetable enterprise budgets, as modified by the BC Ministry of Agriculture Supplement to Blue Paper No. 1 and presented in Table 6.11
- Crop mix in 2013 to 2112 is as defined in BC Ministry of Agriculture Supplement to Blue Paper No.1, 1982, and is comprised of cabbage – 6.90%; turnips – 2.61%; sweet corn – 2.25%; potatoes – 76.64%; cucumbers – 1.87% and lettuce – 9.73%
- Crop prices and gross revenues adjusted to 2011$ using the FPPI for western Canada, and then projected to 2013 dollars using recent trends in the same index
- Production costs adjusted to 2011 dollars using FIPI for western Canada and then projected to 2013 dollars using recent trends in the same index
- Net return to land is calculated as gross revenue minus costs of production

Table 6.11: Vegetable returns to land, 2013 to 2112 (2013 dollars)

Per Acre	1981 ($)	Indices	Year 1	Year 5	Year 10	Year 15	Year 20	Year 25	Year 50	Year 100
Vegetables	**Blue Paper[a]**	**1981–2013[b]**								
Gross revenue	$2,442.84	2.02	$4,939	$5,063	$5,191	$5,322	$5,457	$5,594	$6,337	$8,132
Production expenses	$1,107.76	1.55	$1,717	$1,717	$1,717	$1,717	$1,717	$1,717	$1,717	$1,717
Gross margin	$1,335.08	N/A	$3,222	$3,346	$3,474	$3,605	$3,740	$3,877	$4,620	$6,415
Interest on investment[c]	$49.89	N/A	$73	$73	$73	$73	$73	$73	$73	$73
Management allowance [d]	$122.00	N/A	$902	$902	$902	$902	$902	$902	$902	$902
Depreciation[e]	$226.24	N/A	$157	$157	$157	$157	$157	$157	$157	$157
Return to land	**$936.95**	**N/A**	**$2,090**	**$2,215**	**$2,343**	**$2,474**	**$2,608**	**$2,746**	**$3,489**	**$5,284**

NOTES:
[a] Average weighted vegetable budget from the (then) BC Ministry of Agriculture and Food. 1982. Supplement to Blue Paper No.1: Agricultural Considerations. Appendix Table A-4 (BCMAF 1982)
[b] Revenues from 1981 are adjusted to 2013 dollars by applying a blended Farm Product Price Index (76.64% potatoes and 23.36% vegetables) for the period of 1982 to 2011 and then projected to 2013 dollars using recent trends in the same index. Production expenses from 1981 are adjusted to 2013 dollars by applying FIPI for crop production in western Canada for the period of 1982 to 2011 and the then projected to 2013 dollars using recent trends in the same index
[c] Interest cost is calculated from machinery and building asset values of a model 20 hectare vegetable farm in 1981 adjusted to 2013 dollars by using western Canada FIPI for machinery and western Canada FIPI for buildings for the period 1982 to 2011 and then projected to 2013 dollars using recent trends in the same indices. Interest on investment is calculated at a rate equal to the discount rate selected in the present value calculations for the first 50 years of project
[d] Per hectare return to management is based on a BC Ministry of Agriculture Farming for Profit: 2,500 Acre Grains and Oilseed Operation: Full Operation ,2008) indicating an expected whole farm management return of $45,000
[e] Depreciation is calculated from 2013 values of machinery and building assets at depreciation rates of 15 years for machinery, 30 years for buildings and 40 years for storage bins

7) Costs of production components:

- Direct or variable costs of production
- Return to management (included to ensure residual net return is a return to land only)
- Interest on investment (real interest rate equal to discount rate in first 50 years of the project)
- Depreciation (for ease of calculation, included here rather than having farm depreciable assets included as lump sum capital expenditures in the net present value calculations)
  - Forage, grains, and canola farm sizes in the Project activity zone are assumed to attain regional average farm sizes of approximately 1,000 ha
  - Vegetable farms are assumed to attain average farm sizes of approximately 20 ha
  - Direct production expenses are derived from enterprise budgets for the B.C. Peace Region and Alberta Peace

- Other costs are estimated from enterprise budgets for the B.C. Peace Region and Alberta Peace. These include allowances for management, depreciation, and interest on investment
- Costs are adjusted to 2011 dollars using FIPI for western Canada, and then projected to 2013 dollars using recent trends in the same index

8) Return to land:

- Net return to land is calculated as gross revenue minus costs of production

9) Social return to land adjustments:

- The social values of farming outputs produced in the Project activity zone are close to their market values due to the dismantling of government support systems in B.C. and Canadian agriculture. Subsidies to assist agriculture are no longer market or production based and programs providing such benefits have been terminated. In the current analysis, no adjustments have been made for subsidy programs
- Market distortion effects from foreign exchange benefits in traded production from the Project activity zone have been reduced in the last 30 years. Previous work (BCMAF 1981) added foreign exchange effects to adjust the market returns to land. B.C.'s share of the foreign exchange benefit in 1981 was estimated to be 1.656%, based on a Canadian estimate of 15%. In 1985, the social value of foreign exchange was estimated at 6.5% greater than the market exchange rate in Canada (Jenkins and Kuo 1985). More recent data (Industry Canada and the Centre for the Study of International Economic Relations 1995) indicates the shadow price of foreign exchange in Canada is only 3.5% to 4.5% above market rates, as export subsidies and import tariffs have declined. B.C.'s share of any likely foreign exchange benefit in 2012 is considered negligible. In the current analysis, no adjustment has been made for such minor foreign exchange benefits

10) Net present value of lost agricultural activity (in constant Year 1 dollars)

6.2.1 Net Present Value Base Case Assumptions

The base case valuation of foregone agricultural economic activity used the following assumptions:

- An analysis period of 100 years, starting with the start of Project construction
- 100% utilization of the farmland base over 100 years
- Scenario 2, which allows for 100 ha of vegetable production at full development
- Annual growth in the real value of agricultural production of 0.5%
- The following social discount rates:
  - Discount rate 1 (1 to 50 years) of 3.5%
  - Discount rate 2 (51 to 100 years) of 2.5%

As shown in Table 6.12, the present value of this base case is estimated to be $22.3 million (in Year 1 dollars).

Table 6.12 summarizes results of sensitivity tests adjusting the various parameters from those of the base case. In this sensitivity analysis, foregone agricultural returns range from a low of $13.0 million to a high of $36.6 million. This summary shows that the base case valuation is most sensitive to a) length of the period over which foregone benefits are calculated, b) the area of vegetable production included, and c) the length of the period over which the full development of the agricultural potential of the Project activity zone is assumed to occur.

Table 6.12: Summary of sensitivity analyses to varying the parameters

Parameter Varied (Others Held Constant, as in Base Case)	Economic Valuation (Year 1$)		
	Low	Base	High
Development scenario (1, 2, or 3)	$13.0	$22.3	$31.5
Development period (50, 100, or 150 years)	$17.2	$22.3	$31.0
Annual real growth rate (0.25%, 0.5%, or 0.75%)	$17.3	$22.3	$28.4
Foregone benefits period (100 years or in perpetuity)	N/A	$22.3	$36.6
Discount rate (base rate ± 0.5%)	$17.2	$22.3	$29.4

NOTES:
N/A – not applicable

The assumptions used in the sensitivity analyses and results are presented in the following section.

6.2.2 Net Present Value Sensitivity Tests

Estimates of the present value of the returns to agricultural land within the Project activity zone without the Project were based on the following assumptions:

- Future growth and development starts from the current level and type of agricultural activity
- Three scenarios of the pattern of future agricultural development are considered:
  - Scenario 1 is based on expansion of the current cropping mix, with no new crop types added. The total area in crops and the area of grazing both increase to the amounts shown in Table 6.1
  - Scenario 2 is identical to Scenario 1, except that vegetable production, increasing to 100 ha in Year 100, is included. The vegetable production is assumed to supplant an equal area of other crops
  - Scenario 3 is identical to Scenario 2, except that vegetable cropping reaches 200 ha by Year 100, supplanting an equal area of other crops
- Growth in agricultural use is assumed to occur at a constant rate over time. The sensitivity of the present value of agricultural effects to three different timeframes to full development have been considered:
  - 50 years
  - 100 years
  - 150 years

- Two time periods have been used to estimate foregone agricultural returns due to the project:
  - Period A: Project-related lost returns are calculated over a one hundred year horizon
  - Period B: Project-related lost returns are calculated in perpetuity
- The real terms of trade for agricultural products are assumed to improve by 0.5% per annum relative to the prices of all other products and services in the economy. This translates to real prices for agricultural products increasing at this rate. The sensitivity of the present value of displaced agricultural returns to changes in this rate has been examined using the following rates:
  - 0.25% annual growth rate
  - 0.5% annual growth rate
  - 0.75% annual growth rate
- For base case present value calculations the following social discount rates have been used:
  - Discount rate 1: 3.5% per annum for displaced agricultural returns within the first 50 years following project implementation
  - Discount rate 2: 2.5% per annum for the foregone returns in the second 50 years
  - Discount rate 3: 2% per annum for the foregone returns in the second 100 year period following project implementation (Period B only)
  - Discount rate 4: 1.5% per annum for any foregone returns after 200 years (Period B only)
- The sensitivity of present value calculations for both Periods A and B to the choice of discount rates has been assessed, assuming:
  - Discount rate 1 applying to years 1 to 50 varies between 3% and 4%
  - Discount rate 2 applying to years 51 to 100 varies between 2% and 3%
  - Discount rate 3 applying to years 101 to 200 is set at 2% (not varied)
  - Discount rate 4 applying to years 200+ is set at 1.5% (not varied)

Tables 6.13 to 6.18 present the results of a series of sensitivity tests. The results show the sensitivity of the net present value of foregone benefits to changes to key parameters in the base case, where the value of one key parameter is varied and all others in the base case are held constant. As the individual parameters are varied, the valuations range from a high estimate of $ 36.9 million to a low estimate of $13.1 million.

Table 6.17 co-varies the social discount rates in years 1 to 50 and years 51 to 100, where the discount rate in years 51 to 100 is 1% lower than the discount rate in years 1 to 50.

Table 6.18 shows that modifying the project horizon in the base case to Period B (in perpetuity) and varying the discount rates generates a range of estimated foregone benefits between $26.2 million and $53.1 million.

Table 6.13: Sensitivity analysis of base case to varying the development scenario

Parameter	Economic Valuations for Development Scenario of:		
	Scenario 1	**Scenario 2**	**Scenario 3**
Development period	100 years	100 years	100 years
Annual real growth rate	0.50%	0.50%	0. 50%
Foregone benefits period	Period A	Period A	Period A
Discount rate 1 (years 1–50)	3.5%	3.5%	3.5%
Discount rate 2 (years 51–100)	2.5%	2.5%	2.5%
Present Value (millions Year 1$)	$13.0	$22.3	$31.5

Table 6.14: Sensitivity analysis of base case to varying the development period

Parameter	Economic Valuations for Development Period of:		
	150 years	**100 years**	**50 years**
Development scenario	Scenario 2	Scenario 2	Scenario 2
Annual real growth rate	0.50%	0.50%	0. 50%
Foregone benefits period	Period A	Period A	Period A
Discount rate 1 (years 1–50)	3.5%	3.5%	3.5%
Discount rate 2 (years 51–100)	2.5%	2.5%	2.5%
Present Value (millions Year 1$)	$17.2	$22.3	$31.0

Table 6.15: Sensitivity analysis of base case to varying the annual real growth rate

Parameter	Economic Valuations for Annual Real Growth Rate of:		
	0.25%	**0.50%**	**0. 75%**
Development scenario	Scenario 2	Scenario 2	Scenario 2
Development period	100 years	100 years	100 years
Foregone benefits period	Period A	Period A	Period A
Discount rate 1 (years 1–50)	3.5%	3.5%	3.5%
Discount rate 2 (years 51–100)	2.5%	2.5%	2.5%
Present Value (millions Year 1$)	$17.3	$22.3	$28.4

Table 6.16: Sensitivity analysis of base case to varying the period over which foregone benefits are calculated

Parameter	Economic Valuations for Foregone Benefits Period of:	
	100 Year Period (Period A)	In Perpetuity (Period B)
Development scenario	Scenario 2	Scenario 2
Development period	100 years	100 years
Annual real growth rate	0.50%	0. 50%
Discount rate 1 (years 1–50)	3.5%	3.5%
Discount rate 2 (years 51–100)	2.5%	2.5%
Present Value (millions Year 1$)	$22.3	$36.6

Table 6.17: Sensitivity analysis of base case to varying discount rates

Parameter	Economic Valuations for Discount Rate (Years 1–50) of:		
	4.0%	3.5%	3.0%
Development scenario	Scenario 2	Scenario 2	Scenario 2
Development period	100 years	100 years	100 years
Annual real growth rate	0.50%	0.50%	0. 50%
Foregone benefits period	Period A	Period A	Period A
Discount rate 2 (years 51–100)	3.0%	2.5%	2.0%
Present Value (millions Year 1$)	$17.2	$22.3	$29.4

Table 6.18: Sensitivity analysis of base case with period b to varying discount rates

Parameter	Economic Valuations for Discount Rate (Years 1–50) of:		
	4.0%	3.5%	3.0%
Development scenario	Scenario 2	Scenario 2	Scenario 2
Development period	100 years	100 years	100 years
Annual real growth rate	0.50%	0.50%	0. 50%
Foregone benefits period	Period B	Period B	Period B
Discount rate 2 (years 51–100)	3.0%	2.5%	2.0%
Present Value (millions Year 1$)	$26.2	$36.6	$52.7

7.0 FOOD PRODUCTION AND CONSUMPTION BASELINE

This section describes the baseline food production and consumption information. While the primary focus of this portion of the assessment is food self-reliance in the Peace Agricultural Region, provincial food self-reliance information is presented to provide context. For the following regional and provincial descriptions of food self-reliance, the effects of anticipated changes in population, agricultural practices and climate are examined.

The following sources of information were used in the assessment of food production and consumption:

- *Valuing Food: The Economic Contribution of Canada's Food Sector* (Conference Board of Canada 2011)
- *Food and Agriculture: The Future of Sustainability* (Giovannucci, et al. 2012)
- *Climate Change and Food Security in British Columbia* (Ostry, et al. 2011)
- *Food prices and food security* (Ivanic and Martin 2008)
- Trade liberalization and food security: conceptual links, in *Trade Reforms and Food Security* (FAO 2003)
- Trade and food security: Options for developing countries, in *Multilateral Trade Negotiations on Agriculture: A Resource Manual* (FAO 2000)
- Food security: contributions from science to a new and greener revolution, in *Philosophical Transactions of the Royal Society* 365 (Beddington 2010)
- Food security and climate change: on the potential to adapt global crop production by active selection to rising atmospheric carbon dioxide, in *Proceedings of the Royal Society* 279 (Ziska, et al. 2012)
- *Toward a Typology of Food Security in Developing Countries* (Yu, et al. 2010)
- Food security and growth: Malaysia's strategic approach and future adjustments, in *Food Security Malaysia* (Wong 2007)
- Managing food production systems for resilience, in *Principles of Natural Resource Stewardship: Resilience-Based Management in a Changing World* (Naylor 2008)
- *Thoughts on Regional Food Security & Self-Reliance* (Penfold 2009)
- *Local Food and Agriculture: Six Questionable Assumptions* (Penfold 2010)
- *Rethinking Britain's Food Security* (Barling, et al. 2008)
- *Food Scarcity - A Myth?* (Scholz 2011)
- *Sustainable Agriculture and Food Security in Asia and the Pacific* (UNESCAP 2009)
- *Food Crisis: Causes, Consequences and Alternatives. International Viewpoint Online Magazine* (Vivas 2009)
- *Finding Common Ground Between Food Security and Sustainable Food Systems* (Lezburg 1999)
- *Grain & Oilseed Production, Peace Region: Snapshot Report* (BCMA 2012)

- *BC's Food Self-Reliance: Can BC's Farmers Feed our Growing Population?* (BCMAL 2006)
- *Canada's Action Plan for Food Security (1998)* (Government of Canada 1998)

In addition, the subject of food production and consumption was discussed with staff of the BC Ministry of Agriculture, Director Sustainable Agriculture Development (2012a pers. comm.), Range Agrologist (2012b pers. comm.) and the ALC, Commissioner North Panel 2012 pers. comm.

7.1 Provincial Food Self-Reliance

Food self-reliance is defined as a measure of primary farm gate production in relation to the food needs of the population. In 2006 (BCMAL 2006) it was estimated, using Agricultural Census information (Statistics Canada 2012b), combined with data on food availability for consumption (Statistics Canada 2004)[18], as well as industry consultations on agricultural yields and production, that "… BC farmers produce 48% of all foods consumed in BC and produce 56% of foods consumed that can be economically grown in BC" (BCMAL 2006). With respect to self-reliance trends, the study also noted that "…While it is difficult to summarize across studies that use different methodologies, the various analysis (sic) of B.C.'s food self-reliance indicate BC is at best maintaining past levels of self-reliance" (BCMAL 2006)

Provincial food self-reliance is not independent of the federal approach to food security. Canada's food security strategy is a global commitment that includes enhancing trade in the food and agri-food sectors as a way of reducing vulnerability to food insecurity (Government of Canada 1998). Canada supports fair trade rules and environmentally sustainable trade practices as the means toward increasing food security, rather than agricultural protectionism and promotion of food self-sufficiency (Government of Canada 1998).

7.1.1 Food Consumption in British Columbia

Food availability statistics are compiled for Canada on an annual basis (Statistics Canada 2010). For this assessment, Canadian food availability trends are assumed to be applicable to B.C.

Table 7.1 shows Canadian per capita food availability for 2001 and 2010. Food availability is the annual amount of food that is available for consumption from the Canadian food supply after adjusting for exports, manufacturing uses, animal feeds, waste, and changes in inventory. The statistics in the table do not account for losses in stores, households, private institutions, or restaurants (i.e., the per capita amounts shown in the table include such losses). The food availability data is assumed to be a reasonable proxy for food consumption in Canada and hereafter, in this report, the terms "availability" and "consumption" are used interchangeably.

[18] The data provide measures of food availability for consumption per person in Canada. Food availability was used as a proxy for food consumption in the 2006 report and the same approach is applied in this analysis.

Table 7.1 shows that per capita consumption of fruit, poultry, and pulses and nuts has increased between 2001 and 2010. At the same time, per capita consumption of vegetables, dairy products, red meats, and most other food groups has declined.

Table 7.1: Canadian per capita food consumption[a], 2001 and 2010

Food Group	2001	2010[b]	Percent By Food Group	Percent Change 2001 to 2010
	Kilograms per Capita			
Total fruits – fresh equivalent	124.07	130.17	22.4%	4.9%
Total vegetable – fresh equivalent	192.19	173.06	29.8%	-9.9%
Total dairy products – milk solids	23.78	21.72	3.7%	-8.7%
Eggs	10.83	16.39	2.8%	51.4%
Red meats (carcass)	62.83	52.71	9.1%	-16.1%
Poultry (eviscerated)	36.46	37.82	6.5%	3.7%
Fish	9.65	7.70	1.3%	-20.2%
Total oils and fats	30.90	24.57	4.2%	-20.5%
Total cereal products	84.03	76.95	13.2%	-8.4%
Total pulses and nuts	9.21	8.51	1.5%	-6.4%
Total sugars and syrups	35.38	31.24	5.4%	-11.7%
Total Per Capita Consumption[c]	619.12	580.84	N/A	-6.2%

NOTES:
[a] Food consumption is defined as equivalent to the definition of food availability in the CANSIM publication outlined below
[b] This data series was terminated in 2010
[c] Does not include alcoholic beverages
SOURCE:
Statistics Canada (2012e)

7.1.2 Maintaining Current Levels of Food Self-Reliance in the Province

Over time, changes in provincial food self-reliance will be determined primarily by changes in population and changes in productive capacity. Other factors, such as changes in eating habits, could also affect self-reliance estimates, but such changes tend to be more gradual and usually involve offsetting shifts within the food groups consumed. The above-noted 2006 study on B.C.'s food self-reliance concluded that 2001 levels of provincial self-reliance could be maintained through to 2025 by increasing the area of farmland in food-related production by 30% over 2001 levels. This increase could be achieved by various means including:

- Increasing production area by 30% with a corresponding increase in irrigated area
- Increasing irrigation by 49% over 2005 levels (holding land area constant)
- Improving crop management and use of higher yielding crops and varieties on the current irrigated land base to increase production by 30%

Assuming no substantial change in per capita consumption, the required increase in production to maintain 2001 levels of self-reliance corresponds to an expected population growth rate of about 1% annually.

7.1.2.1 Anticipated Changes in Provincial Food Self-Reliance in Relation to Population Growth

The analysis in a following section concludes that the level of food self-reliance in B.C. in 2011 is marginally higher than the level in 2001, at least for food crops that are grown for direct human consumption. This result occurred despite a small decrease in land in crops and no appreciable change in the area of farmland irrigated. Increased production of fruit, vegetables, grains, and oilseeds, coupled with an apparent 6% decrease in overall per capita food consumption (assuming B.C. per capita consumption followed the general trend in Canada), more than offset the additional food demand from an increasing resident population.

B.C.'s population is projected to further increase by 34.3% between 2011 and 2036, which represents an average annual increase of about 1% (BC Stats No Date), or about the same rate of increase as experienced in the 2001 to 2011 period. Going forward, population growth is anticipated to be the single largest factor affecting aggregate provincial demand for food. Compounding the effect of any increase in population is the fact that long term overall per capita consumption is also expected to increase (Serecon Management Consulting Inc. 2005). While gains in crop yields can be expected to meet some of the projected increasing provincial demand for food, clearly additional land will need to move into food crop production if historical levels of food self-reliance are to be maintained.

7.1.2.2 Anticipated Changes in Provincial Food Self-Reliance in Relation to Land in Crops and Irrigated Farmland

Table 7.2 shows that between 2001 and 2011, B.C. irrigated farmland area did not change while the area of land in field crops declined 4.9%.[19] The total area of land on Census farms increased less than 1% between 2001 and 2011.

It is anticipated that the economics of food markets will be the major determinant governing whether additional lands are switched or developed for food crop production or if more crop land is put under irrigation in the future. In B.C., provincial food self-reliance has historically been constrained by the relative ease of provincial residents to access and afford reasonably priced, high quality, imported food year-round, coupled with the low returns associated with growing most food products in the province. As such, the level of current food self-reliance is a function of market dynamics as farmers seek the most economical crops to grow and enterprises to operate.

[19] Note that this figure includes land in nursery, sod, Christmas tree, floriculture and horse production, which in 2001 was estimated at 151,932 ha or 17% of the land in crops. Since the use of farmland is market driven, it could be available for food crops if it becomes profitable to do so.

Table 7.2: B.C. total farm area, land in crops, irrigated area, 2001 – 2011, and projected population changes to 2036

Year	Total Area of Farms (ha)	Land in Crops[a] (ha)	All Irrigated Area[b] (ha)	Population (millions)[d]
2001[c]	2,587,118	887,354	111,181	4.076
2006[c]	2,835458	857,612	118,538	4.243
2011[c]	2,611,383	843,808	111,139	4.584
2036	NA	NA	NA	6.156
Change (2001 to 2011)	0.9%	-4.9%	-0.06%	+12.5%
Change (2011 to 2036)	NA	NA	NA	+34.3%

NOTES:
[a] Land in crops includes land in food and non-food crops, tame and seeded pasture, and summer fallow
[b] Irrigation is for the year previous to the Census, i.e., 2000 and 2010
[c] Statistics Canada Agricultural Census data (Statistics Canada 2012a, 2012b)
[d] BC Stats (No Date)

Increased greenhouse production is currently capable of generating high levels of food self-reliance for a limited number, but important, group of vegetable crops, consisting of tomatoes, peppers, cucumbers, and lettuce.

7.1.2.3 Anticipated Changes in Provincial Food Self-Reliance in Relation to Climate Change

It is expected that global climate change will change the conditions for agriculture within regions of the province. According to a climate change action plan prepared by the provincial Ministry of Agriculture and Land (BC Agriculture and Food 2010):

> "Some research predicts BC will experience increasing agricultural capability and a broader range of suitable crops. However, it is likely that climate change will increase uncertainty and the costs associated with weather damage for BC's agricultural operations."

The direction of the potential net effect of climate change on provincial food self-reliance has yet to be determined. There is concern that the current world food supply system will be disrupted by climate change, creating global food security issues. With appropriate provincial and federal food strategies,[20] B.C.'s food self-reliance could increase if the agricultural sector takes a more prominent role in the global food supply system.

[20] These responses include making strategic adaptations that increase the tools available to agricultural producers to manage climate change and adopting mitigation measures to reduce agriculture's carbon footprint while creating economic opportunities for doing so.

7.1.3 Specific Provincial Self-Reliance Indicators

Table 7.3, based on the 2006 BC Food Self-Reliance Report, presents an estimate of 2001 B.C. self-reliance by food group. Overall, B.C. was estimated in that report to be 56% self-reliant in foods that can be commercially grown in the province and 48% self-reliant in terms of all foods consumed. B.C. was more than completely self-reliant in fruit capable of being economically grown in the province but has relatively low food grain self-reliance.

Table 7.3: BC food self-reliance estimate, 2001

Food Group	BC Consumption ('000 tonnes)	BC Production ('000 tonnes)	% Self-Reliant
Dairy	1,080	617	57%
Meat and Alternatives	467	298	64%
Vegetables – Grown in BC	764	331	43%
Fruit – Grown in BC	172	273	159%
Grain for Food – Grown in BC	315	43	14%
Fats & Oils – Grown in BC[a]	110	5	5%
Sugars – Grown in BC [a]	3.5	1.5	43%
Total – Grown in BC[b]	**2,798**	**1,562**	**56%**
Fruit – Not Grown in BC	310	0	0
Vegetables – Not Grown in BC	1	0	0
Grain For Food – Not grown in BC [a]	31	0	0
Fats & Oils – Not grown in BC [a]	N/A	0	0
Sugars – Not grown in BC	136	0	0
Total – BC [b]	**3,245**	**1,562**	**48%**

NOTES:
[a] These figures are not reported in the BC Food Self Reliance Report but are contained in its Appendix Tables
[b] Totals do not include categories associated with note a
SOURCE:
Modified from BCMAL (2006)

While B.C., in 2001, was over 100% self-reliant in the production of fruits that can be grown in the province, about two thirds of total fruit consumption consisted of fruits that cannot be grown in B.C. due to climate. Self-reliance in meat and in protein alternatives such as pulses and nuts was estimated at 64% in 2001, though within that category B.C. was 100% self-reliant in poultry meat, egg products, and fish. In comparison, B.C. was only 57% self-reliant in dairy products because of the high consumption of processed dairy products originating from outside of the province in 2001.

It should be noted that any potential to increase provincial production in dairy, poultry meat, and eggs is constrained by the supply management schemes operating in B.C., which limit growth in primary production in these foods to changes in resident demand.

In 2001 as well, B.C. was moderately self-reliant in sugars that could be grown in B.C., such as honey (43%), only about 14% self-sufficient in cereal products, and exhibited low (5%) self-reliance in the fats and oils and food grains.

The 2006 BC Self-Reliance Report serves as a good starting point for an examination of provincial food self-reliance since 2001 and into the future. Using the same assumptions and methodology, estimates of food

self-reliance have been made for 2011, the most recent year for which production and consumption statistics are available.

After carrying out minor adjustments and corrections,[21] Table 7.4 summarizes revised 2001 findings for the BC Self-Reliance Report, focusing on food groups that are most dependent on the supply of good quality agricultural land. As such, dairy, poultry, meat and fish values have been left out of the aggregated self-reliance indicators.

With the adjustments overall B.C. self-reliance, for the subset of food groups selected, is estimated to be 50% for foods that can be commercially grown in the province and 37% in terms of all food crops consumed within these food groups. The adjustments result in a slightly lower level of self-reliance in vegetables and a somewhat higher level of self-reliance in fruits than indicated in the original report.

Table 7.4: BC food self-reliance by selected food groups, 2001 and 2011

Food Group	BC Food Availability 2001[a] ('000 tonnes)	BC Production 2001[b] ('000 tonnes)	Percent Self-Reliant 2001	BC Food Availability 2011[c] ('000 tonnes)	BC Production 2011[d] ('000 tonnes)	Percent Self-Reliant 2011
Food Crops Grown in BC[h]						
Vegetables	775	314	41%	767	319	42%
Fruits	175	335	191%	219	355	162%
Grain for Food	315	40	13%	311	45	15%
Sugars	3.5	1.5	43%	3.8	1.8	46%
Fats and oils	110	5	5%	110	8	7%
A. Food Crops Grown in BC[e]	**1,378**	**695**	**50%**	**1,411**	**729**	**52%**
Food Crops Not Grown in BC[h]						
Vegetables	1	N/A		1	N/A	
Fruits	347			394		
Grains	31			31		
Sugars	135			139		
B. Food Crops Not Grown in BC (5)	**514**			**565**		
Total of Food Crops (A+B)	**1,892**	**695**	**37%**	**1,976**	**729**	**37%**
Fish	38	179	474%	44	NA	NA
Dairy products[f]	1,080	617	57%	NA	NA	NA
Meat & protein alternatives[g]	467	298	64%	484	NA	NA

NOTES:
[a] Food consumption is based on 2001 per capita Canadian food availability for various food commodities converted to fresh weight equivalents for fruits, vegetables and grains, weight of milk equivalent for dairy products, carcass weights of red meats and eviscerated weights of poultry
[b] B.C. food production is based on 2001 Agricultural Census for crop areas, average industry harvest yields
[c] 2011 food availability is calculated from 2011 per capita food statistics
[d] 2011 food production is calculated from the 2011 Agricultural Census using yield coefficients from the 2006 BC Food Self-Reliance report.
[e] Adjustments have been applied to data from the 2006 report (see footnote, above)
[f] Milk - litre equivalent
[g] Includes fresh carcass red meat weights, eviscerated poultry weights, fresh fish weights and weights of harvested pulses and nuts
[h] Fresh weight equivalent
SOURCE:
Modified from BCMAL (2006)

[21] These modifications include: i) Inclusion of immature crop areas that are not yet in production into the production base; ii) downward adjustment of the vegetable area to eliminate double counting; iii) use of revised per capita consumption estimates; correction of mathematical errors; v) adjustment of yields; vi) separation out of additions of mixed units of measurement; vii) Areas of non-producing fruits and vegetables have been included in the calculations.

7.1.4 Changes in Provincial Food Self-Reliance Since 2001

Table 7.4 also presents estimates of 2011 food self-reliance for the selected food groups. Although the B.C. population increased 17.3% in the period between 2001 and 2011, growth in production of most food crop food groups kept pace with the result that self-reliance essentially did not change over the period. Farm-level economic factors have led to increased areas of fruit and vegetable production. Improved markets for grains and oilseeds have increased self-reliance in grains and fats and oils over 2001 levels, although much of this production is destined for export.

An additional factor affecting these results was that per capita food consumption dropped overall and within several food groups, most notably in the vegetable, red meat, fish, cereals, sugars, and oils and fats food groups. One exception to this trend is for the fruits food group, in which provincial self-reliance declined, although still staying well above 100%. For this group, the growth in production was outpaced by growth in per capita consumption of fruits not grown in B.C.

Over 99% of the vegetables consumed in the province, but only 34% of the fruits consumed, are capable of being produced in the province. Considering only the vegetables and fruits capable being grown in B.C., it is estimated that in 2011 B.C. produced the equivalent of about 42% of the consumed vegetables and over 100% of the fruit consumed.

Table 7.5 presents estimates of the field area of vegetables and fruits that would have been required in 2011 to meet B.C. weight equivalents in food consumption of crops that could be grown in the province, based on average crop yields. This estimate excludes consideration of the production and consumption of greenhouse tomatoes, peppers, cucumbers, and lettuce and mushrooms in B.C., since these crops are not soil-based. In 2011, these crops represented about 43% of all the vegetable production in the province.

In 2011, 50% food self-reliance in vegetable crops capable of being grown in the province would have been attained with an additional 1,195 ha of vegetables with no requirement for additional fruit area. In order to attain 100% self-reliance at 2011 levels of food consumption, B.C. required about 14,000 more ha of vegetable area. There was no requirement for additional fruit area to maintain 100% food self-reliance in fruits in 2011.

Table 7.5: Estimated areas of vegetables and fruits required to increase BC Food self-reliance for those crops that can be grown in the province, 2011

Food Group	BC Availability 2011 ('000 tonnes)	BC Production 2011 ('000 tonnes)	Current Ha (2011)	Average Yield Per Hectare (tonnes - all crops)	Additional Ha to Provide 50% Food Self-Reliance	Additional Ha to Provide 100% Food Self-Reliance
Vegetables – field grown in BC	654[a]	137[a]	9,478	19.13	1,195	13,995
Fruits – field grown in BC	219	355	24,494	14.49	0	0

NOTES:
[a] BC production of greenhouse tomatoes, cucumbers, peppers, lettuce and mushrooms have been taken out of both the vegetable demand and supply calculations since these crops are not field grown

7.2 Peace Agricultural Region Food Self-Reliance

It is not particularly meaningful to discuss the food self-reliance status of the Peace Agricultural Region outside of the context of the province since, while the regional land base is capable of producing a wide range of food products, actual use is driven by a combination of political, regional development and food market economic forces. Land use evolved into its current mix of grain and oilseed production, together with beef operations, in response to market factors, production risks, and agronomic conditions favouring certain agricultural commodities. The export market orientation of the region is based on its comparative advantage as a relatively low cost beef production area, together with the fact that a large proportion of the farmland is well suited to production of the feed crops needed by beef enterprises, as well as cereal crops, canola, field peas and fescue seed, most of which has traditionally been exported. Although the Peace Agricultural Region has a low level of food self-reliance in several food groups, the population of the area is very small compared to the overall food production and therefore the region has a relatively high level of overall food self-reliance.

Foods such as poultry, dairy, and fruit, in which B.C. has a relatively high level of self-reliance, are foods for which the Peace Agricultural Region has a low level of self-reliance. Conversely, the Peace Agricultural Region has a level of self-reliance for beef, grains and oilseeds that exceeds 100% several times over, while B.C. as a whole has a relatively low level of self-reliance in these food groups.

7.2.1 Maintaining Current Levels of Food Self-Reliance in the Peace Agricultural Region

Over time, changes in Peace Agricultural Region food self-reliance will be determined primarily by changes in population and changes in food production capacity. Other factors such as changes in eating habits could also affect self-reliance calculations.

7.2.1.1 Anticipated Changes in Peace Agricultural Region Food Self-Reliance in Relation to Population Growth

The level of food self-reliance in the Peace Agricultural Region in 2011 appears to be lower than the level in 2001 due to a small decrease in the area in crops, a small reduction in the area of irrigated farmland, and an increasing resident population. The Peace Agricultural Region's population is projected to increase by a further 32% between 2011 and 2036 (BC Stats No Date) and will be the single largest factor affecting future Peace Agricultural Region food demand.

The Peace Agricultural Region food requirement in 2011, based on the region's proportion of the population of B.C., but not taking possible regional differences in food consumption patterns into account, represents about 1.5% of the provincial food requirement.

7.2.1.2 Anticipated Changes in Peace Agricultural Region Food Self-Reliance in Relation to Land in Crops and Irrigation Use

Table 7.6 shows that between 2001 and 2011, the area of land in crops in the Peace Agricultural Region decreased by 3%, in step with a 4% decline in the total area of land reported on Census farms. Irrigation declined substantially in recent years, however, irrigation varies substantially from year to year, being used on a very small portion of the regional cropland and as a last resort in particularly dry years. Currently, the use of irrigation in the region appears to be more a strategy to avoid critical losses rather than enhance cropping revenues.

There is potential for a large increase in overall Peace Agricultural Region food self-reliance through the increased regional use of what it currently produces. Increased local meat production and more cash crop production would increase regional self-reliance indicators. However, these opportunities are fundamentally related to the economics of being able to compete with imported products.

Table 7.6: Peace Agricultural Region land in crops, irrigated area, projected population changes

Year	Total Area of Farms (ha)	Land in Crops[a] (ha)	All Irrigated Area[b] (ha)	Population ('000s)[d]
2001[c]	868,599	279,396	421	62.2
2006[c]	892,903	255,820	1,083	65.6
2011[c]	831,566	270,506	51	70.6
2036	NA	NA	NA	93.1
Change (2001 to 2011)	-4%	-3%	NA	13.6%
Change (2011 to 2036)	NA	NA	NA	31.9%

NOTES:
[a] Land in crops includes land in food and non-food crops, tame and seeded pasture, and summer fallow.
[b] Irrigation is for the year previous to the Census, i.e., 2000, 2005, and 2010.
[c] Statistics Canada Agricultural Census data (Statistics Canada 2012a, 2012b).
[d] BC Stats (No Date)

7.2.1.3 Anticipated Changes in Peace Agricultural Region Food Self-Reliance in Relation to Global Climate Change

The anticipated increase in the frost-free period and the number of growing degree days will improve agricultural capability and increase the potential for agricultural production.

The direction of the potential net effect of climate change is toward increased regional food self-reliance and the potential for the Peace Agricultural Region to supply more food to the rest of the province, as well as increased exports to the rest of the world.

7.2.2 Specific Peace Agricultural Region Self-Reliance Indicators

Table 7.7 indicates that Peace Agricultural Region food production is concentrated in the production of a few major groups of the provincial food supply. The Peace Agricultural Region produces more grains, food oils (e.g., canola), and sugars (e.g., honey) than it consumes. Historically, dependence on imported vegetables and fruits has always been high.

While data on current meat production in the Peace Agricultural Region is complicated by the export of younger cattle out of the region for finishing and slaughter elsewhere, the region is completely self-reliant in forage and feed grains many times over and could therefore support substantially more red meat production if it were economical to do so.

While not self-reliant in dairy, poultry meat, and egg products, there is also opportunity to expand poultry production in the Peace Agricultural Region.

Table 7.7: Estimated Peace Agricultural Region food self-reliance by selected food group, 2001 and 2011

Food Group	Peace Region Food Availability 2001[a] ('000 tonnes)	Peace Region Production 2001 ('000 tonnes)	Percent Self-Reliant 2001	Peace Region Food Availability 2011 ('000 tonnes)	Peace Region Production 2011 ('000 tonnes)	Percent Self-Reliant 2011
Vegetables – grown in the Peace	8.16	3.89	48%	8.47	0.46	5%
Fruits – grown in the Peace	0.16	0.04	24%	0.36	0.16	45%
Grains – grown in the Peace	4.53	28.73	635%	4.82	34.68	719%
Sugars – grown in the Peace	0.05	0.21	409%	0.06	0.08	143%
Fats and oils – grown in the Peace	1.58	4.83	306%	1.71	7.20	422%
Vegetables – not grown in the Peace[b]	1.78	N/A		3.66	N/A	
Fruits – not grown in the Peace[b]	5.88			9.02		
Grains – not grown in the Peace	0.45			0.48		
Sugars – not grown in the Peace	1.94			2.45		
All vegetables	9.94	3.89	39%	12.12	0.46	4%
All fruits	6.04	0.04	1%	9.37	0.16	2%
All grains for food	4.97	28.73	578%	5.30	34.68	655%

NOTES:
[a] See Table 6.4, above, for explanation of terms and assumptions.
[b] Some fruits and vegetables grown in B.C. are not grown in the Peace Agricultural Region

7.2.3 Changes in Peace Agricultural Region Food Self-Reliance Since 2001

Table 7.7 also indicates that production of food grains, food oils and fats, and sugars has increased in the Peace Agricultural Region and food self-reliance has maintained high levels in these food groups between 2001 and 2011. In the same period, combined imports of vegetables and fruits into the Peace Agricultural Region increased and exceeded 95% of the food consumed in these food groups. Production of vegetables decreased (loss of potato area) while production of fruit (primarily saskatoon berries) increased.

About 75% of the vegetables and approximately 3.5% of the fruits consumed in the Peace Agricultural Region is capable of being field produced in the region. In 2011, it is estimated that vegetables and fruits being grown in the Peace Agricultural Region represented about 5% and 45% of total consumption of vegetables and fruits capable of being grown in the region, respectively.

Table 7.8 presents estimates of the crop area of vegetables and fruits that would be required in 2011 to meet Peace Agricultural Region weight equivalents in food consumption of crops that could be grown in the Peace Agricultural Region. A very high proportion of fruits consumed in the Peace Agricultural Region cannot be commercially grown in the region.

In 2011, 50% food self-reliance of fruits and vegetables capable of being grown in the Peace Agricultural Region would have been attained with an additional 227 ha of vegetables and 2 ha of fruits. In order to attain 100% self-reliance at 2011 levels of food consumption, the Peace Agricultural Region required 483 more ha of vegetable area and 22 more ha of fruits.

Table 7.8: Estimated areas of vegetables and fruits required to increase regional food self reliance in those crops that can be grown in the Peace Agricultural Region, 2011

Food Group	Peace Region Availability 2011 ('000 tonnes)	Peace Region Production 2011 ('000 tonnes)	Current Ha (2011)	Average Yield Per Hectare (tonnes - all crops)	Additional Ha to Provide 50% Food Self-Reliance	Additional Ha to Provide 100% Food Self-Reliance
Vegetables – grown in the Peace	8.47	0.46	28	16.58	227	483
Fruits – grown in the Peace	0.35	0.16	18	8.87	2	22

8.0 CLOSURE

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APPENDIX A

Climatic Moisture Deficit MD Calculations

CLIMATIC MOISTURE DEFICIT MD CALCULATIONS

The following provides a step by step description of the moisture deficit calculations which are summarized in Section 3.1.3

1) Daily potential evapotranspiration from May to September, 2011 was calculated for each of the six BC Hydro climatological stations for which temperature, precipitation, and radiation data were collected, using the Priestley and Taylor formulation (Priestley & Taylor, 1972). This approach has been shown to accurately estimate potential evapotranspiration from a forage crop in the Peace River region of British Columbia (Davis & Davies, 1981; Davis, 1978), as shown on Figure A.1.

$$LE_0 = \alpha (s / s + \gamma) * (R_n - G) \qquad \text{\{Eq. 1\}}$$

where: L = latent heat of evaporation for water
E_0 = potential evaporation
s = slope of the saturation vapour pressure-temperature curve
γ = psychrometric constant
R_n = net radiation flux at the surface
G = soil heat flux
α = the Priestley and Taylor proportionality constant (shown to have a value close to 1.26 in studies in the Peace River region (Davis & Davies, 1981) and elsewhere.

The slope of the saturation vapour pressure-temperature curve (s) was calculated using Eq. 13 in the FA0 Crop Evapotranspiration Guidelines (FAO, 1998) as follows:

$$s = (4098 * (0.6108 * \exp((17.27 * T) / (T + 237.3))) / (T + 237.3)^2 \qquad \text{\{Eq. 2\}}$$

where: T = air temperature {^oC}

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

Net radiation and ground heat flux were measured directly at BC Hydro stations 1, 4, and 7.

Net radiation was estimated at stations 2, 3, and 5 as follows:

$$R_n = 0.559 * R_s - 17.9 \ \{W/m^2\};\ r^2 = 0.86 \qquad \text{\{Eq. 3\}}$$

where: Rs = solar radiation flux at the surface

This equation was developed as a linear regression comparing net radiation as the dependent variable to solar radiation as the independent variable, for the period of May to September. Solar radiation was measured at all six BC Hydro stations during 2011. This regression analysis resulted in an $r^2 = 0.86$.

Ground heat flux was estimated a stations 2, 3, and 5 as follows:

$G = 0.0297 * R_n$ {W/m^2}; $r^2 = 0.48$ {Eq. 4}

This relationship was calculated as the ratio of ground heat flux to net radiation for the period May to September, 2011 from the daily data at stations 1, 4, and 7.

2) Long-term average potential evapotranspiration for the May to September period was estimated for the six BC Hydro climatological station locations by comparing the 2011 evapotranspiration data calculated in Step 1 above, to "average" evapotranspiration estimates calculated from solar radiation data available for Fort St. John from the 'Canadian Weather Year for Energy Calculations' (CWEC) dataset available from Environment Canada (http://climate.weatheroffice.gc.ca/prods_servs/index_e.html). This dataset was created by joining twelve 'typical meteorological months' selected from a database of 30 years of CWEEDS data. The months were chosen by statistically comparing individual monthly means with long term monthly means for daily total global radiation, mean, minimum and maximum dry bulb temperature, mean, minimum and maximum dew point temperature, and mean and maximum wind speed. Average daily potential evapotranspiration was calculated for Fort St. John using the Priestley and Taylor approach [i.e., Eq. 1].

3) Solar radiation data for 2011 for Fort St. John was not available at the time this analysis was done, meaning that it was not possible to develop a direct correlation between evapotranspiration at the six BC Hydro station locations and the Fort St. John weather station for that year using the Priestley and Taylor approach. Instead, a linear regression correlation between the Priestley and Taylor approach and an average of Baier and Robertson's equations 1 and 7 (Baier & Robertson, 1965) was developed from 2011 data at those BC Hydro stations measuring net radiation directly (Stations 1, 4, and 7) as shown on Figure A.2. This resulted in the following relationship:

$LE_0 = .81* (B\&R) + .17$; $r^2 = 0.63$ {Eq. 5}

where: B&R = potential evapotranspiration calculated by Baier and Robertson Eq. 1 & 7 in mm/day

This equation was then used to estimate daily potential evapotranspiration for Fort St. John for the 2011 growing season, allowing direct comparison to the 2011 potential evapotranspiration calculated for each of the BC Hydro stations. [Note: for the purposes of calculating Climatic Moisture Deficit, growing season is defined as the period of May to September.] Average potential evapotranspiration at each BC Hydro station was then calculated as the ratio between the BC Hydro station and 2011 Fort St. John potential evapotranspiration for the 2011 growing season multiplied by average evapotranspiration at Fort St. John, i.e.,:

LE_{LT} (BCH) = LE_{2011}(BCH) / LE_{2011}(FSJ) * LE_{LT} (FSJ) {Eq. 6}

where: LE_{LT} (BCH) = average seasonal evapotranspiration at each of the six BC Hydro climatological stations

LE_{2011}(BCH) = 2011 seasonal evapotranspiration at each of the six BC Hydro climatological stations [from Eq. 1]

LE_{2011}(FSJ) = 2011 seasonal evapotranspiration at Fort St. John [from Eq. 5]

LE_{LT} (FSJ) = average seasonal evapotranspiration at Fort St. John [from Eq. 1]

4) Average growing season precipitation at each BC Hydro climatological station was calculated as the ratio between the BC Hydro station and Fort St. John for 2011 applied to the normal precipitation at Fort St. John. [Precipitation normals for Fort St. John were downloaded from the Environment Canada website: http://climate.weatheroffice.gc.ca/climateData/canada_e.html].

5) Climatic Moisture Deficit was calculated as the difference between average precipitation and potential evapotranspiration over the growing season.

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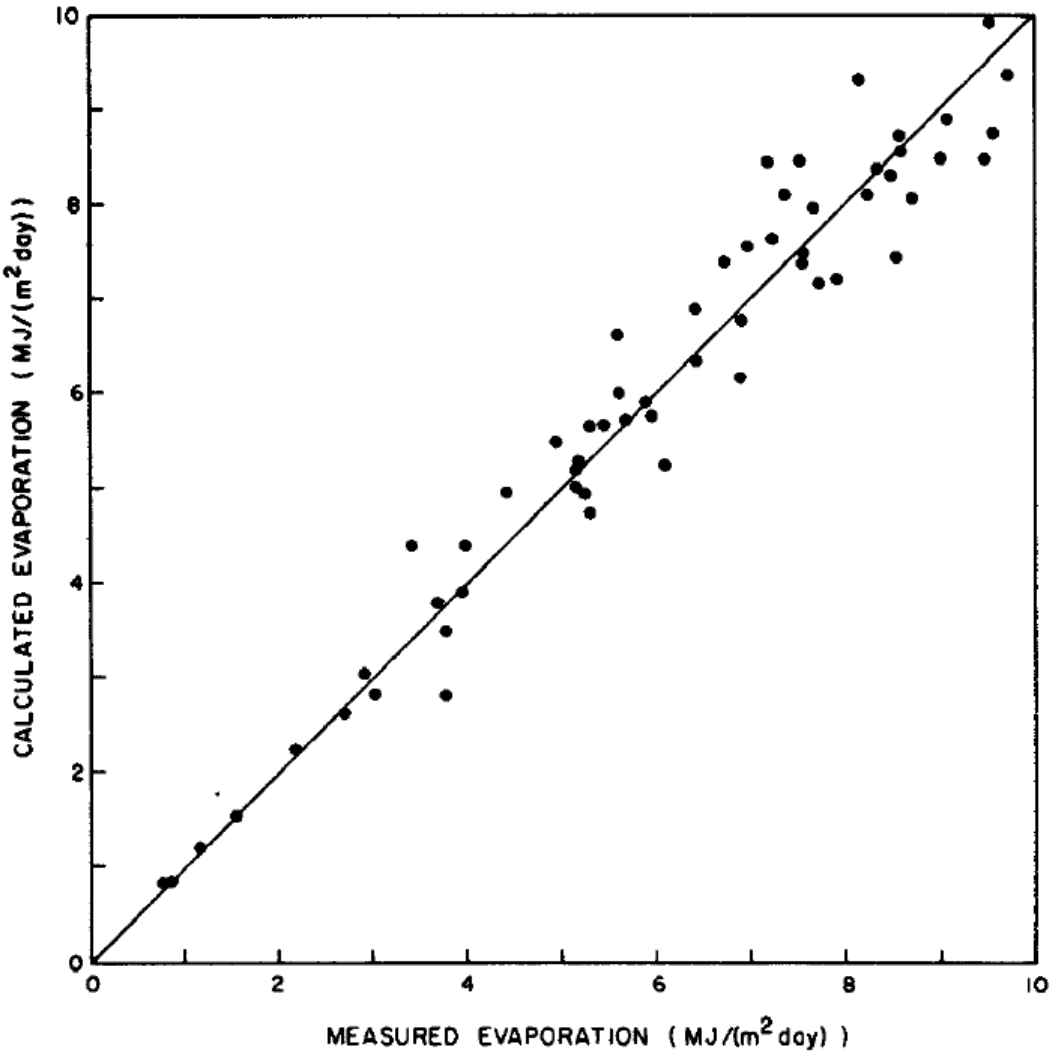

NOTES:
1. COMPARISON OF DAILY EVAPOTRANSPIRATION FROM THE PRIESTLEY & TAYLOR FORMULA WITH MEASURED VALUES AT THE SUNSET PRAIRIE COMMUNITY PASTURE NEAR DAWSON CREEK, BC (FROM DAVIS & DAVIES, 1981).

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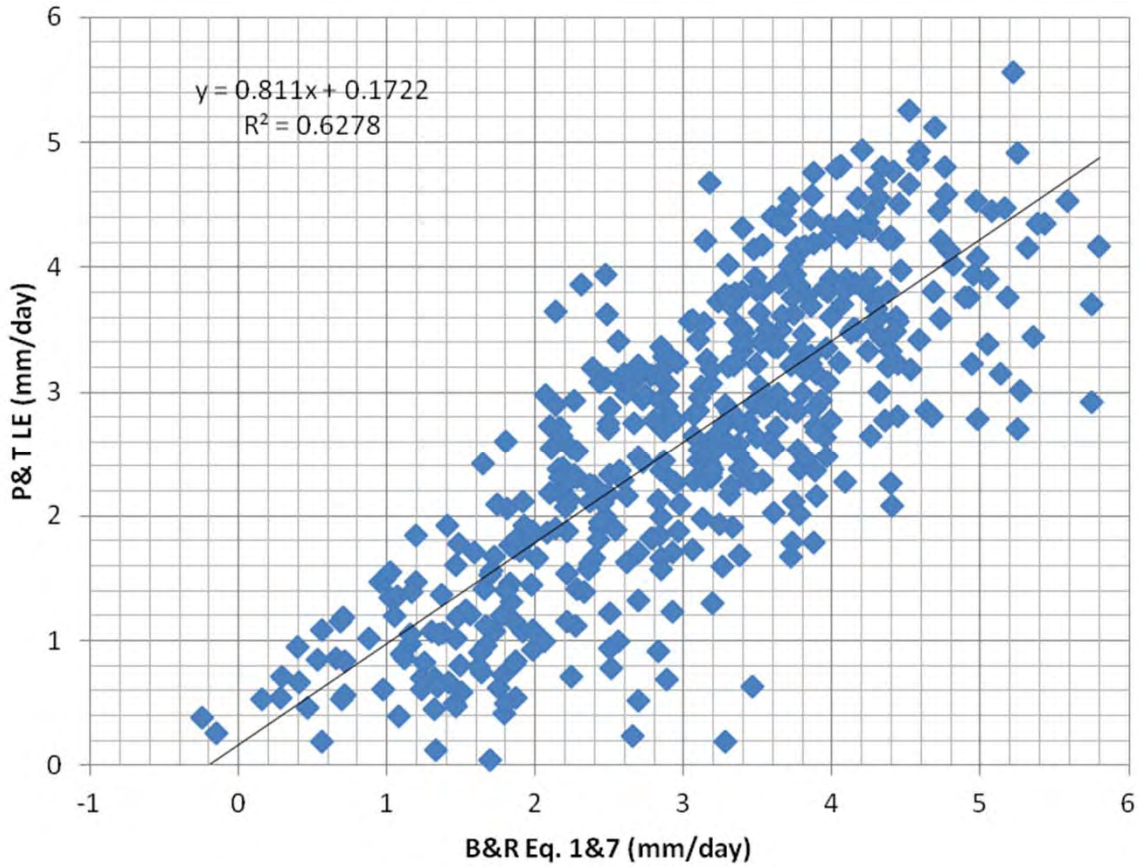
SITE C CLEAN ENERGY PROJECT

Figure A.1 Comparison of daily evapotranspiration

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification



NOTES:
1. PRIESTLY AND TAYLOR EVAPOTRANSPIRATION VS. BAIER AND ROBERTSON EQUATION 1 AND 7 FOR BC HYDRO STATIONS 1, 4, AND 7

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SITE C CLEAN ENERGY PROJECT

Figure A.2 Evapotranspiration Estimates Priestly and Taylor vs Baier and Robertson

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification

APPENDIX B

Agricultural Operator Question Guide

Site C Clean Energy Project

Agricultural Interviews

August 2011

Introduction

BC Hydro is interviewing farmers and ranchers in the Peace as part of an Agricultural Assessment Study for the Site C project. The purpose of this interview is to collect the information required to identify potential impacts from the Site C project and to evaluate the significance of these impacts to the agricultural resource base (agricultural land) and to the agricultural economy.

Project Status

The Site C Clean Energy Project (Site C) is now in Stage 3, the environmental and regulatory review phase, which will include an independent environmental assessment. Stage 3 work includes conducting environmental and engineering field studies in the Peace River valley between the Williston Reservoir and the Alberta border. BC Hydro formally submitted a Project Description Report in May 2011 to the provincial and federal environmental assessment agencies, initiating the process for a thorough environmental assessment of the project.

Background

BC Hydro has contracted Golder Associates to conduct an Agricultural Assessment Study for the Site C project. BC Hydro and the Golder team are working closely with the BC Agricultural Land Commission, the BC Ministry of Agriculture, potentially affected farmers and ranchers, and the Peace River agricultural community on the agricultural assessment which includes a resource inventory, an economic evaluation, and the development of relevant agricultural mitigation and enhancement strategies.

Scope of Work

As part of the field program currently underway to verify and refine agricultural resource mapping, local ranchers, farmers and resource agency specialists are being contacted with information requests to update data on agricultural resources in the study area. For agricultural operations, this information gathering will include an interview with the owner or operator and a tour of the operation.

A BC Hydro Property Representative and agricultural specialists from Golder will meet with the owner/operator to determine and verify data on land ownership, tenure (Crown and other leases, licenses, rental arrangements, etc.), land improvements and land use. The interviewer will follow a question guide and materials will be provided to the owner during the meeting. The interview will be conducted between mid-August and October 2011.

If a follow up interview or assessment is required, a return visit(s) or phone call (s) may be arranged. The property owner will be contacted by a BC Hydro Property Representative to discuss further requirements.

SITE C AGRICULTURAL INTERVIEW

Introduction:

Thank you for taking the time to complete this agricultural interview with us today. The purpose of the interview is to invite you to share information about your property, farm operations and general land use within areas potentially affected by the construction of the proposed Site C Clean Energy project. These questions apply to your entire holdings, which may include BC Hydro leased land and range tenures, as applicable.

Privacy Statement:

Your name and address will not be linked with your answers regarding economic questions in Section C of the interview. Any financial or economic information shared in the interview will be kept confidential and reported only in aggregate. Information that is shared during the interview on the project's potential physical affects on individual operations will be reported to BC Hydro and, through the Agricultural Assessment Report, to the public.

Personal information is being collected during this interview to assist with preparation for the environmental and regulatory review phase of the Site C Clean Energy project, as well as the purposes described in the last paragraph on this page. Specifically, BC Hydro and its consultants are seeking specific property information to help identify current property use, potential project effects and areas that may require further follow-up or study. BC Hydro is collecting this information in accordance with various regulatory obligations related to the Site C project such as the BC Environmental Assessment Act and the Canadian Environmental Assessment Act. If you have any questions about this information collection, please contact your BC Hydro Property Representative, by phone at 604-695-5287 or email at: tony.duffy@bchydro.com.

Interviewers:

Golder Team - Golder team members include Pat Brisbin, and agricultural engineer and agrologist, and Darrell Zbeetnoff, an agricultural economist and agrologist. Both Pat and Darrell have over 30 years of experience with the agricultural industry in BC and with conducting agricultural impacts related to large infrastructure projects. Both come from farming backgrounds; Pat has experience with the beef industry and Darrell with grain farming.

BCH Properties personnel - Tony Duffy, Properties, BC Hydro

Agricultural Assessment Overview

The assessment consists of four components:

- Develop a sound understanding of current agricultural resources in the area; of the agricultural land base and of the local agricultural economy;
- Conduct an assessment of potential impacts to agricultural land and resources, including potential impacts to individual agricultural operations, and to the local and regional agricultural economies. This will include identifying avoidance and mitigation measures which may apply to individual farm operations;
- Identify and assess regional compensation and/or enhancement opportunities to address impacts which cannot be avoided or mitigated; and
- Develop an Agricultural Resource Management Plan which will include recommendations for monitoring mitigation, compensation and enhancement measures and any follow-up work which may be required.

The purpose of this interview is to collect the information we will need to identify potential impacts from the Site C project and to evaluate the significance of these impacts to the agricultural resource base (agricultural land) and to the agricultural economy so that decision makers can make informed decisions on the proposed project.

The information will also be used by the internal BC Hydro Site C project team to identify the potential impacts on individual agricultural operations; impacts on wildlife; to gather information related to highway upgrade designs; recommendations on avoidance and mitigation measures, and to describe impacts which cannot be avoided or mitigated.

SITE C CLEAN ENERGY PROJECT

SECTION A

1) Description of Operation in 2011

We would like to obtain a general description of your agricultural operation, identifying the type of agricultural operation the lands which make up the operation.

a) Operation Identifier:
Name and Locations:

b) Type of Farming Operations

c) Total Farm Area and Locations (note parcels, owner, lease number, licence number of maps)

i) Owned

ii) Private Rented or Leased

iii) Leased from BC Hydro

iv) Crown Lease

v) Grazing Licence

vi) Other (describe)

vii) Total Area

2) Land Use and Cropping

We would now like to collect information on land use and the crops grown on your operation.

a) Could you please describe land use and cropping and identify the areas of different land use and cropping on the maps.

When describing cropping patterns, please describe what crop rotations you use.

- Are there other crops which you have grown in the past?
- If so, why do you no longer grow these crops?
- Are there crops which you may grow in the future?
- If so, why are you not growing these crops now?
- Total Farm Area (ac) note land use on maps

b) Land in Crops

i) summerfallow

ii) tame or seeded pasture

iii) natural land for pasture, and characteristics of the pasture areas and time of the year these areas are used

iv) woodlands and wetlands

v) Christmas trees

vi) other land

c) Type of Crops (List and then note on Map)

- wheat
- oats
- barley
- fall rye
- canola
- flax
- dry field peas
- alfalfa and alfalfa mixtures
- all other tame hay
- forage seed for seed
- potatoes
- fruits (describe)
- berries (describe)
- vegetables (describe)
- nursery products (describe)
- sod for sale
- greenhouse area (ft^2)
    - greenhouse flowers
    - greenhouse vegetables
- other covered crops
- others?

d) Are there areas on your operation which would benefit from the addition of good quality soils?

3) Livestock Numbers

We would also like to collect information on the number and type of livestock on your operation. As able, please note type, class and number.

- Could you please describe the number and type of livestock?
- Do the number and type change during the year?
- Do the number and type change from year to year?
- What year to year variations have occurred during the last 5 to 10 years?
- What mortality rates to you experience with your livestock?

Livestock:

- beef
  - cows / bulls / calves / yearlings
- dairy
  - cows / replacement heifers
- horses
- bison
- sheep and lambs
- goats
- pigs
- chickens for meat
- chickens for eggs
- turkeys
- other poultry (specify)
- llamas and alpacas
- honeybees
- other pollinators
- other (specify)

Further details may include:

- Are there other types of livestock which you have raised in the past?
- If so, why do you no longer raise this type of livestock?
- Are there types of livestock which you may raise in the future?
- If so, why are you not raising these types of livestock now?

4) Water Management

Another area of interest is water management. We would like to gather information on water use and drainage issues on your operation.

a) Do you irrigate (note irrigated areas on map)

- If so, what crops and where?
- If not, why not?

b) Drainage (note drainage features on maps)

- Do you have any drainage improvements such as ditches or drain tiles?
- Are there areas where productivity could be improved with better drainage?
- If so, what drainage improvements would be required?

c) Wells and springs (describe works and note features on map)

- Do you have any wells or springs located within your operation?
- What do you use the water for?
- What are the yields (flows)?
- Are there any problems with the groundwater yield or quality?

d) Livestock Watering (describe works and note features on map)

- How do you water your livestock?
- Are there problems with your livestock water sources?
- Are there improvements which could be made to your livestock water supplies?

e) Do you hold any water licences?

5) Infrastructure

We would like know what infrastructure (buildings, corrals etc) form part of your operation. Could you describe your operation's infrastructure and note the locations on the maps?

- Buildings
- Cattle handling facilities
- Cattle guards
- Bridges
- Fences
- Other infrastructure

6) Access

We also need to understand how you access the different parts of your operation from public roads and how you move equipment between different parts of your operation. Could you please describe and locate on the maps:

- Access and egress points, what type and size of equipment uses these points?
- Farm access routes; what type and size of equipment use these routes and at what time of the year are they used?
- Do you have any need for highway crossings for equipment and/or livestock or conduits under the highway?

7) Livestock Movement

Another characteristic of your operation which we need to understand is livestock movement. Could you please describe and show us on the maps:

- Livestock overwintering areas, when are these areas used?
- Feedlot areas?
- Pasture and range areas, when are these areas used?
- Livestock movement routes, when are these routes used?
- Barriers to cattle movement (fencing, cattle guards, natural barriers)?
- Creek crossings used by livestock?
- Manure storage locations?

8) Other Land Use (open-ended)

a) Do you allow recreational users onto your farm? If so, please describe the type of recreational uses (hunting, fishing, trapping, riding) and identify where these uses occur on the map.

This information will be shared with the team studying wildlife and recreational use in the area.

b) Does your farm provide habitat for wildlife?

Ungulates

c) Do you think deer/elk/moose are attracted to some of your crops? Y ____N____If yes, which species and which crops?

d) Do you try to discourage deer/moose/elk from using your fields? Y___ N___ If yes, please describe how and where.

e) Do you use bait stations or other means to attract deer/moose/elk? Y____ N___ If yes, please describe how and where.

f) Complete the attached table below for each agricultural field. Please assign a number to each field. If multiple areas have the same use, please indicate this by including multiple field numbers in the table.

Other Wildlife

g) Do you see wolves on your property? Y___ N___ If yes, please describe how often, what time of year, and where you see them

h) Do you shoot wolves or other predators on your property? Y___ N___ If yes, under what circumstances and how often.

i) Do you see fishers on your property? Y___ N___ If yes, please describe how often, what time of year, and where you see them

j) Do you trap furbearing animals on your property? Y___ N___ If yes, please describe your target species, your trapping effort each year (how many animals are trapped each year of each species, and where they are captured).

k) Do you see grizzly bears on your property? Y___ N___ If yes, please describe how often, what time of year, and where you see them

l) Do any raptors (hawks, eagles, owls) nest on your property? Y___ N___ If yes, please describe what species (if known), if they use the same site (nest , tree, stand) in multiple years, if you have observed young and if so how many in each year observed.

m) Do you see ducks and/or geese on your property? Y___ N___ If yes, please describe how often, what time of year, and do they damage your crops?

n) Do you see back bears on your property? Y___ N___ If yes, please describe how often, what time of year, and whether they kill or injure your livestock?

SECTION B

BC Hydro Properties Representative to review map with areas of potential impacts.

1) Potential Concerns about Changes to the Agricultural Operations if Site C is constructed:

a) Physical Concerns

Please indicate your anticipated concerns about physical changes to your operation which might occur if Site C is constructed. These concerns may include:

- Direct loss of land due to inundation (describe current and potential use of land which may be lost)
- Direct loss of land due to permanent transmission, highway and road corridors
- Land clearing
- Loss of farm buildings and improvements (note and describe on map)
- Soil disturbance and compaction with consideration of capability ratings
- Introduction and proliferation of invasive species
- Changes to wildlife movement and damage to crops
- Changes to hydrology (runoff and drainage)
- Changes to irrigation
- Changes to water tables (groundwater) and water use
- Other (specify)

b) Farm Operations and Management Concerns

Please indicate your anticipated concerns about management changes if Site C is constructed. These concerns may include:

- Changes to farm access and egress due to inundation
- Changes in farm access and egress due to permanent transmission, highway and road corridors
- Changes in farm access and egress due to temporary transmission, highway and road corridors
- Changes in farm access and egress due to traffic changes related to transmission, highway and road corridors
- Changes to access within the farm operation and between fields and different areas of the operation
- Changes to livestock watering
- Changes in grazing and livestock carrying capacity
- Changes to livestock movements, with consideration of fencing, natural and other barriers, livestock movement routes
- Changes to biosecurity risks (BSE, Avian flu)
- Changes to farm worker safety
- Changes to manure management
- Changes to farm habitation
- Other (specify)

2) Impact Mitigation and Avoidance Options:

Please indicate how your anticipated concerns (described in section B.1 and B.2) might be avoided or mitigated. Options may include:

- Changes to farm access and egress due to inundation
- Changes in farm access and egress due permanent transmission, highway and road corridors and movements
- Changes in farm access and egress due to temporary transmission, highway and road corridors
- Changes in farm access and egress due to temporary movements related to transmission, highway and road
- Changes to access within the farm operation and between fields
- Changes to livestock watering
- Changes in grazing and livestock carrying capacity
- Changes to livestock movements, considering fencing and natural barriers
- Changes to biosecurity risks
- Changes to farm worker safety
- Changes to manure management
- Changes to farm habitation
- Other (specify)

SECTION C

In order to estimate changes which may occur to the local agricultural economy, we would like to collect information on certain economic aspects of your operation.

The information specific to your operation will be used by Pat Brisbin and Darrell Zbeetnoff only, for the purposes of their analysis of changes which may occur to the local agricultural economy. The information collected and the results of the analyses will be reported to BC Hydro and within the Agricultural Assessment in aggregate only. This means that the economic information collected and the results of the analyses will be reported as totals, and not linked with your name or address.

1) Agricultural Operations Economic Indicators

We would like to understand the existing year-to-year economic characteristics of your agricultural operation.

a) Crops

For each crop, please indicate the following:

- Quality expected (grade, protein content)?
- Yields expected (bushels, tonnes, bales (specify size and weight)?
- Prices expected (including CWB payments)?
- Location of markets and delivery points?
- Pasture range carrying capacity (animals, how many days, refer to grazing plan)?

b) Livestock

For each livestock type, please indicate the following:

- Annual animals and products sold, (e.g., animal type, meat, eggs, wool, honey)?
- Proportion or volume consumed on farm?
- Yields/weights by livestock and product type?
- Prices expected?
- Location of markets and delivery points?

c) Crops Used within the Operation

For each crop grown, please indicate the following:

- Proportion of crop grown used as livestock feed on the farm?
- Proportion of crops grown sold as feed locally?

For each livestock type, please indicate the following:

- Proportion of livestock feed needs imported, by type of feed?

SECTION D

Section D, and the remainder of this interview, will provide useful information to BC Hydro and the publically available Agricultural Assessment report.

1) Agricultural Land Potential (open-ended question)

a) Farming Strengths and Opportunities

In your opinion, are there other commercially attractive crops and products that could be grown for food on your farm?

Yes ___ No ___. If yes, what are these crops and/or products?

- New food crops and products?
- Livestock that could be raised?
- Untapped markets?
- Other factors (specify)?

In your opinion, are there other commercially attractive crops and products that could be grown for non-food applications on your farm?

Yes ___ No ___. If yes, what are these crops and/or products?

- Bio-fuel and bio-energy crops (e.g., ethanol, biogas, feedstock)
- Fibre crops (e.g. for cloth, paper, twine, rope)
- Pharmaceutical and therapeutic proteins (e.g., borage, Artemesia, cannabis)
- Renewable polymers (e.g., bio-plastics)
- Specialty chemicals (e.g., essential oils, inks, linseed, hemp, lavender)
- Building and construction materials (e.g., hemp-lime, straw, paints)

In your opinion, are there other opportunities that could economically support your farming operation?

Yes ___ No ___. If yes, what are these opportunities?

- Carbon offset initiatives (e.g., reforestation, minimum till, changes in crop rotations, retiring land)
- Provide ecological goods and services
- Provide additional recreational opportunities

b) Farming Constraints

Are there specific factors that prevent you from producing new crops and products?

Yes ___ No ___. If yes, what are these factors?

- Constraints to implementing farm improvements?
- Constraints to growing new crops?
- Constraints associated with crops grown or attempted in the past?

- Production constraints (e.g., water)?
- Climate and length of growing season?
- Absence of a regional market/infrastructure?

c) Anticipated Impact of Climate Change

- In your opinion, how do you think climate change might affect your farming operation?
- Please explain these potential changes? (list)
- In your opinion, how do you think climate change might affect agriculture in the region?
- Please explain these potential changes? (list)

2) Potential Changes in Future Operating Conditions on Your Farm with Site C

a) In addition to anticipated physical and management changes with Site C discussed in Section B, do you anticipate other potential changes to future operating conditions on your farm in the following areas?

b) Potential changes may include:

- Change in regional climate
- Change in water access (domestic water, livestock watering, irrigation)
- Change in lowlands stabilization
- Change in cropland availability
- Change in on-farm improvements
- Change in cropping
- Change in livestock carrying capacity
- Change in livestock feed imports
- Change in livestock types
- Change in markets
- Change in farm type
- Change in access to agricultural inputs
- Change in market access

SITE C CLEAN ENERGY PROJECT

SECTION E

1) Regional Enhancement Opportunities

As part of the agricultural assessment, BC Hydro is interested in exploring ideas for enhancement strategies which would benefit agriculture in the region, including the Fort St. John area or more broadly the Peace River Regional District. These would be in addition to avoidance and mitigation measures, and compensation, which would be applied to individual agricultural operations.

a) In your opinion, are there opportunities to enhance agriculture in the region in the following areas?

Yes____ No ____

If yes, what are these opportunities? (list and discuss)

b) Are there other ways in which agriculture could be supported in the region?

Yes_____ No_____

If yes, indicate the other ways (list and discuss)

CLOSURE

Thank you for your time.

There may be follow-up phone calls or requests for a second interview to clarify the information which has been provided or to collect additional information. If a second interview is required, BC Hydro properties will contact you to make arrangements.

If you have additional information that comes to mind that you would like to share in relation to this interview or specific questions, please contact Tony Duffy.

Notes from this interview will be written up and sent to you by mail for your review and comment.

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