SITE C CLEAN ENERGY PROJECT

VOLUME 1 APPENDIX A:
VEGETATION CLEARING AND DEBRIS MANAGEMENT PLAN

Prepared for:

BC Hydro and Power Authority

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December 6, 2012

Document Number:
V1A

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Executive Summary

The Site C Clean Energy Project (the Project) on the Peace River in north-eastern British Columbia consists of six locations within the Project activity zone that would require varying degrees of vegetation clearing and debris management. Each location was identified based upon its intended purpose within the development of the Project. These locations include: (i) the dam construction site, (ii) realignments of Highway 29, (iii) construction materials sites and quarries, (iv) proposed access roads, (v) the transmission line corridor and (vi) the proposed reservoir. All combined these six sites constitute a Project activity zone that covers 13,513 hectares of terrain, within which 6,956 hectares have been classified as forest. The remaining area is water (3,871 hectares), shrubs (1,200 hectares), cultivated fields (618 hectares), exposed soils (580 hectares), and existing roads (288 hectares).

Forests within the Project activity zone are predominately deciduous (i.e., hardwood) comprising aspen, cottonwood and birch. Collectively, deciduous-dominated stands cover 64 percent of the forest area. Coniferous-leading stands cover the remaining 36 percent of forest area, comprising primarily spruce trees, with small quantities of Lodgepole pine and larch. Many of the forests within the Project activity zone contain merchantable trees suitable for use by the regional forest products industry. Of the total estimated biomass within the Project activity zone (approximately 3.13 million cubic metres) 48 percent (1,492,000 cubic metres) is classified as merchantable volume, as defined by British Columbia's Ministry of Forests, Lands and Natural Resource Operations.

As part of the Project, removal of vegetation would need to occur prior to reservoir-filling and prior to commencement of construction activities at the dam site, transmission line, roads and quarries. Across portions of the Project activity zone the removal of above-ground biomass with retention of stumps would suffice (e.g., the proposed reservoir site). In other areas where construction is to occur (e.g., quarries and transmission tower locations), the removal of the below-ground biomass would also be required. Most of the vegetation would be felled by ground-based mechanical tree harvesting and processing equipment such as feller-bunchers, after which trees would be transported to roadside using crawler tractors, line skidders or grapple skidders. Photographs of the types of clearing equipment

that would be employed are provided in Appendix G. BC Hydro would ensure that the use of mobile equipment is in compliance with WorkSafeBC Regulations.

Ground-based vegetation clearing equipment would be transported to the proposed Project sites using both the existing road system (that would in some locations require upgrade) and 187 kilometres of new temporary access roads that would need to be constructed. Approximately 72 temporary water crossings would need to be established to provide clearing-equipment access to vegetation on islands within the Peace River and to vegetation adjacent to the Halfway and Moberly rivers.

Approximately seven percent of the Project area would be cleared by hand-felling trees and then extracting vegetation by helicopter. In only a few instances where helicopter extraction is not possible due to safety concerns (e.g., such as at Red Creek) vegetation would be hand-felled and left to float out during the reservoir inundation.

The majority of vegetation clearing activities would occur through the winter months (approximately 93 percent) during the first four years of the eight-year Project construction schedule. Operating vegetation clearing equipment in the winter would improve access to forests alongside the Peace, Moberly and Halfway rivers while minimizing soil disturbance, provide for fish and wildlife concerns and keep activities outside of key bird breeding periods. Winter operations would also minimize clearing activities during periods of high recreational use within the Project activity zone.

Clearing vegetation from the central and western portions of the reservoir site upstream from Cache Creek is currently proposed to occur in years three and four of the Project construction schedule. In consideration of timing of industry's needs for timber from forest clearing and the outcome of other potential concerns around recreational use and visual quality during the construction period, the clearing currently planned for years three and four within the reservoir may be moved into years five and six of the construction schedule. The options for the clearing schedule were presented as part of the BC Hydro-led Fall 2012 public consultation, during which public and stakeholders did not provide specific comments on this schedule. The dam construction site, various quarries and access roads would be prioritized for clearing first, to limit equipment congestion in the latter stages of Project

development. The management of water-borne vegetative debris within the Peace, Moberly and Halfway rivers would continue to occur throughout the eight-year construction schedule and into reservoir operations, as required.

This proposed clearing plan would result in vegetation being cleared from approximately 5,852 hectares (84 percent) of forested land in the Project activity zone. At the dam site, construction materials sites, quarries, proposed Highway 29 realignment areas and proposed access roads all of the non-merchantable vegetation would be cleared. There would be retention of non-merchantable vegetation in riparian areas within the transmission line corridor to manage for watercourse protection. Within the proposed reservoir site, non-merchantable vegetation would be retained in riparian zones, in unstable terrain and where tree tops are lower than 455 metres elevation, which is a five metre buffer for boater safety from the proposed minimum normal operating level of the reservoir of 460 metres.

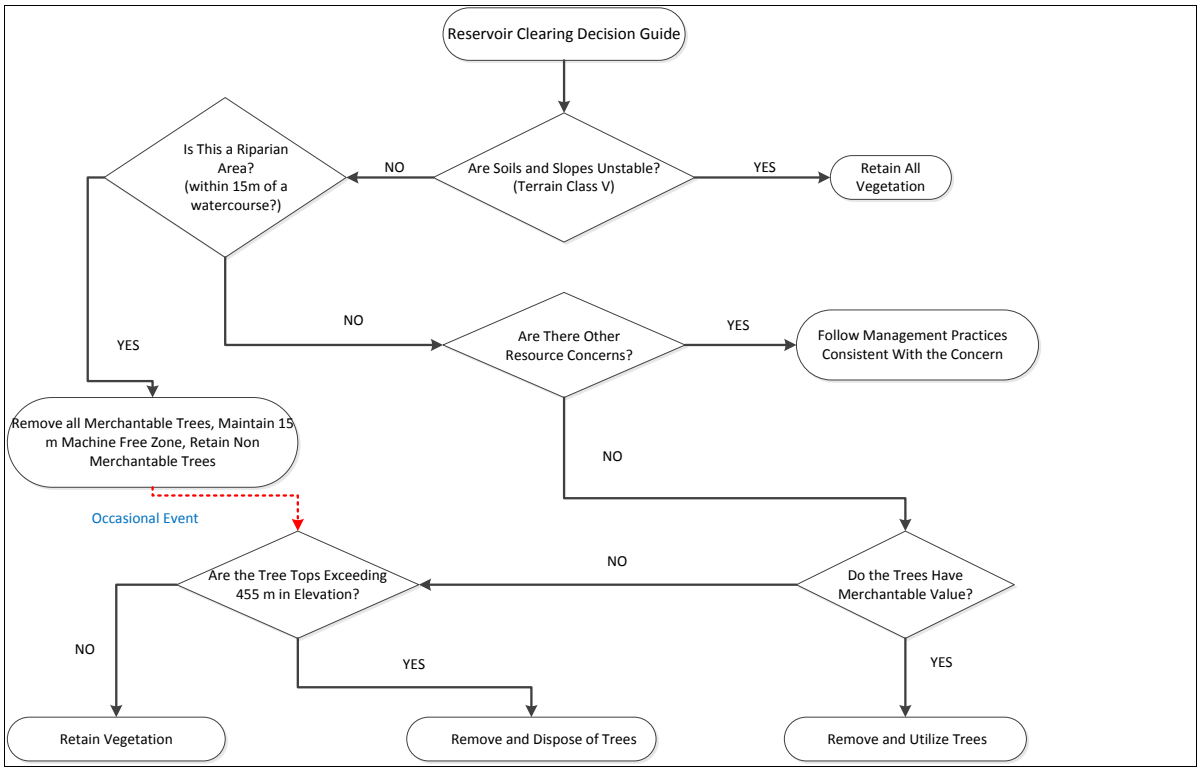
Vegetation clearing would result in the removal of approximately 1,413,000 cubic metres of merchantable fibre (95 percent) in the proposed Project activity zone. The tree species harvested are expected to be 38 percent aspen, 33 percent spruce, 23 percent cottonwood, four percent birch, two percent pine and less than one percent larch.

Merchantable logs would be offered for sale to the forest products industry. Based upon the utilization of fibre by the local forest industry in the Peace region of British Columbia between 2006 and 2010, the merchantable volume proposed to be cleared annually within the Project activity zone would be less than one-third of the forest industry's annual deciduous demand and one-seventh of the annual coniferous demand (BC MFLNRO 2011a).

Merchantable logs sold to the forest products industry would be transported to milling facilities by logging truck or, in the case of deciduous species, there may be whole-tree chipping on-site and transport in 52-foot container trucks.

Non-merchantable fibre is comprised of undersized trees, tree tops, branches, stumps, roots, wood chunks resulting from clearing activities, decaying trees, bark and foliage. During vegetation clearing, varying amounts of non-merchantable fibre would (i) accumulate as debris at the side of roads, (ii) remain dispersed through cleared areas, and

(iii) invariably fall into rivers both as a result of natural processes that occur during the spring freshet, and as a consequence of reservoir-filling. At sites in the Project activity zone where additional site preparation (i.e., grubbing) would take place, the non-merchantable fibre would be gathered using crawler tractors equipped with brush rakes and disposed of. In parts of the proposed transmission corridor where clearing all vegetation is not as critical, some non-merchantable vegetation would be left scattered. A decision matrix on whether to remove or retain vegetation from within the proposed reservoir site is shown below.



Approximately 1,635,000 cubic metres of above- and below-ground non-merchantable fibre exists within forests in the Project activity zone. An estimated 1,189,000 cubic metres of this non-merchantable fibre would be offered to the local forest industry or potential new proponents as biomass for bioenergy. Biomass that is not utilized by industry would be incinerated, land-filled or dispersed. BC Hydro will follow the protocols established by the British Columbia Ministry of Environment with respect to open-burning smoke regulations and a customized smoke management plan specific to vegetation clearing for the proposed

Project. Water-borne non-merchantable fibre would be managed through the establishment of debris collection booms located at strategic locations on the Peace and Moberly rivers. Cranes would remove the water-borne debris for disposal on land.

In 2012, the annual demand for non-merchantable fibre for use as bioenergy by the regional forest industry was equivalent to approximately 225,000 cubic metres. Ninety percent of this demand is currently met as a result of log milling activities that creates residual biomass during the production of lumber or mechanical pulp. As a result, the market demand for biomass is currently limited to about 23,000 cubic metres per year. The regional logging activities that support forest companies' annual requirements for merchantable fibre create quantities of non-merchantable biomass that far exceed this small market demand. As a result, most of the non-merchantable biomass created by logging in the Peace Region is either left by logging contractors to decompose or incinerated at roadsides adjacent to the logging site.

Numerous aspects of this proposed vegetation clearing and debris management plan were reviewed by a multidisciplinary team of foresters, engineers, forest-clearing contractors and forest industry and government participants. Proposed access roads and water crossings have been field-verified and the feasibility of vegetation clearing in difficult terrain has been reviewed through on-site visits by experienced contractors and qualified professionals.

Clearing prescriptions vary by site location, the requirements of construction engineers, and is proposed in consideration of riparian area, unstable slopes and, amongst other information, input received from Aboriginal groups relating to mercury methylization, water quality, boater safety, utilization of forest resources, fish and fish habitat, and wildlife habitat.

ABBREVIATIONS AND ACRONYMS

B.C. ..... British Columbia
BC MFLNRO ..... British Columbia Ministry of Forest, Land and Natural Resource Operations
BC MSRM ..... British Columbia Ministry of Sustainable Resource Management
BC MOE ..... British Columbia Ministry of Environment
BEC ..... Biogeoclimatic Ecosystem Classification
BIOS ..... Biomass Opportunity and Supply
BWBS ..... Boreal White and Black Spruce zone
DoJ ..... Department of Justice
Ha ..... Hectare
IFS ..... Industrial Forestry Service Ltd.
EIS ..... Environmental Impact Statement
Km ..... Kilometre
Kv ..... Kilovolt
LIDAR ..... Light Detection and Ranging
MW ..... Megawatt
MoT ..... B.C. Ministry of Transportation and Infrastructure
OBSCR ..... Open Burning Smoke Control Regulation
ODT ..... Oven dry tonne
OSB ..... Oriented strand board
PSS ..... Primary Smoke Sensitivity
ROW ..... Right-of-way
RPF ..... Registered Professional Forester
ROW ..... Right-of-way
SBS ..... Sub-Boreal Spruce zone
VRI ..... Vegetative Resource Inventory

GLOSSARY

Barge	A roomy, usually flat-bottomed boat used chiefly for the transport of goods on waterways and usually propelled by towing.
Biomass	Dry weight of organic matter (*i.e.*, plants and animals) in an ecosystem.
Bioenergy	Renewable energy made available from materials derived from biological sources (energy derived from biomass).
Boreal	Of or relating to the forest areas of the northern North Temperate Zone, dominated by coniferous trees such as spruce, fir, and pine.
Box Culvert	A wooden, open bottom culvert, usually constructed from on-site materials, utilized for the temporary, short term crossing of small streams or drainages.
Bridge Abutment	The end foundation upon which the bridge superstructure rests.
Cable Logging	A yarding system employing winches, blocks, and cables.
Coarse Woody Debris	Typically, sound or rotting logs, stumps, or large branches that have fallen or been cut and left in the woods, or trees and branches that have died but remain standing or leaning.
Coniferous Tree	Any of various mostly needle-leaved or scale-leaved, chiefly evergreen, cone-bearing gymnospermous trees or shrubs such as pines, spruces, and firs.
Conventional Harvesting	In the interior of British Columbia, harvesting of trees by using any combination of mechanical or hand felling and rubber-tired or tracked skidding equipment.
Crown closure	The percent crown closure in a forest stand is assessed from aerial photographs. Crown closure is based on the amount of ground area covered by the tree crowns (i.e., vertical projection).
Culvert	A tunnel or a drain under a road that carries water from a stream or drainage from one side to the other. Examples include plastic pipes, corrugated metal pipes, box culverts, and arch culverts.
Danger Tree	A tree that is hazardous because of location or lean, physical damage, overhead hazards, deterioration of the limbs, stem or root system, or any combination.
Deactivation	To render a road, trail or any excavated feature inactive or ineffective. For roads, deactivation measures include removal of culverts and bridges, re-contouring the slope, and in some cases planting or seeding.
Debris Trap	Engineered structure located across moving waterways to intercept and collect floating debris (such as fallen trees) and keeping it from continuing down-stream. Examples include fin-booms and shear booms.
Deciduous Tree	Broad-leaved tree that sheds all its leaves during one season (e.g., aspen, cottonwood).

Ephemeral	Lasting a very short time. In the case of ephemeral drainages, these include seasonal streams, non-classified drains and intermittent seepages that only flow during certain months of the year.
Hand Falling	To cut down a tree by using mechanical or non-mechanical hand tools (e.g. chainsaw) and without the use of heavy equipment.
Feller Buncher	A type of motorized harvester used in logging. It consists of a standard heavy equipment base with a tree-grabbing device furnished with a circular saw or a pinching device designed to cut small trees off at the base. The machine then places the cut tree in a stack suitable for a skidder or forwarder, or other means of transport (yarding) for further processing (e.g., delimbing, bucking, loading, or chipping).
Fibre	The hard fibrous substance of trees which composes the body and its branches, and which is covered by the bark.
Freshet	A flood resulting from a heavy rain or a spring thaw.
Grubbing	Removal of stumps, roots, embedded logs, organics, and unsuitable soils before or concurrently with construction activities.
Headpond	A wholly or partly filled artificial lake or reservoir storing water.
Helicoidal	Shaped like a spiral, resembling that of a screw thread.
Ice Bridge	A body of ice that forms across the width of a river and is strong enough to bear traffic.
Merchantable Tree	A tree that has attained sufficient size, quality and (or) volume to make it suitable for harvesting and transport to a processing plant.
Non-merchantable Tree	A trees that is unsuitable for harvesting and processing into other commercial products. This designation may result due to tree size, amount of rot, type of species or overall quality.
Partial Cutting	A harvest system in which only some of the trees are harvested. Retention may include leave trees based on size criteria, importance to wildlife, etc.
Permanent Access Road	For the purpose of this Plan, a newly constructed or upgraded existing road that will continue to be used after the commencement of reservoir filling.
Piling Bridge	A bridge where the roadway is supported by piles driven into the river or stream bed.
Proposed Access Road	A potential, unconstructed road location that is marked in the field, often using flagging tape, surveyed and appearing on a map.
Pulp	The fibrous material in a tree used to make cellulose products such as paper.
Riparian	Relating to the transitional area or zone found between land and a fresh-water feature such as a river, lake or wetland. In this plan the riparian zone is estimated with a 15-metre buffer around all water bodies.
Road Permit	An agreement entered into under the *Forest Act* that allows a person who has the

	right to harvest timber under a licence, agreement, or permit, to construct a road, or maintain an existing road on Crown land, other than a Forest Service Road.
Seismic Trail	A trail located along a seismic line, which is a straight line (usually 1 to 10 meters in width) cut through the forest by the oil and gas industry as part of resource exploration procedures.
Sensitive Soils	Soils that, because of their slope gradient, texture class, moisture regime, or organic matter content, have a very high hazard for displacement, surface erosion, or compaction.
Siltation	The (typically undesirable) increase in concentration and or deposition of water-borne silt in a body of water.
Skidder	A heavy, four-wheel or tracked machine used to haul logs, especially over rugged terrain. Crawler Tractors and Grapple Skidders are examples.
Skidder Crossing	A non-engineered crossing constructed over a small stream, drainage or wet area to allow access to heavy machinery without damaging stream banks or sensitive soils. Examples include rudimentary bridges constructed from on-site material; logs placed side by side (corduroy), and small diameter culverts.
Skid Roads / Trails	An excavated or bladed logging trail used by tracked or rubber-tired skidders to drag logs from the felling site to a landing or roadside processing area. Skid trails are often utilized on slopes deemed too steep for the safe movement of machinery, or in protected areas to concentrate and minimize potential site degradation caused by machinery.
Slope Stability	Susceptibility of a slope to erosion and slides.
Slumping	A mass movement process in which slope failure occurs on a usually curved slip surface and the unit moves downslope as an intact block, frequently rotating outward.
Temporary Access Road	For the purpose of this Plan, a newly constructed, existing or upgraded existing road that will be deactivated prior to the commencement of reservoir filling.
Water-borne	Floating on or transported by water.

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1 INTRODUCTION

This vegetation clearing and debris management plan has been developed by Industrial Forestry Service Ltd. (IFS) for BC Hydro for the Site C Clean Energy Project (the Project). This report describes and quantifies how existing vegetation within the Project activity zone would be managed during Project construction.

Vegetation clearing is quantified in terms of the tree species, areas and volumes that occur within the Project activity zone. The vegetation clearing strategy for the Project describes the criteria for vegetation removal and retention, and gives consideration for operations on unstable slopes and within riparian zones. Vegetation is differentiated between merchantable timber and non-merchantable fibre or debris. Merchantable timber is defined by the British Columbia Ministry of Forests, Lands and Natural Resource Operations (BC MFLNRO) based upon historic utilization by the forest industry within the Peace Region. A wood utilization and disposal strategy (please see Section 2.6 in this plan) is proposed to salvage merchantable timber and subsequently encourage the use of this fibre by the local forest industry. A preliminary clearing schedule is presented.

The vegetation resource inventory for the Project activity zone was updated prior to the development of this plan. Forest stand volumes were calculated using BC MFLNRO growth models for both merchantable and total above-ground biomass. Below-ground biomass was estimated as a percent of total above-ground biomass. As a result, both the merchantable and non-merchantable tree species, and associated volumes that would be made available to the forest industry, are described and quantified.

The proposed disposal strategy also describes BC Hydro's other options to deal with non-merchantable woody debris. Non-merchantable woody fibre is distinguished between ground-based debris that would occur as a result of forest harvesting operations and water-borne woody debris that results from the annual spring freshet and other shoreline erosion events.

The feasibility of this plan was enhanced through extensive field reconnaissance of the proposed dam construction site and reservoir. A multidisciplinary team that included registered professional foresters, forest technicians, logging contractors, forest engineers, regional wood procurement foresters, and river debris management engineers and

contractors provided the author with a combination of verbal information and written material in local vegetation and debris management as their knowledge and experience related to the proposed Project.

2 CLEARING PLAN OVERVIEW

2.1 Proposed Clearing Sites

Six potential sites were identified within the Project activity zone as requiring varying degrees of vegetation removal. Each site was identified based upon its intended purpose within the development of the Project. The analyzed sites were:

- The dam construction site
- Quarries (Portage Mountain, West Pine, 85th Avenue, Area E, Wuthrich, Del Rio)
- Highway-29 Realignment
- Access Roads
- Transmission corridor
- Reservoir

For the location of each of these clearing sites, see Volume 1 Section 4 Project Description Figure 4.11. Each location is briefly described in the sub-sections that follow. Please see Volume 1 Section 4 Project Description for more detailed information.

2.1.1 Dam Construction Site

The dam construction site includes the proposed location of the Site C dam, generating facilities, transmission interconnection facilities, as well as areas adjacent to the dam that would be required for construction activities (e.g., worker accommodations, on-site construction materials, spoil area, existing roads and proposed roads).

2.1.2 Off-Site Construction Materials

A variety of quarried and excavated materials, such as riprap, bedding materials, rock, sand, gravel and till would be sourced for the construction of the Project. These materials would be obtained from a variety of locations. Materials that are excavated and transported

from a location away from the dam construction site means they are "off-site" construction materials. Six locations have been identified as providing off-site construction materials within 150 kilometres from the dam construction site. These are the Portage Mountain, West Pine, 85th Avenue, Del Rio, Area E and Wuthrich quarries.

2.1.3 Highway 29 Realignment Areas

Highway 29 connects Hudson's Hope to Fort St. John and parallels the north side of the Peace River. Segments of the existing highway would be flooded by the Site C reservoir. Six locations covering approximately 30 kilometres along Highway 29 would be realigned away from the reservoir shoreline. These locations occur near Lynx Creek, Dry Creek, Farrell Creek, Farrell Creek East, Halfway River and Cache Creek.

2.1.4 Access Roads

Temporary and permanent roads would be used to provide access for equipment undertaking vegetation clearing and removal from the Project activity zone. Where feasible, existing access roads would be used and upgraded as required in accordance with applicable British Columbia and Canadian guidelines and codes. Temporary clearing access roads would be located, designed and later deactivated in accordance with British Columbia standards and applicable guidelines (these can be found in the B.C. Forest Act, B.C. Forest and Range Practices Act and the B.C. MFLNRO Engineering Manual). Most of the temporary roads would be located to provide access for reservoir clearing. Due to the existence of the 138 kilovolt transmission lines, road access exists along much of the proposed route for the transmission corridor.

2.1.5 Transmission Line Corridor

The proposed transmission corridor would follow an existing BC Hydro transmission line leading from the edge of the dam construction site to the Peace Canyon Dam. Transmission right-of-way clearing would involve widening the existing transmission corridor to accommodate two new 500 kilovolt AC transmission lines to connect the Site C facilities to the existing Peace Canyon Substation.

2.1.6 Reservoir

The reservoir would be located along 83 kilometres of the existing Peace River between Fort St. John and Hudson's Hope. This area would be inundated by the proposed Site C dam to a maximum normal reservoir level of 461.8 metres elevation. The reservoir would have a minimum operating level of 455.0 metres. Reservoir filling would take place near the end of the construction schedule (see Volume 1 Appendix B Reservoir Filling Plan) and several years after vegetation clearing has completed. In this clearing plan, the proposed reservoir site refers to an area below the shore line that has been modelled to progressively develop as a result of wind erosion and wave action within five years after reservoir filling (see Volume 2 Appendix B Geology, Terrain Stability and Soil Reports).

2.1.7 Summary of Potential Activity Area

The physical geography associated with each proposed clearing site for the Project activity zone is shown in Table 2.1.

Table 2.1 Sites within the Project activity zone

Clearing Sites	Physiographic Area Description (hectares)						
	Forest	Water	Existing Roads	Exposed Soil	Cultivated	Shrubs	Total Area
Dam Construction Site	1,435.0	199.4	105.4	127.6	0.0	167.7	2,035
Highway 29 realignment	194.0	16.1	42.2	57.5	71.1	36.9	418
Construction Materials Sites	394.4	0.5	21.6	58.9	0.0	150.5	626
Access Roads	168.8	3.5	4.6	1.7	6.4	11.0	196
Transmission Right-of-way	742.2	2.3	32.3	140.2	0.0	314.2	1,231
Proposed Reservoir[1]	4,021.4	3648.8	81.6	194.5	540.3	520.3	9,007
Project Activity Zone	**6,956**	**3,871**	**288**	**580**	**618**	**1,200**	**13,513**
Percent of Total	**51%**	**29%**	**2%**	**4%**	**5%**	**9%**	**100%**

NOTES:

Note 1 The reservoir site excludes access roads and is to a 5-year beach erosion line. This erosion line is described in Volume 2 Appendix B Geology, Terrain Stability and Soil Reports. The surface area of the reservoir post inundation would also include part of the dam construction site and would vary with the depth of the water. The reservoir's surface area would be 9,330 hectares when filled to the maximum normal level of 461.8 metres elevation.

The classification of forest area is based upon the British Columbia Land Cover Classification Scheme (BC MSRM 2002). All areas having tree crowns that cover more than five percent of the ground area were considered "forested" for the purposes of this plan. Within the Project activity zone, approximately 51 percent of the area is covered in forest (6,956 hectares), 29 percent is water (3,871 hectares), and the remaining 20 percent consists of roads, clay banks, gravel bars, pastures and areas with low growing vegetation (2,686 hectares).

2.2 Vegetation Inventory

To support this clearing plan, an update to the British Columbia Ministry of Forests, Lands and Natural Resource Operations' vegetative resource inventory (VRI) was completed in 2011 by Industrial Forestry Service Ltd. for the Project activity zone. This was done to improve the accuracy of the existing forest inventory and address changes that had occurred in recent years as a result of tree growth, merchantability classifications and changes to the Peace River watercourse. The inventory update was carried out using 2007 colour photography in combination with extensive aerial and ground field verification. Vegetated areas were delineated and classified according to tree species, age, crown closure, height and site quality characteristics. Forest stand volumes were calculated using BC MFLNRO growth models for both merchantable and total above-ground biomass[1]. Below-ground biomass was estimated as a percent of total above-ground biomass. Additional information on this update and the vegetation inventory are provided in Appendices A and B respectively.

All of the Project component areas have varying degrees of vegetation. Non-vegetated areas include the Peace River, tributary streams and wetlands, clay banks, gravel bars and roads. Areas that are vegetated but lack tree cover have been broadly classified as "shrubs", which include:

[1] Gross biomass estimates were derived using BC MFLNRO growth models and are in oven dry tonnes (ODTs). These models do not include below ground biomass. Estimates were increased by 20 percent to incorporate below ground biomass (Kajimoto et al 1999; Naesset 2003). ODTs were converted to cubic metre equivalents. Merchantable volume is calculated using the BC MFLNRO variable density yield prediction model (version 7) that calculates tree volumes in cubic metres (BC MFLNRO 2011b).

- Bryoids (mosses, liverworts or lichens) that exist in environments too harsh for vascular plants.
- Forbs and graminoids (natural shrubs that are distinguished from pastures).
- Medium-tall scrub willows (*Salix spp.*) which are abundant in burned-over areas.
- Dwarf evergreen (*Ledum groenlandicum* [Labrador tea], *Chamaedaphne calyculata* [leatherleaf]).
- Willows and scrub birch (*Betula glandulosa*) that may exist together with stunted black spruce.

Tree and shrub species that occur in the Project activity zone include white spruce (*Picea glauca*), Engelmann spruce (*Picea engelmannii*), black spruce (*Picea mariana*), tamarack (*Larix laricina*), lodgepole pine (*Pinus contorta var. latifolia*), subalpine fir (*Abies lasiocarpa*), trembling aspen (*Populus tremuloides*), black cottonwood (*Populus balsamifera ssp. trichocarpa*), balsam poplar (*Populus balsamifera ssp. balsamifera*), white birch (*Betula papyrifera*), choke cherry (*Prunus virginiana*), pin cherry (*Prunus pensylvanica*), as well as many willow species and alder. Areas in the Peace region where white spruce and Engelmann spruce ranges overlap, or where black poplar and balsam poplar ranges overlap, may result in some hybridization of these tree species. For simplicity, ‘spruce’ includes all spruce species and ‘poplar’ includes all poplar species. A discussion of tree merchantability criteria is provided in Section 2.3.

In addition to the living forest biomass, there is also woody biomass in the form of dead standing trees, windfall and deadfall throughout the Project area. This volume is included in the estimates of non-merchantable volume. The non-merchantable volume is estimated in the forest cover inventory using BC MFLNRO total stand biomass equations (Kivari, et al. 2011). A location with a high volume of this dead vegetation is shown in Photograph 2.1. Varying quantities of wood chunks and whole trees are also introduced annually into the Project activity zone as a consequence of the annual freshet of the Peace River and its tributaries, bank erosion and heavy rainfall events. A photograph of some of the debris left by the 2011 freshet on the Peace River is shown in Photograph 2.2.

Photo Credit: Industrial Forestry Service Ltd. (2011)

Photograph 2.1 Natural ground-based debris

Photo Credit: Industrial Forestry Service Ltd. (2011)

Photograph 2.2 Natural water-borne debris

2.2.1 Biogeoclimatic Classification

The Biogeoclimatic Ecosystem Classification (BEC) system is a hierarchical classification system used in British Columbia to classify ecological landscape units. Climate, vegetation and topography are the three main characteristics that define the BEC system (Meidinger 1991). The Project activity zone extends primarily across the Boreal White and Black Spruce (BWBS) BEC zone, but also touches the Sub-Boreal Spruce (SBS) zone, in the subzones and variants described below.

2.2.1.1 Boreal White and Black Spruce

The Project activity zone extends across two subzones of the BWBS. The Boreal White and Black Spruce moist warm subzone (BWBSmw) accounts for 13,353 hectares, or 99 percent, of the Project activity zone. BWBSmw is characterized by a drier and warmer climate compared to the adjacent BWBS subzones found in higher elevations to the north and west. Forested habitats within this subzone are typically dominated by trembling aspen (*Populus tremuloides*) with balsam poplar (*P. balsamifera ssp. balsamifera*) common on lower slopes and along water courses (Delong et al. 2011). White spruce (*Picea glauca*) forests appear in moist sites. Lodgepole pine (*Pinus contorta var. latifolia*) forests occur as a seral species in drier and poorer areas. Black spruce (*Picea mariana*) can be found mixed with lodgepole pine on upland sites that have cold soils or limited rooting, and in organic soils with minor amounts of tamarack (*Larix laricina*). Common understory species include prickly rose (*Rosa acicularis*), highbush cranberry (*Viburnum edule*), bunchberry (*Cornus canadensis*), Labrador tea (*Ledum groenlandicum*), and kinnikinnick (*Arctostaphylos uva-ursi*).

The Boreal White and Black Spruce wet cool (variant 1) subzone (BWBSwk1) is similar to the BWBSmw with wetter, shorter summers and colder winters. The BWBSwk1 subzone is at higher elevations and comprises 47 hectares, or 0.4 percent of the Project activity zone.

2.2.1.2 Sub-Boreal Spruce

The Sub-Boreal Spruce Finlay-Peace wet cool (variant 2) subzone (SBSwk2) is distinguished from adjacent subzones (i.e., BWBSmw, BWBSwk1) by a wetter climate with higher summer precipitation, higher winter snowfall and a slightly longer growing season. Forested areas within this subzone are often climax forests dominated by hybrid white spruce (*Picea engelmannii, x glauca*) and subalpine fir (*Abies lasiocarpa*). On gently sloped

upland sites, black spruce occurs with lodgepole pine, while along streams and rivers, hybrid white spruce occurs with black cottonwood (P. balsamifera, spp. trichocarpa). Stands of paper birch (*Betula papyrifera*) are also known to be present in the eastern region near Williston Lake (DeLong 2004). This subzone accounts for 0.8 percent of the Project activity zone.

2.3 Merchantable Forest

Most mature forest stands have varying amounts of merchantable and non-merchantable fibre. This report applies the tree utilization specifications identified by the British Columbia Ministry of Forests, Lands and Natural Resource Operations in their description of stand merchantability in the timber supply reviews for the Dawson Creek and Fort St. John timber supply areas. Please see Appendix C for a discussion on the definition of merchantable forest.

Table 2.2 quantifies the dominant tree species and merchantable volume in the Project activity zone.

Table 2.2 Dominant tree species within the Project activity zone

Tree Species		Gross Area by Dominant Species (ha)	Merchantable volume (cubic metres)	Percent of Total Volume
Coniferous	Spruce	1,485.6	498,221	33.4%
	Pine	114.2	29,996	2.0%
	Tamarack	81.5	2,707	0.2%
Total Coniferous		**1,681**	**530,924**	**35.6%**
Deciduous	Cottonwood[1]	1,861.3	339,951	22.8%
	Aspen	3,052.4	557,443	37.4%
	Birch	361.2	63,937	4.3%
Total Deciduous		**5,274.9**	**961,331**	**64.5%**
	Total All Species	**6,956**	**1,492,255**	**100%**

NOTE:
Note 1 Old, decadent cottonwood stands are estimated to cover 468.5 hectares and equate to 182,950 cubic metres of volume. This volume is included as part of the total merchantable cottonwood volume identified above.

Of the total forested area potentially affected by the Project (6,956 hectares), coniferous-leading stands comprise 36 percent of the merchantable volume (530,924 cubic metres) and deciduous-leading stands of trees comprise 64 percent of the volume (961,331 cubic metres). Lowland areas throughout the Project activity zone contain substantial quantities of

large, decadent cottonwood trees. Despite being classified as a merchantable species by the BC MFLNRO these decadent cottonwood trees offer challenges to effective harvesting and utilization due to advanced levels of decay. The merchantable volume associated with these cottonwood stands is estimated to be 183,000 cubic metres.

2.4 Non-Merchantable Vegetation

Non-merchantable vegetation is used to describe all of the biomass that does not meet the merchantability description provided by the BC MFLNRO. Biomass equations developed by the BC MFLNRO were applied to the vegetation resource inventory for the Project activity zone to calculate total stand biomass. These equations provided estimates for above-ground biomass and were derived in oven-dry tonnes. Since stump removal would need to be carried out in some parts of the Project activity zone, estimates of below-ground biomass were obtained by multiplying the gross biomass by 20 percent (Kajimoto et al 1999; Naesset 2003). Subtracting the merchantable volume from the total biomass volume (i.e., above- and below-ground) provided an estimate of the total non-merchantable vegetation in the Project activity zone. The total non-merchantable biomass within the Project activity zone, converted from oven dry tonnes to cubic metres, was estimated to be 1,636,000 cubic metres. Please see Appendix F for additional information on the conversion of units of biomass from oven dry tonnes to cubic metres equivalent.

2.5 Clearing Strategy

The prescription for clearing vegetation varies by site location, the requirements of construction engineers and is proposed in consideration of, amongst other information, input received from Aboriginal groups relating to mercury methylization, water quality, boater safety, utilization of forest resources, fish and fish habitat, and wildlife habitat.

Areas of the Project activity zone that would require major earthworks, such as the dam site, Highway 29 realignment, new all-season access roads and proposed quarry areas, would require complete removal of vegetation - including stumps. This would be followed by the grubbing and removal of top soil (e.g., please see Volume 1 Section 4 Project Description). The transmission line would have a combination of clearing with and without stump removal. The reservoir would have several clearing treatments prescribed. Depending on location, access, ground stability and other factors, trees within the reservoir

may or may not be removed. Additional detail on the area and volume that would need to be cleared from various sites within the Project activity zone is provided in the sections following.

The falling of standing merchantable and non-merchantable trees within the Project activity zone would be done according to the British Columbia Occupational Health and Safety Regulation (i.e., sec. 26.11 and 26.21 to 29.30) and WorkSafeBC Guidelines (Part 26).

The falling of merchantable trees within riparian areas would follow BC Hydro's Approved Work Practices for Managing Riparian Vegetation (BC Hydro 2003)[2].

Grubbing areas involves the removal of stumps, roots, buried logs and logging slash (e.g., branches, tops, shrubs) and other debris that is left on the ground after clearing operations. "Stripping" refers to the removal of topsoil or other organic material, and mineral soils that would be removed for construction purposes. Additional information on stripping is provided in Volume 1 Section 4 Project Description.

The majority of the clearing would be done during the winter months. However, scheduling issues and access restrictions to certain areas may prompt clearing activities to occur during the late summer or fall seasons. BC Hydro would attempt to schedule clearing activities in time periods that affords the least-risk for selected aquatic and terrestrial wildlife of primary management concern to the BC MFLNRO in the Peace Region (please see Volume 2 Section 12 Fish and Fish Habitat and Volume 2 Section 14 Wildlife Resources). When vegetation clearing activities are operationally constrained to a time period that has the potential to disturb or harm resident and migratory birds or their active nests, surveys would be completed by qualified environmental professionals to determine active nesting sites and ensure that clearing contractors are aware of the appropriate BC Hydro clearing mitigation practices. The proposed protocols with respect to clearing vegetation in consideration for wildlife resources are identified in Volume 2 Section 14 Wildlife Resources.

[2] This plan would see the definition for riparian management area for slopes less than 60 percent from top of bank being applied to all slopes adjacent to streams, rivers or other fisheries-sensitive zones.

2.6 Wood Utilization and Disposal Strategy

Wood that is removed within the Project activity zone as part of the vegetation clearing process would either be sold to the forest industry or disposed of in a manner described in Section 2.6.2. The forest products industry in the British Columbia communities of Fort St. John, Taylor, Dawson Creek and Chetwynd consisted in 2012 of three sawmills, two pulp mills and two oriented strand board (OSB) plants.[3] These facilities utilize coniferous and deciduous sawlogs, pulp logs, wood chips and small quantities of waste wood. Within the local communities, the utilization of waste wood exclusively for the production of bioenergy or biofuel is extremely limited. At a broader scale, the regional communities of Mackenzie, British Columbia and Grande Prairie, Alberta have sawmills, pulp mills and bioenergy facilities. The transportation distance of waste wood from the Project to processing facilities near these two communities may be cost prohibitive. BC Hydro's strategy for disposing of vegetation that is not or cannot be used by the forest industry would depend upon its location, potential new, local industrial demand and British Columbia regulations that are in place at the time of vegetation clearing.

2.6.1 Merchantable Wood Utilization

Merchantable logs harvested during vegetation clearing would be offered for sale to the forest industry. To ensure that maximum value is recovered, harvested merchantable coniferous and deciduous trees would be transported to either a roadside or a central collection area within the forest for processing. Processing coniferous trees involves mechanically removing the limbs and tops and then cutting the stems into commercial log lengths for loading onto logging trucks. Processing deciduous trees can involve either a similar log-processing activity or an activity whereby the whole-tree is chipped on-site (i.e., for eventual use in a pulp or OSB mill).

Vegetation clearing would result in the availability of approximately 1.4 million cubic metres of merchantable wood for sale to the forest industry over a four-year period (see Appendix D for more detail). The existing regional British Columbia forest industry (i.e., within a 100-kilometre radius of the proposed Project) currently has the capacity to utilize all of the

[3] The Louisiana Pacific Canada Ltd. OSB plant in Dawson Creek and the Tembec Inc. pulp mill near Chetwynd curtailed operations in 2012 as a result of market-related forces.

merchantable wood harvested from the Project activity zone. The regional log processing capacity in 2011 was 2.86 million cubic metres of coniferous logs and 2.1 million cubic metres of deciduous logs annually (BC MFLNRO 2012). However, the regional industry's average annual log consumption between 2006 and 2010 was somewhat lower at 1,544,000 cubic metres of merchantable deciduous fibre and 1,884,000 cubic metres of merchantable coniferous logs (BC MFLNRO 2011). On a regional basis, the clearing for the Project would supply less than one-third of the forest industry's annual deciduous volume demand and one-seventh of the annual coniferous log demand. Please see Volume 3 Section 21 Forestry for a more complete description of the regional forest industry.

2.6.2 Non-Merchantable Wood Disposal

The amount of non-merchantable wood that is estimated to exist within the Project activity zone is estimated at 1,636,000 cubic metres. Non-merchantable wood consists of branches, tree tops, bark, foliage, stumps, roots, undersized trees, rotten and broken trees, water-borne woody debris and ground vegetation (e.g., brush). Within the dam construction site, quarries, Highway 29 realignment and proposed access roads, all non-merchantable wood and debris will be removed to allow construction activities to occur. Within the transmission corridor and the reservoir, some of this non-merchantable fibre would be retained on-site to serve as fish habitat, minimize soil erosion and reduce siltation. The amount of non-merchantable wood that is expected to be removed, and would need to be disposed of, is estimated at 1,188,000 cubic metres (see Appendix D for more detail).

The options to dispose of this volume are:

- Sale or delivery to a waste wood biomass processing plant (i.e., charcoal plant, pellet plant or biomass power generating plant)
- Incineration (either on-site or off-site)
- Landfilling (biomass burial)
- Scattering

The preferred method of disposal is the sale and delivery of non-merchantable vegetation to a biomass processing plant. The Tembec pulp mill near Chetwynd, British Columbia and the Canfor sawmills in Fort St. John and Chetwynd use non-merchantable biomass for the production of energy. The quantity utilized is approximately 83,000 cubic metres per year (35,000 oven dry tonnes [ODT]) at Canfor (Saugstad 2012 pers. comm.) and 142,000 cubic

metres per year (60,000 ODT) at Tembec (Braybrook 2012 pers. comm.). All of the non-merchantable volume consumed by Canfor is produced as a by-product from the production of lumber. The volume consumed by Tembec is primarily bark created during pulp log processing. Tembec currently does not have sufficient bark to operate their steam energy plant, necessitating the purchase of about 24,000 cubic metres (10,000 ODT) of bark each year. This market demand is approximately two percent of the total amount that would need to be disposed of during vegetation clearing operations. Due to the ability of Canfor and Tembec to self-source most, if not all, of their non-merchantable biomass requirements from existing industrial operations, they currently (i.e., 2012) do not have any demand for the non-merchantable biomass generated from clearing vegetation from within the Project activity zone.[4]

Two new private industrial developments that potentially could utilize non-merchantable biomass are in the planning stages for construction at Chetwynd, British Columbia. BC Hydro will monitor the progress of these industrial developments and facilitate discussions to ensure industry is aware that a large quantity of waste wood may become available for a short-term during the construction phase of the Project.

Alternative methods for disposal of non-merchantable wood include incineration, land-filling and scattering. Incineration would involve the piling and burning of non-merchantable wood on-site or transporting the biomass a short distance to a forced-air incineration location constructed by BC Hydro for this purpose. The British Columbia Ministry of Environment has the mandate to regulate smoke emissions from open burning activities through the application of the Open Burning Smoke Control Regulation which is currently under review (BC MoE 2012). In anticipation of potential changes that may occur as a result of this review, a Smoke Management Plan is being developed by BC Hydro (please see Appendix E). This plan would address smoke management strategies, identify best practices, identify ignition and smoke release periods and ensure that incineration is conducted in adherence to government regulations.

Land filling non-merchantable biomass is a consideration in areas where burning is problematic due to proximity to communities and where large excavations are taking place

[4] The Tembec pulp mill commenced production curtailment in September 2012 as a result of market-related forces

as part of Project development. Land filling has the advantage of eliminating smoke-related emissions and locking up biomass in long-term storage, to aid in managing the Project's greenhouse gas emissions. Construction activities would generate surplus excavated materials that would need to be moved and stored as part of the construction plan; this creates an opportunity to incorporate land-filling of woody debris during that process.

In the transmission line corridor, a combination of scattering non-merchantable wood in low vegetation density areas, or reducing the size of the non-merchantable wood through chipping or grinding and then scattering the fibre away from riparian areas, may also be considered.

Burning, land-filling or scattering non-merchantable biomass would only be done if there is no regional demand for this fibre.

3 CLEARING THE DAM CONSTRUCTION SITE

3.1 Dam Construction Site General Description

The proposed dam site, adjacent construction area and worker camps would be located approximately seven kilometres south-west of the city of Fort St. John. Primary access to this area currently includes the extension of an existing road from the south (by way of Chetwynd, British Columbia and the Jackfish Lake Road) and a road from the north (by way of Fort St. John and Highway 97). Many trails and small access roads currently cross the area, predominately on the south bank of the Peace River. Please see Volume 1 Section 4 Project Description Figure 4.36 for a view of the location of the dam construction site.

New permanent roads would need to be constructed and some existing roads upgraded to provide both temporary and long-term access to the dam site. Details of this road development and the general topography of the location are provided in Volume 1 Section 4 Project Description.

Approximately 70 percent (1,435 hectares) of the area within the proposed dam construction site is currently forested. Table 3.1 shows the distribution of existing physical features within the dam construction site.

Table 3.1 Physical features in the dam construction site

Feature	Area (ha)	Percent
Forest	1,435.0	70.5%
Water	199.4	9.8%
Existing roads	105.4	5.2%
Shrub	167.7	8.2%
Exposed soil	127.6	6.3%
Gross Area	**2,035**	**100%**

Please see Volume 1 Section 4 Project Description Figure 4.36 for an overview of the dam construction site and the classification of activity sectors within the area. The area and volume in these sectors are quantified in Table 3.2. For the purposes of this plan, vegetation clearing was assumed to occur throughout both the "Potential Construction Area – subject to further design", and within the "Restricted Activities Zone – Limited Activities". It is possible that some of the forests within these two areas would be retained.

Table 3.2 Dam site area and volume classifications

Dam site area classification	Forest Area (ha)	Total Area (ha)	Merchantable Volume (cubic metres)	Gross Biomass (cubic metres)	Potential vegetation clearing required?
Construction Areas	1,279.8	1786.8	264,432	571,102	Yes
Potential Construction Area – Subject to further design[1]	27.3	42.9	7,201	15,073	Assume Yes
Restricted Activities Zone - Limited Activities	127.9	205.5	21,250	50,057	Yes
Total Proposed to be Cleared	**1,435**	**2,035**	**292,883**	**636,232**	**n/a**

Notes:
Note 1. Pending further investigation into designs, the area and volume cleared may be changed in this area.

An estimated 292,883 cubic metres of merchantable timber exists at the proposed dam construction site. Deciduous trees comprise 93 percent of this volume. The gross volume of biomass within the dam construction site is presently estimated to be 636,232 cubic metres.

Ground slopes across the dam construction site vary. Slopes greater than 45 percent are typically a barrier to conventional logging equipment (e.g., feller-bunchers and wheeled

skidders). Table 3.3 shows that the majority of the proposed dam site contains moderate slopes below 45 percent. Where slopes exceed 45 percent, skid roads would be constructed to facilitate the safe removal of vegetation and stumps.

Table 3.3 Dam construction site slope conditions

Slope class	Forest Area (ha)	Percent Area
0-45%	1279.6	89.2%
46-70%	51.4	3.6%
>70%	104.0	7.2%
Total	**1,435**	**100%**

3.2 Dam Site Clearing Strategy

Within the dam construction site (e.g., please see Section 4 Project Description Figure 4.36), all trees, shrubs, stumps and larger roots would be cleared; with the exception of the area on the south side of the Peace River and west of the Moberly River (i.e., 102 hectares). This area would retain its stumps, as the area would be used to relocate soils from the east side of the Moberly River.

The total forest area and merchantable volume in the dam construction site is 1,435 hectares and 292,883 cubic metres. All 1,435 hectares would be cleared and merchantable tree volume would be salvaged. An estimated 343,044 cubic metres of non-merchantable biomass would be removed and disposed of, either by incineration or land filling.

Clearing would be carried out using a combination of feller-bunchers and some hand-falling Whole trees would be transported to log landings or the roadside using crawler tractors, line skidders and grapple skidders. BC Hydro would require all of its contractors using mobile equipment and manual tree falling techniques in forestry work areas to be in compliance with the WorkSafeBC Regulations, with particular attention to Part 26 – Forestry Operations (WorkSafeBC 2012).

After trees have been transported to landings or the roadside, sorting, processing and debris disposal activities would occur. Examples of the types of clearing equipment that may be employed are provided in Appendix G. Logs and wood chips would then be transported by logging and chip trucks to processing facilities in the area.

As a general rule, on slopes exceeding 45 percent, hand-felling would be employed. On the south-bank, slopes exceeding 75 percent are seldom sustained for more than 50 metres and short skid-roads would be used as necessary to facilitate the safe clearing and stumping of construction areas. On the north bank, steep hill-side sections are often sustained for 200 to 400 metres. In these areas, a more extensive network of skid roads would be required to facilitate the safe access for crawler tractors to remove logs and stumps.

The volume of merchantable and non-merchantable wood at the dam site is summarized in Table 3.4. Please see Appendix D for more summary information.

Table 3.4 Volumes proposed for clearing in the dam construction zone

Merchantable volume (m^3)			Non-merchantable volume (m^3) [1]	Total cleared biomass (m^3)
Deciduous	Coniferous	Total		
272,189	20,694	292,883	343,349	636,232

NOTES:
1 The estimated non-merchantable volume includes stumps and below ground biomass.

3.3 Dam Site Clearing Schedule

Construction of the dam and the generating station would take place over eight years with the majority of the vegetation clearing for construction being completed in the first year. Though this would create an intensive concentration of equipment in a relatively short period of time, it would also minimize the congestion of trucks and heavy equipment that would ensue in the latter portions of the construction project.

Clearing of the dam site would preferably be concentrated during winter months. Clearing outside of this window would employ the mitigation measures described in Volume 2 Section 14 Wildlife Resources.

4 CLEARING FOR HIGHWAY 29 REALIGNMENTS

4.1 Highway 29 Realignment General Description

BC Hydro has identified six locations along Highway 29, between Hudson's Hope and Fort St. John where the existing highway right-of-way would need to be shifted to provide safe transit along the north shore of the proposed reservoir. Volume 1 Section 4.3.4 Highway 29 Realignments describe each of these six locations, as well as the location and length of proposed bridges and causeways. Volume 1 Section 4 Figure 4.11 provides a general overview of the location of these six sites. Volume 1 Section 4 Figures 4.28 to 4.33 show the general arrangement of Highway 29 realignment segments at Lynx Creek, Dry Creek, Farrell Creek, Farrell Creek East, Halfway River and Cache Creek respectively.

Table 4.1 lists the highway segments and quantifies the area and volumes of biomass and merchantable forest in each area. The total length of the realignment would be approximately 30 kilometres covering 418 hectares. About a third of the area affected by the highway realignments is already cleared as it follows along the existing highway right-of-way (42 hectares) or over cultivated land (71 hectares). Exposed soil and shrub areas comprise 95 hectares, and water covers 16 hectares, leaving approximately 194 hectares of forest. The forest is predominately deciduous (80 percent). The total merchantable volume of both coniferous and deciduous tree species is 23,986 cubic metres. An estimated 19,266 cubic metres of merchantable deciduous fibre and 4,720 cubic metres of coniferous logs would be removed. Accumulated non-merchantable fibre is estimated at 27,761 cubic metres.

Table 4.1 Highway 29 Realignment area and volume

Realignment Section	Area (hectares)		Volume (cubic metres)			
	Gross	Forest	Merchantable coniferous logs	Merchantable deciduous	Total merchantable	Gross Biomass
Lynx Creek	105.7	47.7	1,186	4,866	6,052	13,319
Farrell Creek East	69.1	24.4	755	2,413	3,168	6,827
Halfway River	44.0	25.2	11	1,769	1,780	3,829
Farrell Creek	34.1	18.3	218	3,107	3,325	7,200
Dry Creek	26.4	15.8	106	1,820	1,926	4,267
Cache Creek	138.7	62.6	2,444	5,291	7,735	16,305
Total	**418**	**194**	**4,720**	**19,266**	**23,986**	**51,747**

The majority of the Highway 29 realignment sections occur in areas where slopes are relatively flat. However, steeper slopes exceeding 70 percent exist on approaches to the rivers or creeks. Table 4.2 describes the forest area within each realignment section by slope classification.

Table 4.2 Highway 29 forest areas by slope classification

Realignment Section	Forest area (ha) by slope classification			
	0-45%	46-70%	Greater than 70%	Total (ha)
Lynx Creek	44.9	1.07	1.8	47.7
Farrell Creek East	20.5	1.98	1.9	24.4
Halfway River	23.4	0.00	1.8	25.2
Farrell Creek	16.8	0.00	1.4	18.3
Dry Creek	12.4	0.92	2.4	15.8
Cache Creek	53.9	3.35	5.3	62.6
Total Forest Area	**172**	**7**	**15**	**194**

4.2 Highway 29 Realignment Clearing Strategy

Within the Highway 29 realignment sections, complete removal of commercial and non-commercial vegetation, including vegetation on steep slopes would be required. Appendix D provides summary information of the area and volume that would be cleared. Vegetation would be removed primarily with conventional falling equipment (e.g., feller-bunchers) and the use of skidders to transport logs to roadside. See photographs in Appendix G for examples of the types of clearing equipment that would be used. Commercially-valued trees would be removed first. Non-merchantable fibre and stumps would be removed through the use of tracked bull-dozers.

Clearing vegetation near riparian habitat, waterways and where activities could affect migratory birds would follow the permits, approvals, regulations and guidelines established by the British Columbia Ministry of Transportation and Infrastructure for clearing and grubbing on highway construction projects (MoT 2012). In addition, all clearing activities would follow the environmental laws and regulations of B.C. and Canada. These include the following:

- Fisheries Act Section 34(1), 35(1) and 36
- Navigable Waters Protection Act Sections 5(1), 5(2), 5(3) ~~6(1) 6(4) 10(1), 10(2)~~
- Migratory Bird Convention Act, Section 12
- Water Act Section 9, Water Act Regulation Part 7
- Fish Protection Act
- Wildlife Act, Sections 9, 34 and 35
- Weed Control Act, Weed Control Regulations

The disposal strategy of merchantable logs and non-merchantable wood is described in Section 2.6 of this plan. The site reclamation activities that would occur post vegetation clearing is identified in Volume 1 Section 4.3.4 Project Descriptions Highway 29 Realignments, and Volume 1 Section 4.4.1 Site Preparation.

4.3 Highway 29 Realignment Clearing Schedule

The following proposed clearing schedule timelines are approximate and are based on preliminary construction timelines. These would be updated as required to align with the Highway 29 construction schedule.

Table 4.3 Highway 29 clearing schedule

Realignment Section	Clearing Schedule
Halfway River	Year 1 Summer
Cache Creek	Year 1 Summer
Lynx Creek	Year 3 Summer
Farrell Creek East (Km 21 to 27)	Year 3 Summer
Farrell Creek	Year 3 Summer
Dry Creek	Year 3 Summer

5 CLEARING FOR CONSTRUCTION MATERIAL SITES

5.1 Construction Material Sites General Description

Construction of the Site C dam would require a variety of granular materials. Though the majority of materials required for construction of the earthfill dam are available from the dam construction site, other material is expected to be sourced off-site from the construction and reservoir areas. Please see Volume 1 Section 4.3.5 Project Description for more information. Potential quarries identified by BC Hydro as possible sources of construction material include Portage Mountain, West Pine, 85th Avenue industrial quarry, Del Rio Pit, Area E and the Wuthrich Quarry. The location of each of these construction materials sites is shown in Volume 1 Section 4 Figure 4.11 Site C Project Activity Zone.

The area and vegetative volume associated with each of the potential construction materials sites is identified in Table 5.1. Construction material sites require the clearing of an estimated 394 hectares of forested area and 89,456 cubic metres of merchantable volume.

Table 5.1 Construction materials sites areas and volume

Quarry Name	Area (ha)		Merchantable Volume (m^3)			Total Biomass Volume (m^3)
	Total	Forest Area Proposed for clearing	Coniferous	Deciduous	Total	
Portage Mountain	150.7	149.7	10,921	12,660	23,581	55,291
West Pine	104.0	89.2	18,681	2,382	21,063	43,456
85th Avenue [1]	111.2	12.5	0	1,551	1,551	3,390
Del Rio Pit	161.5	116.5	27,318	11,982	39,300	73,118
Area E	80.1	13.7	686	661	1,347	3,697
Wuthrich	18.3	12.8	0	2,614	2,614	5,419
Total	**626**	**394**	**57,606**	**31,850**	**89,456**	**184,371**

NOTES:
Note 1 Area and volume clearing for the 85th Avenue industrial site quarry includes the haul route leading to the dam site.
Note 2 Potential aggregate sites have been identified, but at this time none of this area is proposed for clearing for construction materials. Several of these sites are adjacent to the Highway-29 realignment or within the reservoir.

5.2 Construction Material Sites Clearing Strategy

Within the proposed construction materials sites, complete removal of commercial and non-commercial vegetation would be required. This clearing would result in the removal of all commercially-valued trees first, followed by stump and non-merchantable biomass removal. Clearing near riparian habitat would follow the guidelines approved by the British Columbia Ministry of Transportation and Infrastructure. Vegetation clearing would result in an estimated 31,850 cubic metres of deciduous fibre and an estimated 57,606 cubic metres of coniferous fibre. Total biomass is estimated to be 184,371 cubic metres.

The disposal strategy of merchantable logs and wood waste is described in Section 2.6. Clearing vegetation from proposed quarries falls within the regulatory framework of the British Columbia Ministry of Forests Lands and Natural Resource Operations. BC Hydro would require forest clearing authority through an Occupant Licence to Cut issued under Section 47.4(2) of the Forest Act (BC MFLNRO 2010). BC Hydro would ensure that only the timber that is necessary to facilitate the proposed use of the land is removed. When clearing in and around riparian areas, BC Hydro contractors will follow the Land Development Guidelines for the Protection of Aquatic Habitat established by the Canadian

Department of Fisheries and Oceans (DFO 1993). Following the guidelines established in this document would ensure that appropriate riparian and erosion control measures are taken to mitigate environmental impacts outside of the proposed quarry. Vegetation clearing within the quarries identified in the Project activity zone would require the complete removal of vegetation, followed by grubbing after clearing is complete. BC Hydro would therefore acquire an exemption from the applicable forestry practice requirements identified in Part 4 of the Forest Planning and Practices Regulation (Section 35-70 inclusive) (BC MFLNRO 2009).

5.3 Construction Material Sites Clearing Schedule

The proposed clearing schedule timelines shown in Table 5.2 are approximate and are based on the preliminary construction timelines. These would be updated as required to align with the construction schedule.

Table 5.2 Construction materials sites clearing schedule

Component	Construction materials site	Clearing Schedule
Temporary riprap	Wuthrich quarry	Year 1 winter/summer
	85th Ave	Year 1 winter/summer
Till material	Portage Mountain	Year 2 winter/summer
Permanent riprap	West Pine	Years 1 and 2 winter/summer
Gravel	Wuthrich	Years 1 and 2 winter/summer
Gravel	Del Rio pit	As required

6 CLEARING FOR ACCESS ROADS

6.1 Access Roads General Description

A general description of the road access to the Project activity zone is provided in Volume 1 Section 4.3.7 Road and Rail Access. The description in this section describes road access to all construction sites except for the reservoir and a small portion of the transmission corridor, for vegetation clearing purposes.

Project access to the Project activity zone would require clearing activities that fall into the four classes shown below.

1. Existing access roads requiring upgrade
2. Proposed new temporary all-season access roads
3. Proposed new temporary access roads
4. Proposed new temporary water crossings

In addition to access roads, the construction of a large number of temporary water crossings would be required. Crossings may include the installation of temporary bridges or snow crossings. Depending on the length of span, abutment bridges or piling bridges may be used. Snow-crossing construction involves placing a box culvert over a drainage, whereupon it is covered by snow, ice and or gravel. Examples of these types of crossings are provided in Appendix I.

6.2 Existing Roads Requiring Upgrade

Existing roads that would require upgrading to access the reservoir and transmission corridor are shown in Figure 6-1. Approximately 54 kilometres of existing roads would require upgrading in the form of ditching, right-of-way brushing, re-establishment of culverts and spot gravelling. Many of these roads do not have proper names and are found at the terminal point of longer, more developed road networks. The biomass volume associated with upgrading these roads for forestry use is expected to be negligible.

On the south side of the reservoir, two existing road networks lead to the centre of the proposed reservoir: 1) the Project Access Road, which transitions into the South Monias (also known as the Del Rio Road); and 2) the North Monias. Leading to the south-west end of the reservoir is the Medicine Woman Road, which would require upgrading for the portion of road occurring north of the existing transmission corridor.

Road access within the transmission corridor is already in place as a result of the previous construction of two existing 138 kv transmission lines and associated ongoing corridor maintenance.

Other existing roads that would require upgrading include portions of the Beaver Loop Road, Old Hope Road and Wilder Road.

All roads would be upgraded to the standards required by the British Columbia Ministry of Forest Lands and Natural Resource Operations as described in the Engineering Manual (BC MFLNRO 2012b).

6.3 New Access Road Strategy

The strategy for the development of new temporary access roads for the Project activity zone is:

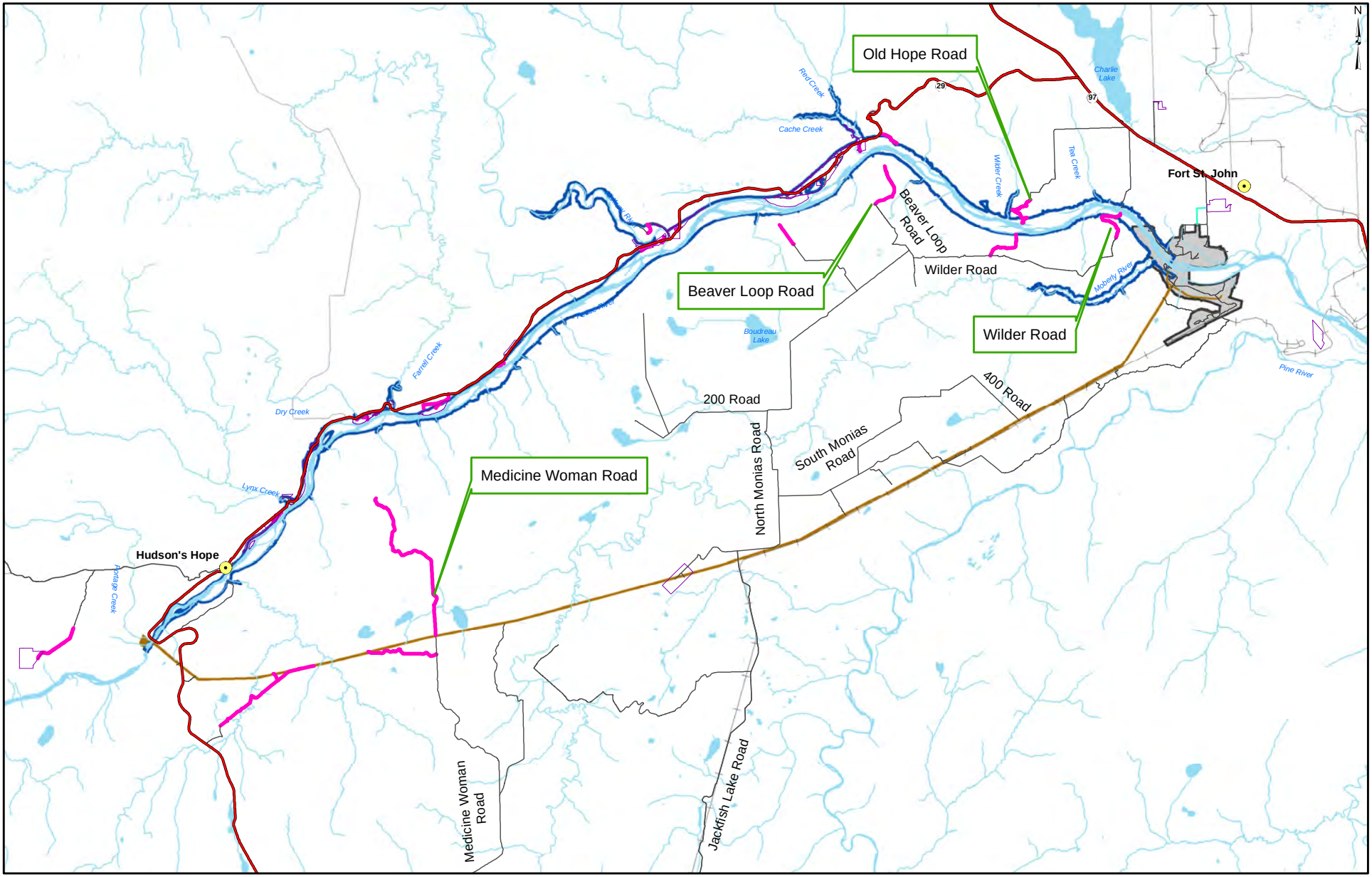
1. Minimize the amount of new temporary access outside of the Project activity zone.
2. Avoid where possible, construction of roads through ungulate winter range near the Moberly River.
3. Remove all vegetation from the access road corridor, with retention of some low-cut stumps where road use is for temporary winter access.
4. Clear road corridors near riparian habitat following guidelines approved by the Ministry of Forests, Lands and Natural Resource Operations' Engineering Manual (BC MFLNRO 2012b).
5. Deactivate roads once clearing activities are complete, if not required for other components of Project construction or operations. The deactivation of roads accessing the south bank would include re-contouring side cuts and the placement of coarse woody debris on the track outside of the reservoir to reduce potential future ATV access and to create habitat for small furbearers.

Figure 6-2 shows the location of proposed temporary all-season and winter access roads. Most of these roads were field checked to verify their feasibility in the summer of 2012.

Proposed temporary access routes were field-located and traversed from the top of the southern plateau down to the Peace River. The steep side slopes and areas of moist clay soils were reviewed, along with the proposed access locations, by forest road engineers completing field surveys in summer 2011 and 2012. Access construction down these slopes would be conducted in dry summer conditions. This would prevent the placement of snow, ice and frozen material in the road fill that would otherwise occur during winter construction. These materials do not compact easily and will settle when they thaw. The resulting fill is unstable, low in strength and highly erodible.

New access roads would be cleared by feller-bunchers to salvage merchantable logs. Non-merchantable fibre would be either burned on site or land filled. Temporary road construction down the slopes to the Peace River would be completed with excavators and tracked dozers and would employ standards set by the British Columbia Ministry of Forest Land and Natural Resource Operations' Engineering Manual (BC MFLNRO 2012b).

Construction of temporary winter access roads would be the primary method of accessing vegetation that would be cleared during winter months. By using deep snow or frozen ground as the running surface, particularly in soft or fine textured soils, clearing equipment have a lower environmental impact then when working on all-weather roads. These roads would be constructed in the early part of the winter so that harvesting could be completed before snowmelt and the break-up of frozen ground in the spring. A detailed description of the construction process and rationale for winter access construction is described in the British Columbia Ministry of Forest, Land and Natural Resource Operations' Engineering Manual, Chapter 5 Section 12 (BC MFLNRO 2012b).



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

Proposed Reservoir
Dam Site Area
Transmission Corridor
Off-site Construction Materials
Conveyor Corridor
Existing Roads Requiring Upgrade
Roads
Highway
Railway

0 10 Km

SITE C CLEAN ENERGY PROJECT

BC hydro

Figure 6-1:
Existing Roads
Requring Upgrade

DATE	December 06, 2012	DWG NO	1016-C14-A6210-1	R3

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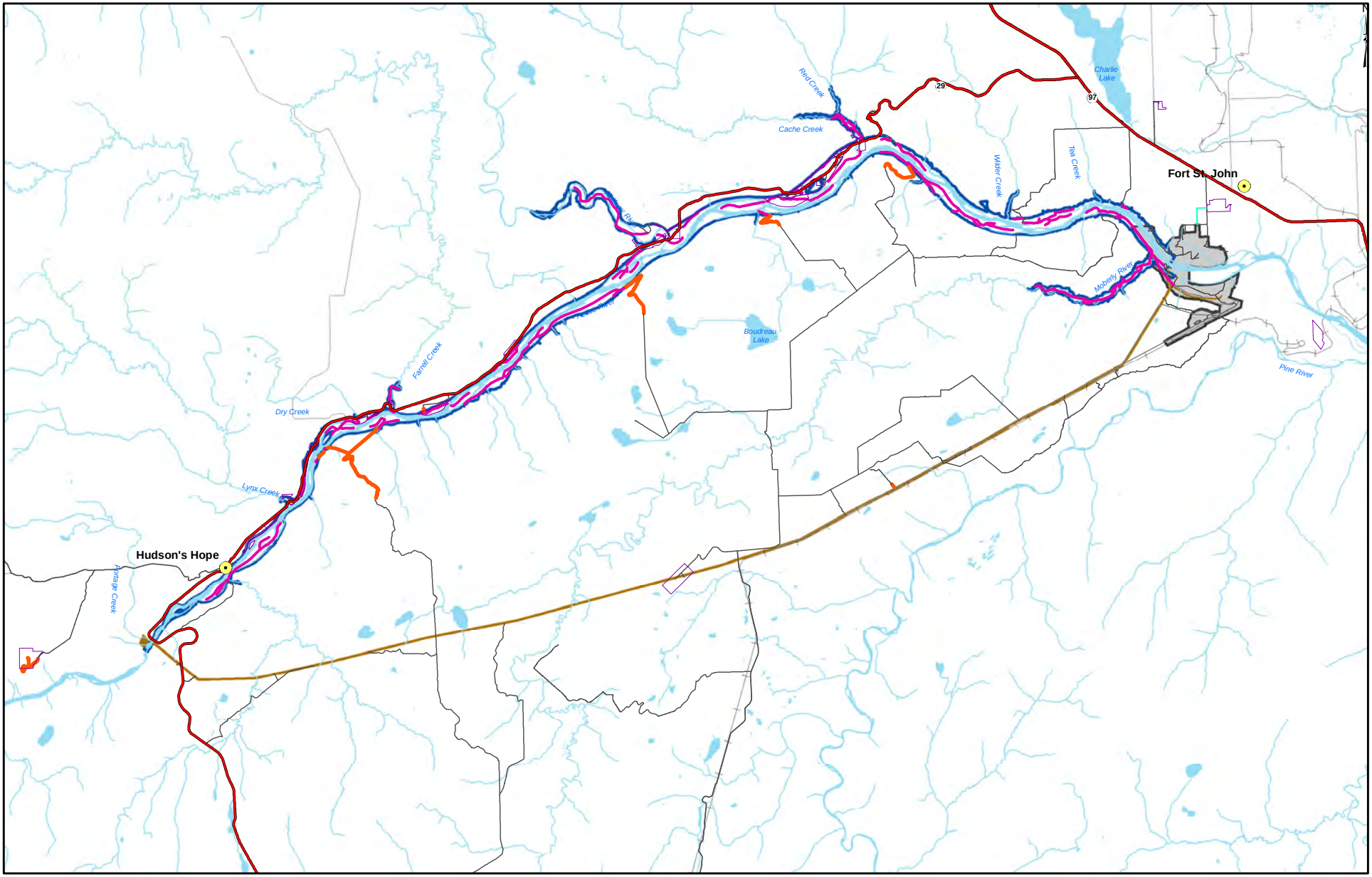
Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification.



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

Proposed Reservoir
Dam Site Area
Transmission Corridor
Off-site Construction Materials
Conveyor Corridor
Temporary All Season Access
Temporary Winter Access
Access Road to Dam Site
Existing Roads
Highway
Railway

0 10 Km

BC hydro

SITE C CLEAN ENERGY PROJECT

Figure 6-2:
Proposed
Temporary Road Access

DATE	December 06, 2012	DWG NO	1016-C14-A6210-2	R3

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

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6.3.1 Temporary All Season Access Roads

Approximately 70 kilometres of new temporary all season access roads covering approximately 87 hectares, would be required leading to the reservoir and the dam site.

In the summer of 2011, three short proposed access routes (i.e., 10.3 kilometres) were identified through field reconnaissance leading to the central portions of the reservoir. One longer route (9.6 kilometres) was identified leading to the south-west end of the reservoir. Figure 6-2 shows the general location of new temporary all season access routes.

The volume of merchantable trees associated with clearing the right-of-ways for these roads is approximately 13,505 cubic metres. Non-merchantable volume is estimated to be 17,821 cubic metres.

6.3.2 Temporary Winter Access Roads

Access roads within the proposed reservoir would consist of temporary winter access roads that would be deactivated after vegetation clearing has been completed. An estimated 128 kilometres of temporary winter access road would be required for reservoir clearing. Examples of temporary winter access roads are provided in Appendix I.

A summary of the area and volume cleared for temporary winter access roads within the Project activity zone is provided in Table 6.1. Vegetation clearing of temporary winter access roads would result in the removal of an estimated 27,158 cubic metres of merchantable logs. Total biomass removed is estimated to be 54,563 cubic metres.

The disposal strategy of merchantable logs and wood waste is described in Section 2.6.

Table 6.1 Proposed road access

Access Roads[1]	Length (km)	Gross Area (ha)	Forest Area (ha)	Merchantable Volume (m^3)	Total Biomass Volume (m^3)
Existing road upgrades	54.3	n/a	n/a	n/a	n/a
Proposed new all season roads	70.0	87.1	74.9	13,505	31,326
Proposed temporary winter access roads	115.9	108.9	93.9	27,158	54,563
Total	**240**	**196**	**169**	**40,663**	**85,889**

Notes:
Note 1. This includes access to the reservoir, transmission line, dam site and the Portage Mountain quarry. This does not include proposed new roads within the Site C dam construction site, Highway 29 realignment and within other proposed quarry sites.

6.3.3 Temporary Water Crossings

An estimated 72 temporary water crossings would be required to access timbered vegetation on the islands and lowlands of the Peace, Halfway and Moberly rivers. The majority of these crossings (i.e., 46) would be winter crossings; 11 would be abutment bridges and 15 would be piling bridges. In many areas, “skidder-crossings” would be constructed to allow logging equipment to cross small streams, minor drainages and wet areas. An estimated 88 skidder-crossings would be required. Additional detail regarding water crossings is provided in Appendix I.

6.4 Access Clearing Schedule

The proposed access clearing schedule is based on the preliminary construction and clearing schedules. See Appendix D for additional detail on areas and volumes cleared by year. Clearing at the east-end of the reservoir would occur early in the schedule to accommodate the headponding effect that would occur during river diversion, resulting in partial, temporary flooding at the east end of the reservoir (please see Volume 1 Appendix B Reservoir Filling Plan).

Due to operational difficulties associated with slopes, soil types and moisture conditions with the construction of temporary access roads down the steep side-slopes on the south

side of the Peace River, these roads would be constructed during the summer when soils were dry. These would be primarily utilized during the winter months.

Table 6.2 Access road clearing schedule

Access Road	Clearing Schedule
to Dam site	Year 1 summer
to east end of reservoir	Year 2 summer
within east end of reservoir	Year 2 winter
centre of reservoir	Year 3 winter/summer
west end of reservoir	Year 4 winter/summer
along east end of transmission line	Year 1 winter/summer

7 CLEARING FOR TRANSMISSION CORRIDOR

7.1 Transmission Corridor General Description

Details of the substation and transmission corridor that is part of the Project activity zone are provided in Volume 1 Section 4.3.3 and Section 4.4.5.1.1. The location of the transmission corridor is shown in Volume 1 Section 4 Project Description Figure 4.25.

The transmission corridor is approximately 74 kilometres in length and the existing right of way has a cross-section which is 118 metres wide. Approximately 46 metres of the right-of-way had been previously cleared to support existing electrical requirements.

West of the intersection of the Jackfish Forest Service Road with the existing right of way, 72 metres of new clearing extent would be required to extend the right-of way to its 118 metre width. However, up to an additional 14 metres of clearing beyond the right-of-way would be required to remove any danger trees. Please see Volume 1 Section 4 Figure 4.26a for a cross section view of this clearing extent.

East of the intersection of the of the Jackfish Forest Service Road and the existing right of way, 89 metres of new clearing would extend the right of way to a 135 metre cross sectional width. This width would include an additional 17 metres of right-of-way that would be used to accommodate the Project Access Road to the Dam site. Please see Volume 1 Section 4 Figure 4.26b for a cross section view of this clearing extent.

Although small quantities of vegetation exist within the current 46-metre cleared corridor, additional clearing within this portion of the right-of-way is not proposed.

The existing transmission corridor (exclusive of the Dam construction site, Del Rio quarry and Project Access Road) encompasses an area of 1,231 hectares. Within this area 742 hectares is forested and would require vegetation clearing.

The forested area within the transmission corridor occurs primarily on a flat plateau that runs between the Moberly and Pine rivers. Soil here is composed of silts and or clays and is quite wet. Deciduous species, primarily trembling aspen, predominate at 61 percent of the merchantable volume. Coniferous species comprise 39 percent of the merchantable volume within the right-of-way. Most of this volume is white spruce (72 percent), with lodgepole pine (28 percent) contributing the remainder. The vegetative volume within the transmission right-of-way is shown in Table 7.1.

Table 7.1 Vegetation within Transmission right-of-way

Transmission Line Section	Forested Area (ha)	Merchantable Volume (m^3)			Biomass Volume (m^3)
		Deciduous	Coniferous	Total	
Transmission Corridor	742.2	79,749	51,896	131,645	293,041

7.2 Transmission Corridor Clearing Strategy

Within the transmission corridor, clearing would entail a combination of brushing vegetation to a maximum 30 centimetre stump height, falling trees within the corridor, full vegetation grubbing and partial cutting. Full vegetation grubbing would occur in locations where transmission towers are to be constructed, as well as for the re-establishment of access roads along the existing partially cleared right-of-way. Full grubbing would generally occur in areas where deciduous forest cover exceeds 30 percent in order to reduce future suckering of these stems[5]. Clearing vegetation to stump height would occur in most other areas between the transmission towers.

[5] Suckering occurs when a secondary shoot is produced from the base or roots of a woody plant that gives rise to a new plant. Deciduous tree roots are highly prone to 'suckering'.

Table 7.2 shows the area and volume that would be cleared for the transmission right-of-way. The disposal strategy of merchantable logs and non-merchantable fibre is described in Section 2.6.

Table 7.2 Transmission right-of-way clearing

Forest Area (hectares)				Forest Volume cleared (cubic metres)	
Vegetation Cleared to stumps	Trees cleared, stumps and non-merch. trees retained (i.e., riparian areas)	Trees cleared and stumps removed	Total Clearing Zone	Merchantable volume cleared	Gross Volume cleared
241.3	19.7	481.2	742	130,808	270,898

7.3 Transmission Corridor Clearing Schedule

The clearing schedule for the Site C transmission line is based on the construction schedule timelines defined in Volume 1 Section 4 Figure 4.41. Clearing would occur in year two of construction and would occur primarily during winter months.

8 CLEARING FOR THE PROPOSED RESERVOIR

8.1 Proposed Reservoir Site General Description

The proposed reservoir site is that area within the Project activity zone that would be inundated with water when reservoir filling commences (please see Volume 1 Appendix V1B Reservoir Filling and Commission Plan). In this clearing plan the reservoir site excludes those portions of the Project activity zone that have been previously described as the dam construction site and access roads. Vegetation clearing for the dam site and access roads would require a clearing strategy that exceeds the intensity of clearing that is required in the remainder of the reservoir site. This section of the plan describes the forests and conditions within the proposed reservoir site and the influence these conditions have on whether vegetation clearing is required.

The proposed reservoir would be 9,330 hectares when filled to the maximum normal reservoir level of 461.8 metres. Vegetation clearing is planned for above this elevation to account for wave action and progressive erosion that would occur at the shore of the reservoir. Volume 2 Appendix B Part 2 Preliminary Reservoir Impact Lines provides

additional information regarding the effect of the reservoir on the shoreline and the establishment of a 5-year beach line. In response to this analysis, the proposed reservoir clearing site was increased by approximately 180 hectares to an area that included consideration for reservoir impact lines.

The proposed reservoir clearing site does not include areas within the dam construction site (345 hectares), Highway 29 realignment (114 hectares) and access roads (190 hectares) that would also be inundated at the time or reservoir filling. The strategy for clearing vegetation from within each of these sites was discussed in Sections 3.2, 4.2 and 6.3.2, respectively.

8.2 Vegetation Inventory within the Proposed Reservoir

The existing land classifications within the proposed reservoir are water, exposed soils (i.e., gravel bars, roads, trails and clay banks), cultivated areas, shrub and forest. The area within each of these classifications is shown in Table 8.1.

Table 8.1 Topographic features within the proposed reservoir

Feature	Area (ha)	Percent
Cultivated	540.3	6.0%
Exposed soil	194.5	2.2%
Shrubs	520.3	5.8%
Water	3,648.8	40.5%
Existing Roads	81.6	0.9%
Forest	4,021.4	44.6%
Gross Area	**9,007**	**100%**

Fifty-seven percent of the forests within the proposed reservoir are deciduous. The deciduous volume is comprised largely of cottonwood trees (55 percent), some of which are large decadent cottonwood trees growing in the valley bottoms and on islands. The remaining 43 percent of the forests are coniferous, with spruce trees comprising the majority of this volume. Table 8.2 describes the merchantable volume by leading species. The forest inventory for the Project activity zone identified 914,229 cubic metres of merchantable tree volume within the proposed reservoir.

Table 8.2 Reservoir area tree species

Tree species		Gross area by leading species (ha)	Merchantable volume (m^3)	Total biomass volume (m3)
Coniferous	Spruce	1074.5	385,430	732,006
	Pine	0.3	20	34
	Larch	34.4	1,344	3,742
Total Coniferous		**1,109**	**386,794**	**735,782**
Deciduous	Cottonwood	1634.3	289,814	604,702
	Aspen	954.9	178,610	400,290
	Birch	323.1	59,011	125,002
Total Deciduous		**2,912**	**527,435**	**1,129,994**
Total all species		**4021**	**914,229**	**1,865,776**

8.2.1 Slopes and Slope Stability within the Proposed Reservoir

Slope and terrain stability are relevant factors when determining whether a particular area within the proposed reservoir site could be cleared safely, and the equipment that would be required to clear it.

The Peace River Valley topography is characterized by a relatively flat river channel combined with islands that transition to steep side slopes along both the north and south sides of the valley, (please see Photograph 8.1). LIDAR remote sensing data[6], for the reservoir, was used to accurately measure ground elevations and calculate slope gradients. Steep slopes are prevalent along both north- and south-faces of the proposed reservoir. The areas by slope classification throughout the proposed reservoir site are shown in Table 8.3. About eleven percent of the forested area slopes in the proposed reservoir exceed 70 percent. The majority of these steep slopes are along the perimeter of the proposed reservoir and rarely extend upward more than 40 metres to the edge of the 5-year beach-line.

[6] LIDAR (Light Detection and Ranging) is an optical remote sensing technology that can measure distance to a target. It is commonly used in contour mapping.

Table 8.3 Reservoir slope classifications

Slope Class	Forest Area (ha)	Percent Forest Area
0-35%	3,420.3	85.1%
35-70%	143.1	3.6%
70% +	457.1	11.4%
Total	**4,021**	**100%**

As a combined result of the steep side-slopes and the moisture that exists in wetlands on the plateaus above the Peace River valley, particularly on the south bank, incidents of ground slumping occur along the sides of the valley. Evidence of this slumping is seen in Photograph 8.1. Slope stability analysis was completed by BGC Engineering Inc. (please see Volume 2 Appendix B Geology, Terrain Stability and Soil Reports). This analysis identified historic landslides, slide deposits and classified the terrain based on its stability and associated operating risks for vegetation clearing and road construction. A description of the terrain classifications within the proposed reservoir and the forest area within each class is provided in Table 8.4. The terrain classification system shown in Table 8.4 is used to identify areas of slope stability concern and to guide harvesting and road construction activities in the province of British Columbia. An example of a terrain class V slope within the proposed reservoir is shown in Photograph 8.2.

Table 8.4 Terrain stability classification

Terrain Classification	Interpretation [1]	Forest Area (ha)
I	No significant stability problems exist	3085.8
II	There is a very low likelihood of landslides following timber harvesting or road construction. Minor slumping is expected along road cuts, especially for 1 or 2 years following construction.	92.4
III	There is a low (<30%) likelihood of landslide initiation following timber harvesting or road construction. Minor slumping is expected along road cuts, especially for 1 or 2 years following construction.	236.9
IV	Expected to contain areas with a moderate (30-70%) likelihood of landslide initiation following timber harvesting or road construction. Wet season construction will significantly increase the potential for road-related landslides.	210.5
V	Expected to contain areas with a high (>70%) likelihood of landslide initiation following timber harvesting or road construction. Wet season construction will significantly increase the potential for road-related landslides.	395.8
Total		**4,021**

Note 1 Please see Volume 2 Appendix B Geology, Terrain Stability and Soil Reports

As a result of these slope and terrain stability classifications it is apparent that: 1) within the reservoir 396 hectares of forest are in Terrain Class V and will not be cleared as a result of risks to both worker safety and environmental damage; 2) special clearing techniques may be required for approximately 457 hectares of forest in Terrain Class III and IV. These techniques may involve hand-falling trees down the slope and reaching up the slope with a skidder cable or excavator arm to safely draw the vegetation to areas where wheeled or tracked skidders can forward the vegetation to a roadside.

Credit: Industrial Forestry Service Ltd.

Photograph 8.1 Steep slopes on south side of the Peace River

Credit: Industrial Forestry Service Ltd.

Photograph 8.2 Terrain Class V slope

8.2.2 Riparian Areas within the Proposed Reservoir

BC Hydro's strategy with respect to vegetation clearing operations near waterways is to preserve a riparian zone for the protection of fish and water quality.

Within the proposed reservoir site, approximately 936 hectares are classified as riparian area, of which 665 hectares is forested. In order to ensure that clearing of the reservoir activity zone manages for the preservation of a riparian zone during the construction period, a 15 metre buffer from the high water mark of all defined watercourses would be established to preserve non-merchantable vegetation in these riparian zones. This 15-metre distance is consistent with the definition used for slopes less than 50 percent in the *Approved Work Practices for Managing Riparian Vegetation* October 2003, developed by BC Hydro, Fisheries and Oceans Canada and the British Columbia Ministry of Water,

Lands and Air Protection for prescribing riparian maintenance on transmission line corridors. Merchantable timber that exists within riparian zones is typically taller than 15 metres in height. These stems would be either hand-felled with the tree top falling outside of the riparian area (to be pulled out by the top using skidder cables, or feller-bunchers would reach into the zone with a cutting arm that would cut and extract the timber without damaging the soils within the riparian zone (please see photographs of clearing equipment in Appendix G).

Table 8.5 Reservoir riparian areas

Reservoir	Gross Area (ha)	Forested Area (ha)	Merchantable volume (m^3)	Non-merchantable volume (m^3)
Riparian Area	936.4	665.0	125,170	131,652

8.2.3 Access to Islands

Approximately 28 percent of the forest area in the proposed reservoir site (1,141 hectares) and 33 percent of the volume (306,215 cubic metres) exists on 65 islands within the Peace River. Due to varying water levels at different times of the year the transportation of harvesting equipment to islands would only be possible through a combination of access methods. The establishment of temporary bridges, ice bridges (weather dependent), snow and gravel that would be pushed over culverts, helicopters and barges were considered. Investigations, both through consultation and field study, concluded the following:

- All islands could be accessed by helicopter.
- All of the islands could be accessed by some form of bridge structure. Many of these structures may be as simple as ice or snow crossings over box culverts (e.g. in side channels or where the water flow is slower).
- Ice bridges across the main channel of the Peace River are not feasible due to the typically higher water flow into the Peace River during winter months from the Peace Canyon Generating Station.
- Information pertaining to average water currents, water temperatures and winter air temperature shows that ice formation on the upstream reaches of the Peace River has been rare. BC Hydro ice specialists have indicated that in any given year there is approximately a 50 percent chance that the Peace River ice front will extend into British Columbia. Although ice fronts have been observed as far as the District of Taylor roughly 20 percent of the time, this has not occurred since 1996, and was

close in 2011 (Volume 2 Appendix G Downstream Ice Regime Technical Data Report).

- Ice formation does occur most years on the Halfway and Moberly rivers. Winter water flows down these two rivers are substantially less in comparison to the Peace River. Equipment access up the Moberly and Halfway rivers during winter months is therefore feasible as a result of low water levels and frozen gravel bars. (BC Hydro 2009).
- Barges could be used to access forested island areas east of the Halfway River; however west of the Halfway River, the shallow water depths observed would prohibit the safe operation of barges for both delivery of forest-clearing machinery and extraction of trees (Sundve 2011, pers. comm.).

Examples of some of the islands that exist within the Peace River are provided by Photograph 8.3 and Photograph 8.4. As a result of the consultations and field investigations, access to islands in the Peace River would be by temporary bridge and by helicopter (where road access was restricted). Access to islands and to isolated timber along the Halfway and Moberly rivers would be by snow and ice crossings if water levels and temperatures permit, or by temporary bridge where the conditions did not warrant a snow or ice crossing. Construction of water crossings would be carried out in accordance with the standards in the British Columbia Ministry of Forests Land and Natural Resource Operations' Engineering Manual (BC MFLNRO 2012b).

Credit: Industrial Forestry Service Ltd. (2011)

Photograph 8.3 Islands in the centre of the Peace River

Credit: Industrial Forestry Service Ltd. (2011)

Photograph 8.4 Low water access to islands in the Peace River

8.2.4 Other Concerns in the Proposed Reservoir

The development of a clearing plan for the proposed reservoir site was completed conscious of the impacts of vegetation clearing on fish habitat, mercury methylation, water quality, boater safety, future recreational use and the proposed level of filling. Information pertaining to each of these topics is discussed in their respective chapters in the Environmental Impact Statement (EIS). The applicability of this information with respect to reservoir clearing is summarized very briefly.

- Fish Habitat – vegetation that remains within an inundated reservoir can provide good quality fish habitat (please see Volume 2 Section 12 Fish and Fish Habitat).
- Mercury Methylation – clearing all vegetation from the bottom of a reservoir will reduce mercury in fish by a negligible amount, (see Volume 2 Section11.9 Methylmercury).
- Recreation – clearing vegetation such that vegetation tops do not extend beyond the waterline improves recreational opportunities and boater safety (see Volume 3 Section 25 Outdoor Recreation and Tourism and Section 26 Navigation).
- Greenhouse gases – retaining vegetation in the proposed reservoir reduces greenhouse gas emissions (see Volume 2 Section 15 Greenhouse Gases).
- Dam operations – remove vegetation from areas that would fall into the reservoir through wave action and erosion within a few years post inundation and float to the spillway (see Volume 2 Appendix B Part 2 Preliminary Reservoir Impact Lines).

As a result of these studies and the information provided previously with regard to access, terrain stability, slopes, riparian habitat and tree merchantability, a clearing decision matrix was developed to derive a clearing strategy for the proposed reservoir site. This decision matrix is described below.

8.3 Reservoir Clearing Strategy

Based on a review and analysis of the factors discussed in Section 8.1, a clearing strategy for the reservoir was developed.

Portions of the proposed reservoir site are included in the dam construction site and access roads. These areas would be cleared according to Section 3.2 and Section 6.3.2 of this

plan. The remaining area within the proposed reservoir site contains 4,021 hectares of forest. In order of priority, the guiding principles for clearing are:

1) Retain vegetation in areas where worker safety is a concern due to ground instability (i.e., Terrain Class V).
2) Restrict clearing in riparian areas for water quality and wildlife habitat prior to reservoir inundation.
3) Adjust clearing to the 5-year “beach” line to limit the amount of debris entering the reservoir post-inundation.
4) Remove vegetation for navigational safety issues that would arise post-inundation.
5) Remove merchantable logs that could be used by the regional forest products industry.
6) Retain non-merchantable standing trees for future fish habitat.
7) Evaluate other resource concerns as they arise and retain or remove vegetation accordingly.

In balancing these factors, a reservoir clearing-decision matrix was developed to spatially identify specific areas where trees would be removed from the reservoir and where trees would be retained. The reservoir clearing decision matrix is shown in Figure 8-1. Spatially this decision matrix was applied to the forest inventory for the proposed reservoir site and vegetated areas and volumes were summarized. Terrain Class V areas were identified through terrain stability mapping. Riparian areas were identified by buffering a 15 metre corridor around all streams and rivers. The 5-year beach line was identified through reservoir impact line mapping, and potential navigational safety issues were identified spatially using stand-level growth models to estimate which tree tops would extend above 455 metres elevation[7] by 2018. And thus present a potential navigational concern post-inundation. Merchantable forest area and volume were identified using the definitions for stand merchantability identified by the British Columbia Ministry of Forests Land and Natural Resource Operations in the timber supply review process (BC MFLNRO 2012a) and discussed further in Appendix C.

[7] The 455 meter elevation would be the lowest level at which the generating station could be operated if the reservoir had to be drawn down for any reason (see Volume 1 Section 4 Project Description).

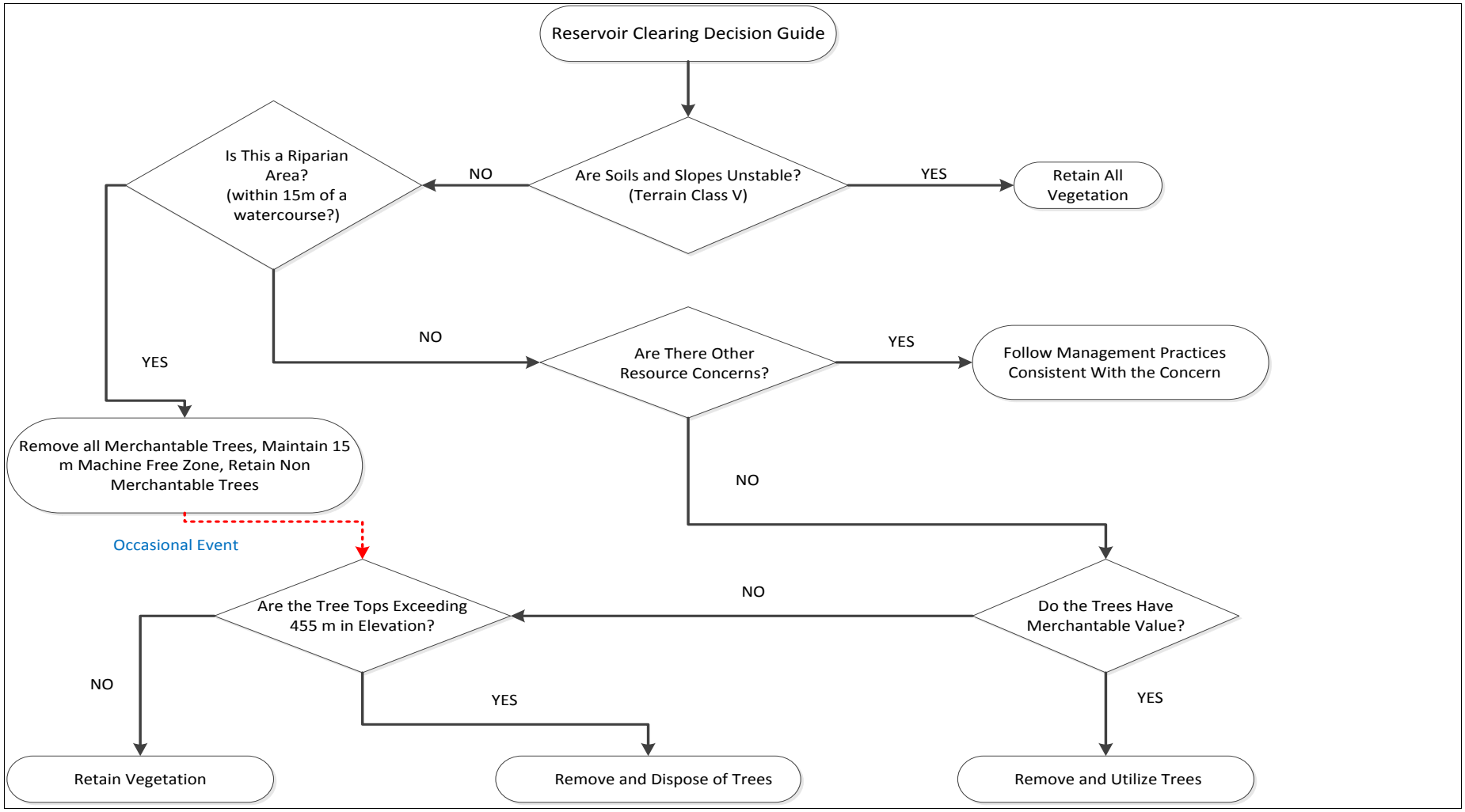


Figure 8-1 Reservoir vegetation clearing decision matrix

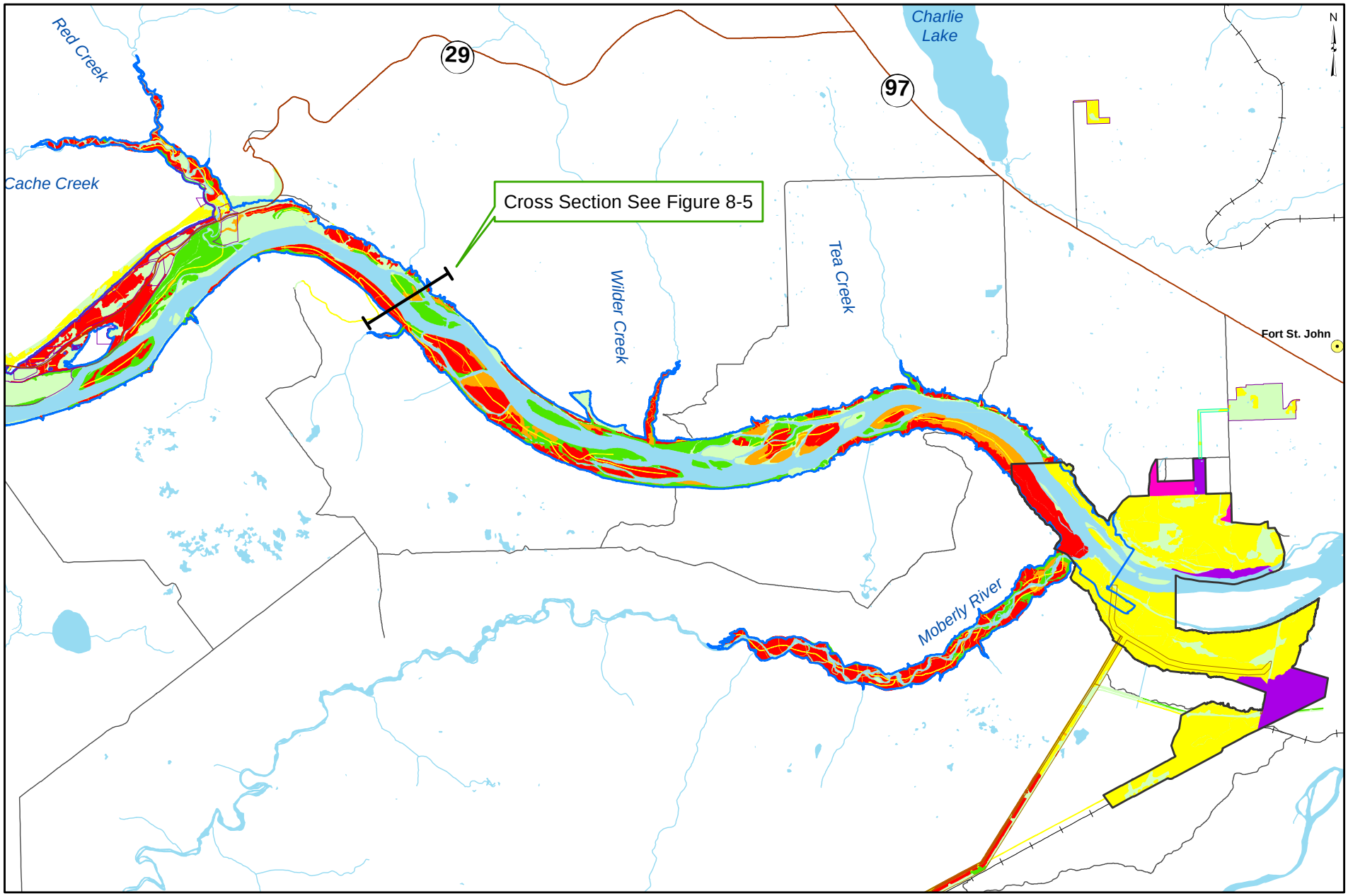
The vegetation clearing decision matrix for the reservoir site would result in the clearing of 2,918 hectares of forest, which is 73 percent of the forested area within the proposed reservoir site. Clearing would salvage 835,580 cubic metres of merchantable wood or 91 percent of the merchantable logs within the proposed reservoir site. These trees would be offered for sale to the forest industry. Clearing would also salvage remove 536,653 cubic metres of non-merchantable fibre. Table 8.6 shows the areas and volumes within the proposed reservoir site that would be cleared. Within the proposed reservoir site, 56 percent of the merchantable volume cleared (469,787 cubic metres) would be deciduous and 44 percent (365,793 cubic metres) of the volume would be coniferous. Additional detail regarding volume and species that would be cleared is provided in Appendix D.

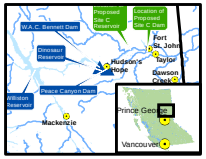
Table 8.6 Reservoir clearing

Reservoir	Area (ha)	Merchantable Volume (m^3)	Non-Merchantable Volume (m^3)	Total Biomass (m^3)
Total Forest	4,021.4	914,229	951,547	1,865,776
Forest proposed for clearing	2,917.5	835,580	536,653	1,372,233

Figure 8-2, Figure 8-3, and Figure 8-4 show the locations of these areas within the east, central and western portions of the Project activity zone, respectively. As an example, Figure 8-5 provides a cross-sectional illustration of the clearing matrix results.

Clearing would be carried out primarily using conventional harvesting equipment (i.e., feller-bunchers, crawler tractors, line skidders and/or grapple skidders). Approximately seven percent of the volume (55,802 cubic metres) would be hand felled and removed by helicopter (see examples in Appendix G). Only in a few very restricted sites where access by helicopter would be unsafe, would felling occur and then the vegetation would either be incinerated on site or left to float out after reservoir inundation. The volume associated with these sites is estimated to be 2,252 cubic metres.





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of BC

- Clear Vegetation and Grub
- Clear Merchantable Trees
- Clear Vegetation
- Retain Vegetation
- Non Treed
- Proposed Reservoir
- Dam Site Area
- Transmission Corridor
- Off-site Construction Materials
- Conveyor Corridor
- Clearing Subject to Further Design
- Limited Clearing
- Existing Roads
- Highway
- Railway

0 5 Km

SITE C CLEAN ENERGY PROJECT

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Figure 8-2: Project Activity Zone Clearing Strategy (Eastern Portion)

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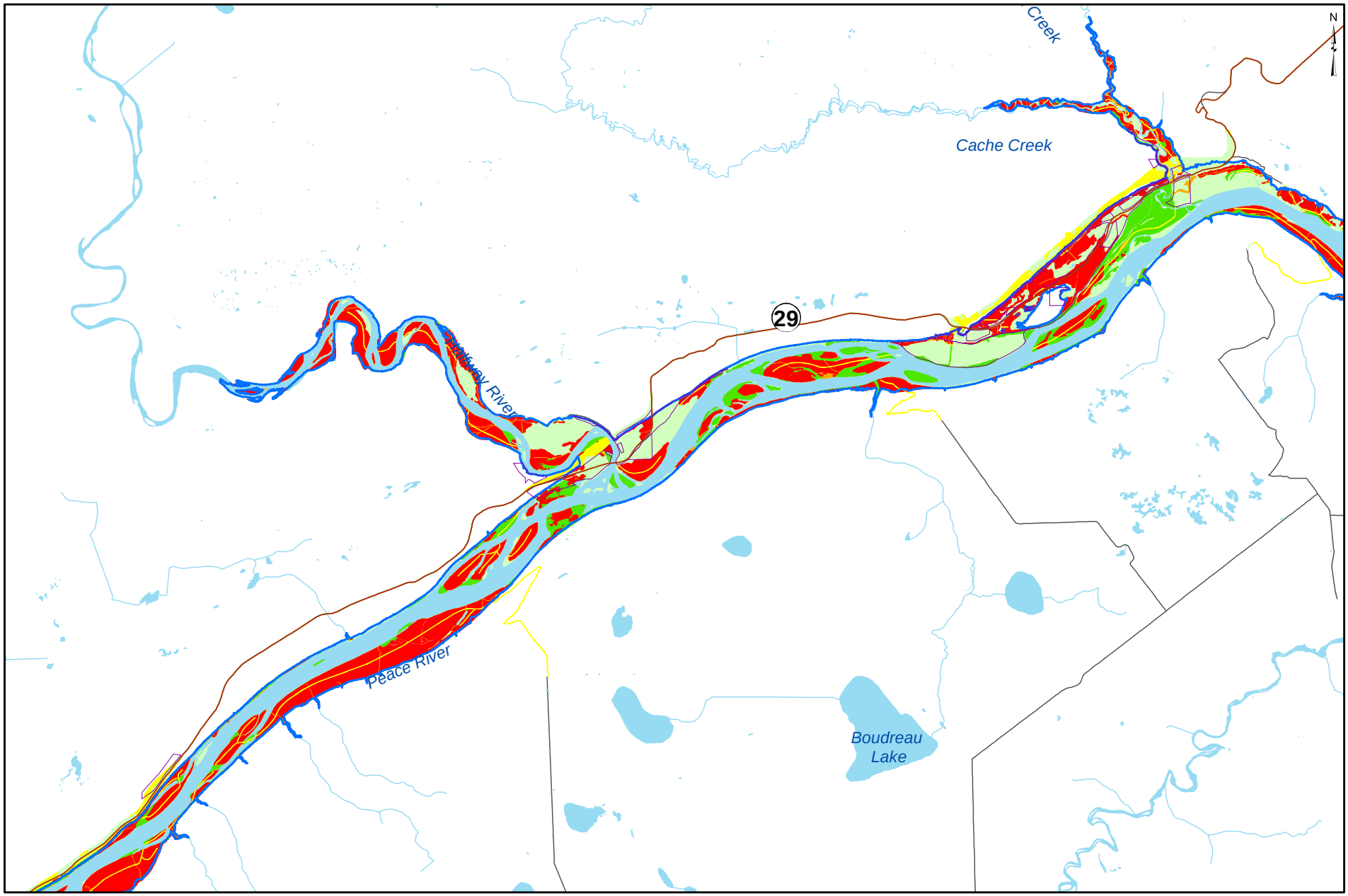

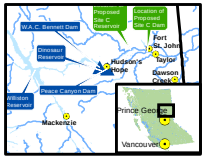

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of BC

- Clear Vegetation and Grub
- Clear Merchantable Trees
- Clear Vegetation
- Retain Vegetation
- Non Treed
- Proposed Reservoir
- Dam Site Area
- Transmission Corridor
- Off-site Construction Materials
- Existing Roads
- Highway
- Railway

0 5 Km

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Figure 8-3: Project Activity Zone Clearing Strategy (Central Portion)

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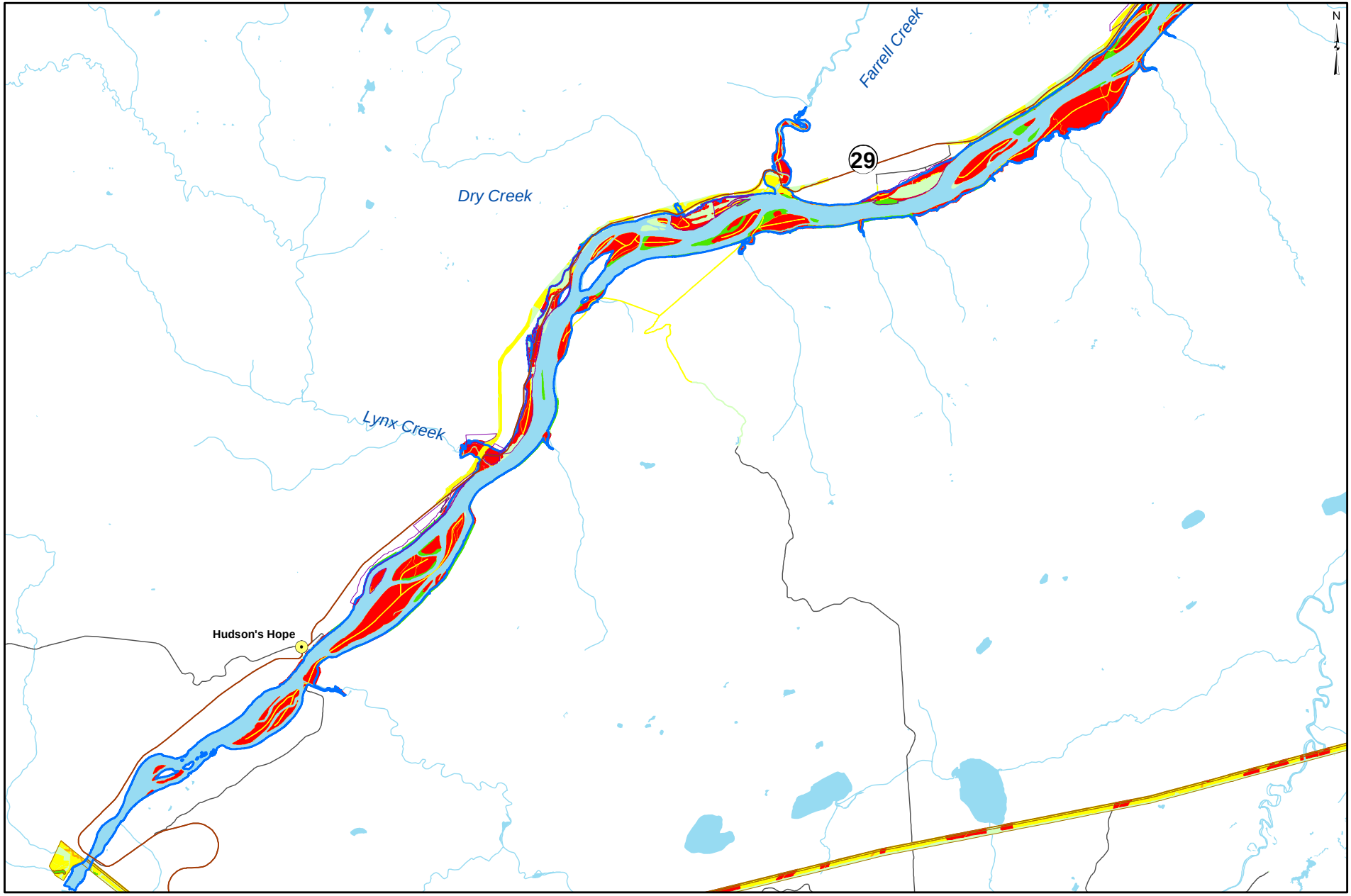

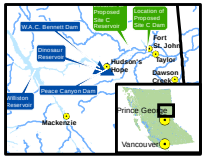

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of BC

- Clear Vegetation and Grub
- Clear Merchantable Trees
- Clear Vegetation
- Retain Vegetation
- Non Treed
- Proposed Reservoir
- Dam Site Area
- Transmission Corridor
- Off-site Construction Materials
- Existing Roads
- Highway
- Railway

0 5 Km

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Figure 8-4: Project Activity Zone Clearing Strategy (Western Portion)

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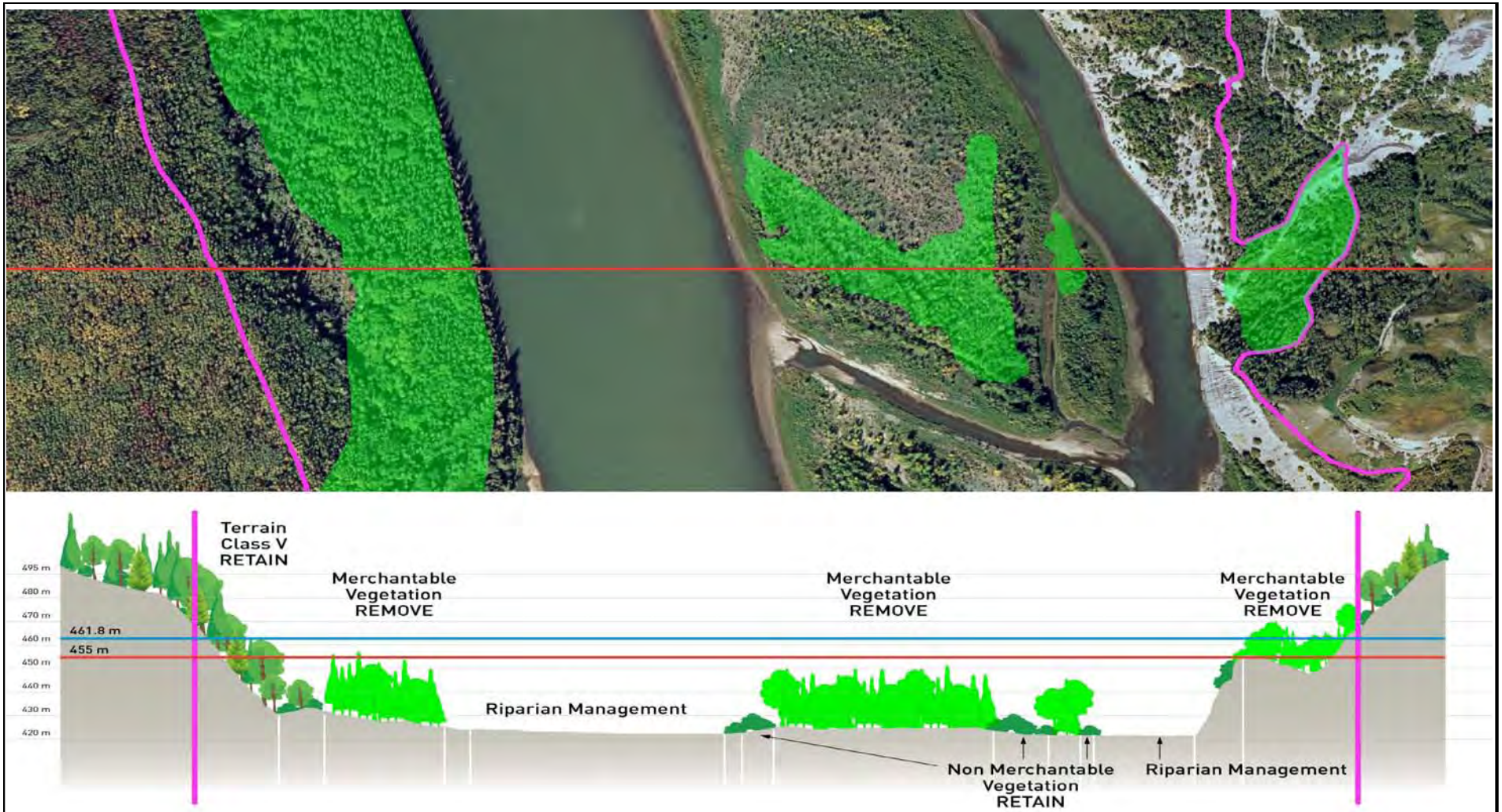

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Figure 8.5 Cross-sectional illustration of the clearing matrix results

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

8.4 Reservoir Clearing Schedule

The clearing schedule for the reservoir site would be finalized after the consultation process is complete. Vegetation clearing is presently proposed to occur over a four-year time horizon. Unforeseen events may result in delays in the completion of clearing activities in a four-year time frame. It is expected that these delays would not exceed an additional year and would still fall within the eight-year dam construction schedule.

Vegetation clearing in the eastern portion of the proposed reservoir site (i.e., from the dam construction site to Cache Creek and including the Moberly) would occur in years one and two of the Project Schedule. Clearing activities would be coordinated with dam construction site vegetation clearing in order to reduce equipment congestion later in the Project work schedule.

Clearing vegetation from the central and western portions of the reservoir site upstream from Cache Creek is currently proposed to occur in years three and four of the project construction schedule. In consideration of timing of industry's need for timber from clearing, and the outcome of other concerns around recreational use and visual quality during the construction period, the clearing currently planned for years three and four within the reservoir may be moved into years five and six of the eight-year construction schedule. The options for the clearing schedule were presented as part of the BC Hydro-led Fall 2012 public consultation. Public and stakeholders did not provide specific comments on this schedule.

The majority of vegetation clearing activities for the Site C reservoir are proposed to occur during winter season due to:

- Operability and road access constraints;
- Sensitive soil conditions;
- The timing of recreational use on the Peace River; and
- Wildlife concerns, which are concentrated in the spring, summer and fall (please see Volume 2 Section 14 Wildlife Resources).

A small amount of area located on the north-side of the reservoir would be cleared during the summer in conjunction with Highway-29 realignment construction activities. Reservoir clearing would generally progress from east to west to ensure that trees are removed prior

to an impact from reservoir headponding. Table 8.7 shows the schedule of merchantable volume proposed to be removed and the area cleared by year and season from the proposed reservoir site. This clearing schedule should:

- Minimize the duration of road maintenance activities;
- Make sufficient volumes available to attract interest by industry for prompt utilization; and
- Address public comments regarding access from the south bank - as full deactivation of new access roads leading to the proposed reservoir is planned following the completion of harvesting and debris management.

Table 8.7 and Table 8.8 expand the clearing schedule to include estimated merchantable volume by tree species, areas, volumes and season.

Table 8.7 Reservoir clearing by season and year

Reservoir	Summer		Winter		Yearly Total	
	Area (ha	Merchantable Volume (m^3)	Area (ha)	Merchantable Volume (m^3)	Area (ha)	Merchantable Volume (m^3)
Year 1	11.7	1,991	362.2	125,931	373.9	127,922
Year 2	129.0	26,693	479.6	181,725	608.6	208,418
Year 3	128.1	22,360	616.1	166,572	744.2	188,933
Year 4	60.2	7,011	1,130.6	303,296	1,190.8	310,307
Total	**329**	**58,055**	**2,588.5**	**777,524**	**2,917.5**	**835,580**

Table 8.8 Reservoir clearing by species

Year	Season	Merchantable Species Volume (m^3)						Total
		Cottonwood	Aspen	Birch	Larch	Spruce	Pine	
1	Summer	1,237	681	2	0	71	0	1,991
	Winter	66,782	26,240	0	0	32,910	0	125,932
2	Summer	5,807	9,383	1,422	0	10,081	0	26,693
	Winter	70,516	13,899	10,728	0	86,570	12	181,725
3	Summer	9,657	3,436	248	0	9,019	0	22,360
	Winter	59,643	31,409	1,270	1,344	72,898	8	166,572
4	Summer	57	1,168	2,288	0	3,498	0	7,011
	Winter	53,859	73,104	26,951	0	149,382	0	303,296
	Total	**267,558**	**159,320**	**42,909**	**1,344**	**364,429**	**20**	**835,580**

9 MANAGING WATERBORNE WOODY DEBRIS

9.1 Waterborne Woody Debris General Description

Naturally occurring woody debris will enter the Peace River and its tributaries each year as a result of the spring freshet, wind, wave and ice action that erodes shorelines and undercuts river banks, forest litter, beaver dams and debris jams. This is a natural occurrence that varies in intensity depending on the severity of the annual spring freshet. Photograph 9.5 and Photograph 9.6 illustrate locations in the Peace River watershed where an estimated 23,000 cubic metres were deposited naturally during a 50-year flood event in 2011.

Credit: Industrial Forestry Service Ltd. (2011)

Photograph 8.5 Natural woody debris at confluence of Peace and Moberly rivers

Credit: Industrial Forestry Service Ltd. (2011)

Photograph 8.6 Natural woody debris along Peace River

Woody debris would enter the proposed reservoir site during the headponding event[8] and at reservoir-filling as vegetation clearing debris that could not practically be removed during clearing activities. This material would eventually float down the reservoir to the dam site. At other dam sites in British Columbia, this material is prevented from entering the dam through the uses of log booms that capture the floating material. This material is then removed using boats to push the debris to a crane that extracts it from the reservoir. Photograph 9.1and Photograph 9.2 show the removal of waterborne woody debris from the Dinosaur Reservoir. During the construction of the proposed Site C dam, waterborne woody debris would need to be captured and removed from the river and later from the reservoir for both boater safety and dam operational purposes.

[8] Please see Volume 1 Appendix B Reservoir Filling Plan

Credit: Industrial Forestry Service Ltd. (2011)

Photograph 9.1 River boat used to push woody debris

Credit: Industrial Forestry Service Ltd. (2011)

Photograph 9.2 Crane used to extract woody debris

BC Hydro has considerable experience managing waterborne woody debris extraction in reservoirs using catchment booms and using natural shoreline collection points. However, operating a debris boom on a river involves consideration of river currents and of the public's use of the river for navigation and recreation.

A river-based debris collection site has operated on the lower Fraser River between Hope and Agassiz British Columbia for the past 40 years. The contractor managing the site relies on the hydraulics of the river at a certain location to concentrate and move woody debris into a trap. The amount of debris delivered to a side channel is increased through the use of a fin boom, which lies at an oblique angle to the stream flow and captures debris that would otherwise bypass the side channel trap. Additional information on these river debris traps is provided in Appendix H.

The volume of waterborne woody debris that would enter the Peace River annually as a result of natural events, vegetation clearing, and inundation of the reservoir is very difficult to predict. A preliminary analysis of the sources of woody debris that could enter the river between Hudson's Hope and the proposed dam site is between 7,000 cubic metres and 47,000 cubic metres annually, over the eight-year construction schedule. Woody debris is expected to continue to accumulate at the dam site for three to four years after commissioning of the dam. Thereafter, the annual volume is expected to stabilize to approximately 1,000 cubic metres annually.

9.2 Waterborne Debris Clearing Strategy

The strategy for dealing with waterborne woody debris is:

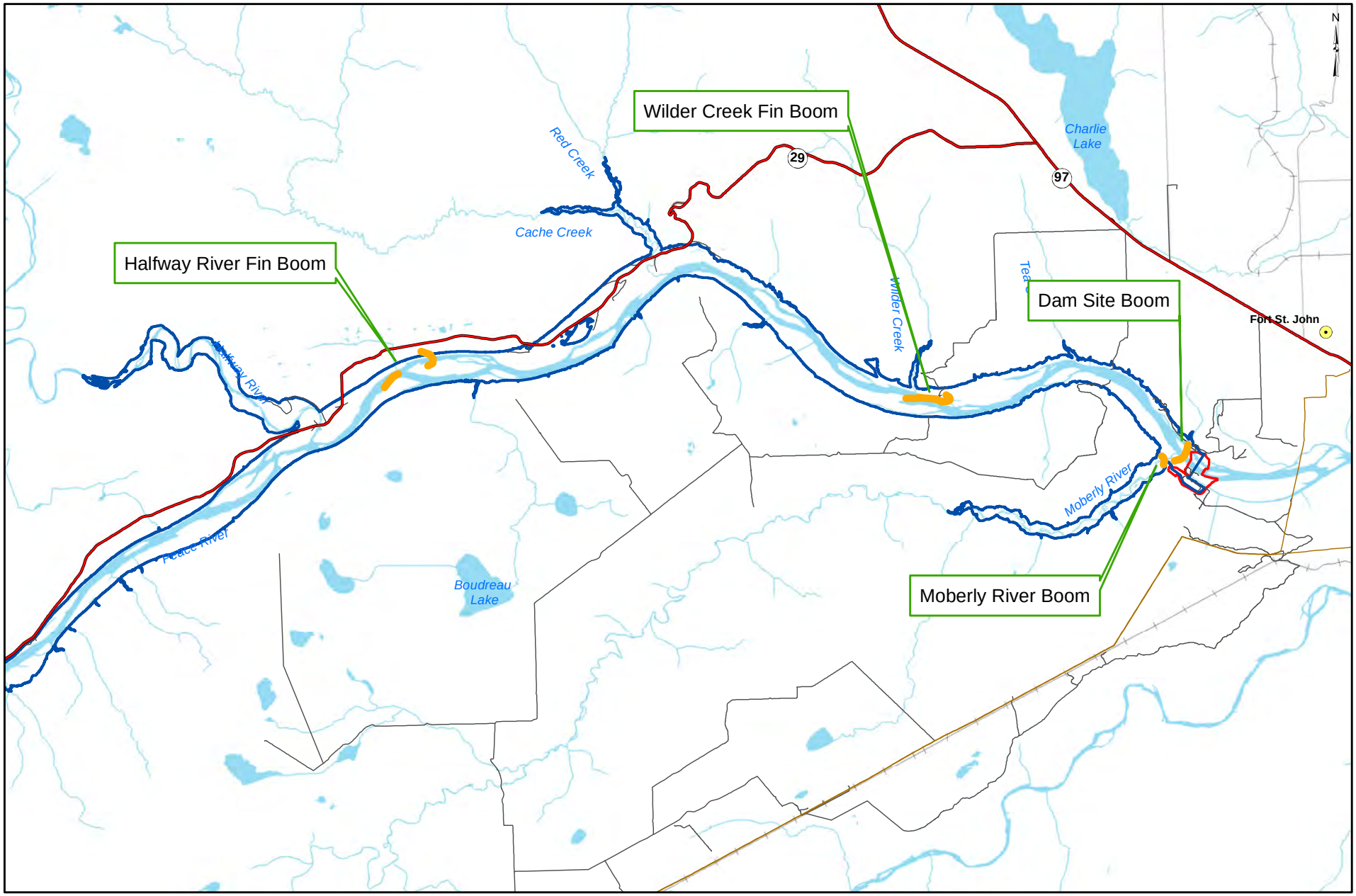
- Remove as much debris as possible from the proposed reservoir site prior to the headponding event through ground based vegetation clearing activities
- Clear vegetation above the 461.8 metre maximum normal reservoir operating level (to the 5-year beach line) to reduce the amount of post-inundation debris entering the reservoir.
- Construct a fin-boom on the Peace River downstream of Wilder Creek to capture river-borne woody debris floating down the Peace River.

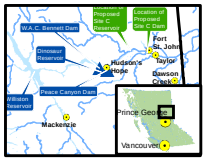
- The Wilder Creek boom would remain in operation until at least such a time as the diversion of the Peace River resulted in a headpond. The effects of the headpond may extend sufficiently upstream of the dam construction site that currents are reduced, which may reduce the effectiveness of the trap at this location. Should this occur the trap would be moved to a location just downstream of the confluence of the Peace and Halfway rivers.
- Construct a debris catchment boom across the Peace River immediately upstream of the dam construction site.
- Construct a debris catchment boom across the Moberly River immediately upstream of its confluence with the Peace River.
- Employ boat, and crane to remove woody debris from the water.
- Secure authorizations under the *Navigable Waters Protection Act* for booms on waterways (DoJ 1985).
- BC Hydro would continue to manage for water-borne debris using catchment booms after commissioning of the Site C dam.
- During the first five to ten years of reservoir operations additional sites for temporary or seasonal debris collection booms would be identified based on the observation of natural debris movement and collection. These additional reservoir booms would be designed to allow for boat passage.
- Dispose of merchantable wood removed from the river and/or reservoir by offering this fibre for sale to the forest industry. Please see Section 2.6.1.
- Dispose of non-merchantable wood removed from the river and/or reservoir as discussed in Section 2.6.2

The location of the waterborne woody debris catchment sites are shown in Figure 9-1. Additional information on river-borne debris management is provided in Appendix H.

9.3 Waterborne Debris Clearing Schedule

Debris booms would be located in the Peace River in year one of the Project clearing schedule. These booms would be maintained for the duration of the construction schedule.





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

Proposed Boom Locations
Proposed Site C Dam
Proposed Reservoir
Existing Roads
Highway
Railway

0 4 Km

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Figure 9-1: Proposed location of water-borne woody Debris Catchment Booms

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The information contained in this document is based upon work undertaken in accordance with current forestry and forest engineering guidelines and laws as practiced in the province of British Columbia at the time the work was performed. The information provided in this document was compiled from the work of foresters, technicians and engineers employed or sub-contracted by Industrial Forestry Service Ltd. (IFS), and from information provided to IFS by the British Columbia Hydro and Power Authority. Information obtained from secondary sources has been assumed to be correct; Industrial Forestry Service Ltd. accepts no responsibility for damages or liability that may arise from use of material from this document.

If any conditions become apparent that deviate from our understanding of conditions as presented in this document, Industrial Forestry Service Ltd. requests that we be notified immediately, and permitted to re-assess the procedures and recommendations provided herein.

This report was prepared by Robert Schuetz, R.P.F., Tim Giesbrecht, ATE., and Hesheng Zhang, GIS Technician. If you have any questions or comments on the contents of this report, please contact the undersigned.

Robert Schuetz, R.P.F.
President
Industrial Forestry Service Ltd.

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APPENDIX A

Key Revisions from Preliminary Stage 2 Report

KEY REVISIONS FROM PRELIMINARY STAGE 2 REPORT

The Preliminary Vegetation Clearing Considerations report, developed under Stage 2 of the Site C Clean Energy Plan development process, was presented in the public consultation phase of the process. Results from this consultation recognised public concerns and areas for attention with respect to reservoir preparation and wood waste disposal. As a result of the input received, the preliminary clearing plan produced by Industrial Forestry Service Ltd. for BC Hydro has undergone extensive modification to address areas of concern.

The 2009 *Preliminary Clearing Considerations Report* was an office-based exercise used to develop a theoretical forest clearing plan, using the best available information at that time. This revised clearing plan builds on the information assembled previously and enhances it through field verification, new information describing other resource concerns, new project design information, new information developed solely for this clearing plan and an expanded dialogue with regional forest industry stakeholders.

The adjustments made to the preliminary clearing plan are summarized as follows:

1. *Updated forest cover inventory for potential activity zones*

   The forest inventory used in the June 2009 preliminary clearing plan was a database acquired from the British Columbia Ministry of Forests, Lands and Natural Resource Operations Inventory Branch. This database had been constructed using aerial photography from the 1980s and 1990s and updated for projected tree growth. As a consequence, portions of the forest information for the current landscape and specifically along the river channel in the proposed reservoir were unreliable, based on the age of the inventory and changes to the river. The British Columbia government has since updated their inventory data using aerial photography taken during the years 1999 to 2006. However, the accuracy at the stand level, while sufficient for estimates across large landmasses, was considered insufficient for the very detailed analysis of tree heights, crown closures and volumes required for the clearing plan for the Project. An updated forest inventory was therefore produced to British Columbia Ministry of Forests, Lands and Natural

Resource Operations' Vegetation Resource Inventory (VRI) Standards, using 2007 photography and projecting tree growth to 2011. See Appendix B for more detail.

2. *Updated estimates of total and recoverable biomass*

Total and recoverable biomass estimates were enhanced and updated using biomass modelling equations provided by the British Columbia Ministry of Forests Lands and Natural Resource Operations and independently confirmed by FPInnovations. Since 2009 the MFLNRO has incorporated biomass estimates into their inventory database using volume to biomass conversion formulas (Kivari, Xu and Otukol 2011). This volume information was then compared to gross and recoverable biomass estimates for the same activity zone as estimated by FPInnovations. Researchers with FPInnovations utilized their proprietary 'BIOS' model to predict whole stem volumes (above ground biomass) and recoverable biomass. The results from both sources were comparable. The results also greatly exceeded the biomass estimates used in the 2009 preliminary clearing plan (roughly by a factor of two).

3. *Updated clearing specifications that give consideration to fish habitat, recreational boating use, and slope stability*

Clearing specifications were updated to consider fish habitat by incorporating a 15m riparian zone around all waterways. In addition, non-merchantable forest that was 6.8 metres below the 461.8 metre projected maximum reservoir elevation (e.g. below 455 metre elevation) would be retained to support fish habitat.

Recreation and boater safety was incorporated by prescribing clearing of vegetation between 455 metres and 461.8 metres elevation, creating a minimum draft of five metres below minimum reservoir elevation of 460.0 metres. This differs from the Stage 2 consideration wherein it was assumed that all vegetation would be cleared to stump height.

Terrain stability information was incorporated by identifying areas with slope stability concerns. See Volume 2 Appendix B Geology, Terrain Stability and Soil Reports for more information. Unstable slopes would not be cleared of vegetation.

4. *A revised reservoir clearing area updated for consideration of progressive shoreline erosion and a revised dam design*

   The clearing plan was revised to account for the updated dam design, wave action integrity and progressive shoreline erosion. Mitigating actions such as retaining forest vegetation in Terrain Stability Class 5 areas assist in the protection of surface features from erosion (back channels & streams) and this information was incorporated into the revised vegetation clearing plan. Furthermore, clearing is planned for areas predicted to erode within the first five years, in order to minimise the volumes of floating debris on the reservoir.

5. *New information regarding transmission line clearing requirements*

   The existing transmission line right-of-way activity area was widened by approximately 35 metres from the Stage 2 report which would increase the amount of vegetation clearing required.

6. *Enhanced information on the location of construction materials (quarries, borrow, pits, spoil areas)*

   Proposed construction materials sites have been further identified and incorporated into the clearing plan.

7. *Updated clearing schedule concerns with consideration for fish and wildlife critical periods*

   Vegetation clearing activities would be scheduled to optimize winter harvest opportunities in order to avoid time periods critical to fish-spawning and sensitive to bird nesting.

8. *Updated information on the fibre utilisation of the local forest industry*

   Interviews were conducted with local forestry industry representatives and British Columbia provincial government forest managers to acquire information with regard to current fibre utilisation in the area.

9. *Updated information on current utilisation, timing and involvement of local contracting work force*

   The current plan considers information gathered from meetings with forest licensees in summer 2011 regarding timber utilization, timing and involvement of the local contractor work force. Discussions included forest industry fibre needs, existing forest tenures, and the nature of the local contracting community including Aboriginal groups.

10. *Updated road access and water crossing plan*

    All potential water crossing and bridge structure (piling or abutment) locations were field-verified by logging contractors, barge experts, forest engineers and foresters in 2011 and 2012 to confirm their suitability (slope stability, grade and location). Extensive ground reconnaissance work was completed to verify road access routes, access road switch-backs and water-crossing locations to ensure the access plan was technically feasible. Based on the field assessment, many of the previously proposed ice-crossings have been replaced with proposed abutment and piling bridges

APPENDIX B

Details on the vegetation inventory update

VEGETATION INVENTORY UPDATE

As part of the vegetation clearing plan for the Site C Project, Industrial Forestry Service Ltd. (IFS) completed a re-inventory of the Project activity zone. This work was completed during the fall 2011. Due to the relatively small size of the Project, in comparison to traditional British Columbia government inventories which cover tens of thousands of hectares, IFS was able to focus considerable attention to forest stands (species, crown closure, tree height) within Project activity areas and provide a more precise inventory. Improvements over the existing government inventory include:

- 172 percent more forest stand polygons.
- Average forest-stand polygon size of eight hectares (as compared with average government inventory polygon size of 15 hectares).
- Photography that is consistent to one year (2007) as opposed to government inventory photography that spans ten years from 1999 to 2006.
- Field verification of forest inventory stands using 265 air and ground observations as compared with 20 observations in the government's inventory for the same area.
- Biomass estimates as per the government biomass equations, but confirmed using localized data from FPInnovations as derived in their BIOS model.

Use of the new inventory for the clearing plan resulting in very accurate measures of:

- Crown closure
- Tree heights
- Tree species composition
- Multi-layered stands
- Stand age

Upon completion of the forest inventory, stand information (species type, species percent, stand age, stand height, crown closure, merchantable volume, biomass volume, stump volumes) was added to a geographic information system data base for the Project area. Other inventories that were included in this database and used to create the maps and tables provided in this report include:

- LIDAR ground elevations
- Biogeoclimatic ecosystem classification zones
- Logging history
- Land ownership

- Riparian areas
- Seismic lines
- Terrain slopes
- Terrain stability classifications
- Timber supply area
- Tree farm licence boundaries
- Woodlot boundaries
- Cultivated pastures
- Existing rivers and wetlands
- Headponding areas
- Existing roads
- Proposed roads
- Proposed water crossings
- Community boundaries

APPENDIX C

Definition of commercial merchantable forest

MERCHANTABLE FOREST DEFINITION

Commercially merchantable trees as defined in this report employed a definition from the timber supply review reports[9] for the Dawson Creek and Fort St. John timber supply areas. Table C-1 describes the merchantability criteria used by the British Columbia Ministry of Forests, Lands and Natural Resource Operations forest analysis branch in the most current timber supply review.

Table C-1 B.C. Government merchantability criteria

Species	Dawson Creek timber supply area				Fort St. John timber supply area			
	Minimum diameter at breast height (cm)	Maximum stump height (cm)	Minimum top diameter inside bark (cm)	Minimum harvestable volume (m^3/ha)	Minimum diameter at breast height (cm)	Maximum stump height (cm)	Minimum top diameter inside bark (cm)	Minimum harvestable volume (m^3/ha)
Spruce	17.5	30	10.0	120	17.5	30	10.0	140
Balsam	17.5	30	10.0	120	17.5	30	10.0	140
Pine	12.5	30	10.0	120	12.5	30	10.0	140
Pine (Height class 2)	9	30	7.5	120	12.5	30	7.5	140
Aspen	12.5	30	10.0	120	12.5	30	10.0	120
Balsam Poplar	12.5	30	10.0	120	12.5	30	10.0	120

Tree utilization levels are used to define the maximum stump height, minimum top diameter (inside bark) and minimum diameter at breast height (dbh) for each tree species that is considered commercially viable. These utilization factors are used as inputs into a British Columbia Ministry of Forests, Lands and Natural Resource Operations tree growth model that, along with Forest Inventory Zone (FIZ) decay, waste and breakage factors by species and age, calculates net merchantable volume for each stand of trees. The tree size merchantability criteria used in this plan are described in Table C-2 below. The small pine

[9] Source: British Columbia Ministry of Forest, Lands and Natural Resource Operations, forest tenures branch apportionment web site (http://www.for.gov.bc.ca/hts/tsas.htm). Report effective date 2011-09-01.

category was not identified as very little pine exists in the Project area (i.e., about 1.9 percent of the total merchantable volume).

Stand volume is also used in the timber supply reviews to define a commercially acceptable minimum volume per hectare criteria. The minimum volume per hectare used in this Project is the lesser of the volume criteria used in the Dawson Creek and Fort St. John timber supply reviews. Stands with volumes less than the minimum stand size criteria are not considered merchantable. Table C-2 also shows the minimum volume criteria used in this Project (i.e., 120 cubic metres per hectare). Conversations with forest licensees in the region revealed that the utilization specifications vary between mills and over time.

Table C-2 Commercial tree merchantability size criteria

Species	Minimum diameter at breast height (cm)	Maximum stump height (cm)	Minimum top diameter inside bark (cm)	Minimum harvestable volume (m^3/ha)
Spruce	17.5	30	10.0	120
Balsam (subalpine fir)	17.5	30	10.0	120
Pine	12.5	30	10.0	120
Aspen	12.5	30	10.0	120
Balsam poplar (cottonwood)	12.5	30	10.0	120

Clearing the potential activity areas of vegetation would result in two broad categories of woody fibre: commercial fibre (e.g., shown in Photograph C-1) and non-commercial fibre, or waste wood (e.g., shown in Photograph C-2).

Credit: BC Hydro

Photograph C-1 Commercial forest

Credit: BC Hydro

Photograph C-2 Non-commercial forest

APPENDIX D

Summary Clearing Tables

The following tables detail the area and volume proposed for clearing within the Project activity zone.

Table D-1 Project vegetation area cleared

Project Area Description	Area (hectares)						Total Area (ha)
	Dam Site	Highway 29 Re-location	Construction materials	Access roads	Transmission ROW	Reservoir	
Gross Land Area	1,835.7	401.8	625.4	193.0	1,228.9	5,358.1	9,643
Forest Area	1,435.0	194.0	394.4	168.8	742.2	4,021.4	6,956
Area cleared and stumps are removed	1,332.8	194.0	394.4	168.8	481.2	0.0	2,571
Area cleared and stumps are retained	102.2	0.0	0.0	0.0	241.3	2,330.1	2,674
Area cleared, stumps & non-merchantable trees are retained (i.e., riparian areas)	0.0	0.0	0.0	0.0	19.7	587.4	607
Total area cleared	**1,435.0**	**194.0**	**394.4**	**168.8**	**742.2**	**2,917.5**	**5,852**
Total forest area retained	0	0.0	0.0	0.0	0	1,103.9	1,104

Table D-2 Site C vegetation volume cleared

Project Area Description	Volume (cubic metres)						Total volume (cubic metres)
	Dam Site	Highway 29 Realignment	Construction materials	Access roads	Transmission ROW	Reservoir	
Gross volume	636,232	51,747	184,371	85,889	293,041	1,865,776	**3,117,056**
Merchantable volume	292,883	23,986	89,456	40,663	131,645	914,229	**1,492,862**
Total merchantable volume cleared	**292,883**	**23,986**	**89,456**	**40,663**	**130,808**	**835,580**	**1,413,376**
Total merchantable volume retained	0	0	0	0	837	78,649	79,486
Total non-merchantable volume cleared	**343,349**	**27,761**	**94,915**	**45,226**	**140,090**	**536,653**	**1,187,994**
Total non-merchantable volume retained	0	0	0	0	21,306	414,894	**436,200**

Table D-3 Commercial tree species volume cleared

Commercial Tree Species	Volume (cubic metres)		Total Volume (cubic metres)	Percent
	Fort St. John Timber Supply Area	Dawson Creek Timber Supply Area[1]		
Aspen	143,276	394,872	538,148	38.1
Cottonwood	176,976	140,494	317,470	22.4
Birch	4,224	43,611	47,835	3.4
Spruce	214,583	262,637	477,221	33.8
Pine	383	29,612	29,996	2.1
Larch	1,359	1,346	2,706	0.2
Total	**540,801**	**872,572**	**1,413,376**	**100**

Note: Note 1 this area includes Tree Farm Licence No 48.

Table D-4 Volume cleared by Site and Year

Year	Project activity zone – operating site	Area (hectares)	Merchantable Volume (m3)	Non Merchantable Volume (m3)	Total (m^3)
1	Dam Site	1,435.0	292,883	343,349	636,232
	Highway 29 Re-alignment	87.8	9,516	10,619	20,135
	Construction Material Sites	26.8	5,695	5,750	11.445
	Access Road	66.2	11,864	14,922	26,786
	Reservoir	373.9	127,922	80,718	208,640
2	Construction Material Sites	218.0	60,180	57,454	117,634
	Access Road	26.6	8,271	8,124	16,395
	Reservoir	608.6	208,418	121,312	329,730
	Transmission Corridor	742.2	130,808	140,090	270,898
3	Highway 29 Re-alignment	106.2	14,470	17,142	31,612
	Construction Material Sites	149.7	23,581	31,711	55,292
	Access Road	33.6	9,161	10,308	19,469
	Reservoir	744.2	188,933	125,317	314,250
4	Access Road	42.4	11,367	11,872	23,239
	Reservoir	1,190.8	310,307	209,306	519,613
All Years	Dam Site	1,435.0	292,883	343,349	636,232
	Highway 29 Re-alignment	194.0	23,985	27,761	51,747
	Construction Material Sites	394.4	89,456	94,915	184,371
	Access Road	168.8	40,663	45,226	85,889
	Transmission Corridor	742.2	130,808	140,090	270,898
	Reservoir	2,917.5	835,581	536,653	1,372,233
	Grand Total	**5,852**	**1,413,376**	**1,187,994**	**2,601,370**

APPENDIX E

Open burning smoke control regulation

OPEN BURNING SMOKE CONTROL REGULATIONS

Under the authority of the Environmental Management Act, the British Columbia Ministry of Environment has the mandate to regulate smoke emissions from open burning activities through the application of the Open Burning Smoke Control Regulation (OBSCR)[10]. The OBSCR is currently under review by the British Columbia Ministry of Environment.

Information on the current status of the British Columbia Ministry of Environment review of the OBSCR is available at the following link:

http://www.env.gov.bc.ca/epd/codes/open_burning/index.htm

In anticipation of potential changes that may occur as a result of the British Columbia Ministry of Environment review of the OBSCR, BC Hydro would develop a Smoke Management Plan for the Project. The Smoke Management Plan for the Project would identify the efforts that would be taken to reduce open burning activities and the best management practices that would be followed to minimize the effect of burning activities on public and environmental concerns. Appropriate practices would include:

1. proper woody debris pile construction and seasoning
2. adherence to ignition criteria and smoke release periods
3. adherence to pre-burn protocols
4. training of operators
5. adhere to appropriate light-up procedures
6. adhere to post-burn protocols
7. utilization of customized daily venting forecasts for the Site C area by provincial government meteorologists
8. ignition when venting conditions are best
9. incineration generally in late summer and early fall
10. avoidance of sensitive time periods (public long weekends)
11. notification and reporting of intentions and results
12. separate practices for identified smoke sensitivity zones (based upon population density)

[10] Link to the regulation http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/34_145_93

Other considerations that would be made to minimize the effect of smoke on the public and the environment include:

- Forced air burning of non-merchantable wood in large steel containers, with an on-site loader for the disposal of the wood waste materials near areas with a population density greater than 200 people per square kilometer are primary smoke sensitivity (PSS) zones. Burning would be more constrained in areas within 10 km of PSS zones.
- Consideration to land filling non-merchantable wood close to PSS zones.
- Non-merchantable wood located near the British Columbia communities of Hudson's Hope, Fort St. John and Taylor may be transported to special incineration sites.
- Non-merchantable wood along the Highway 29 realignments and the transmission right-of-way would be carried out in mobile burn boxes that can be moved along the right-of-way by the clearing contractor. This would minimize smoke visibility dangers to travelers along the Highway and address safety issues near existing transmission lines.

It is estimated that approximately 1.2 million cubic metres of wood waste material would be generated from clearing the total Project area. This includes branches and tops of harvested trees, logs presently lying on the ground, and non-commercial trees projecting above 455 metres elevation

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APPENDIX F

Conversion factors

CONVERSION FACTORS

In British Columbia, merchantable logs are measured as volume in terms of cubic metres. Sawmill residual biomass in the form of pulp chips, sawdust, shavings and bark (hog fuel) are sold in terms of its weight in oven-dry tonnes. Both logs and waste wood are typically shipped in their green form (with moisture included in the fibre) and shipping is paid based on the total green weight. For consistency, this clearing plan uses cubic metres to describe both tree volumes and waste wood volumes. To convert waste wood volumes in cubic metres to oven-dry tonnes or green tonnes, the following conversion factors provide a general measure of conversion.

Cubic metre to green tonne

Converting timber from cubic metres to green tonnes varies by species and is influenced by seasonal variations in moisture content. Conifer species generally weigh less than deciduous and range from 0.75 to 0.85 cubic metres per green tonne. Deciduous species generally weigh more than coniferous species and range from 0.95 to 1.1 cubic metres per green tonne. The average conversion factor utilized for all conifers is estimated at 0.8 cubic metres per green tonne and for deciduous 1.0 cubic metre per green tonne, assuming winter harvesting.

Table F-1 Cubic metre to green ton conversion

Species	Cubic Metre	To	Green Tonne
Deciduous	1	=	1.0
Coniferous	1	=	0.8

Source: British Columbia Ministry of Forest, Lands and Natural Resource Operations Harvest Billing System

Cubic metre to oven-dry tonne

The specific gravity of merchantable timber varies by species. Conifer species range from 2.29 to 2.78 cubic metres of green volume per oven-dry tonne and deciduous species range from 1.86 to 2.96 cubic metres of green volume per oven-dry tonne (Ung, Bernier & Guo 2008). As a general rule, the volume weighted average specific gravity utilized for all species is estimated at 2.64 cubic metres of green volume per oven-dry tonne (i.e., 0.382 oven-dry tonnes per cubic metre).

Table F-2 Cubic metre to oven dry tonne conversion

Species	Cubic Metre	To	Oven Dry Tonne
Deciduous	1	=	0.381
Coniferous	1	=	0.385

Stem volume to stump volume

Stump volume varies by species and is not included in the reported total stem volume that is calculated by the BC Ministry of Forest Lands and Natural Resource Operations Inventory Branch or by FPInnovations in their BIOS model. The average below ground stump volume for all species is estimated at 20 percent of the reported total above ground stem volume. (Kajimoto et al 1999; Naesset 2003.

APPENDIX G

Examples of vegetation clearing equipment

Credit: Industrial Forestry Service Ltd.

Photograph G-1 Hand felling

Credit: BC Hydro

Photograph G-2 Grapple wheeled skidder

Credit: Internet (anonymous)

Photograph G-3 Grapple log yarder

Credit: BC Hydro

Photograph G-4 Feller buncher

Credit: Industrial Forestry Service Ltd.

Photograph G-5 Grapple tracked skidder (skidcat)

Credit: Industrial Forestry Service Ltd.

Photograph G-6 Cable log yarder

Credit: Industrial Forestry Service Ltd.

Photograph G-7 Helicopter yarding with choker cables

Credit: BC Hydro

Photograph G-8 Helicopter yarding with grapple hook

Credit: BC Hydro

Photograph G-9 Log processor

Credit: BC Hydro

Photograph G-11 Wheeled log loader

Credit: BC Hydro

Photograph G-10 Butt'N top log loader

Credit: Internet (anonymous)

Photograph G-12 Crawler tractor with root rake

Credit: BC Hydro

Photograph G-13 Excavators raking and piling wood

Credit: BC Hydro

Photograph G-14 Excavator raking wood waste

Credit: Internet (anonymous)

Photograph G-15 Biomass grinder

Credit: Internet (anonymous)

Photograph G-16 Wood waste tub grinder

Credit: Internet (anonymous)

Photograph G-17 Wood waste log chipper

Credit: BC Hydro

Photograph G-18 Self-loading logging truck

Credit: Internet (anonymous)

Photograph G-19 Tree-length logging truck

Credit: Industrial Forestry Service Ltd.

Photograph G-20 Short-log logging truck configuration

Credit: Internet (anonymous)

Photograph G-21 Wood waste truck

Credit: Internet (anonymous)

Photograph G-22 Chip and biomass truck

Credit: BC Hydro

Photograph G-23 Rock truck hauling wood waste

Credit: BC Hydro

Photograph G-24 Burning wood waste piles

Credit: BC Hydro

Photograph G-25 Excavator tending burning piles

Credit: Internet (anonymous)

Photograph G-27 Trench incinerator

Credit: Industrial Forestry Service Ltd.

Photograph G-26 Incineration container

APPENDIX H

WATERBORNE DEBRIS MANAGEMENT STRATEGY

Waterborne Debris Management Strategy

Throughout the construction period of the proposed Site C Project considerable volumes of woody debris will inevitably enter the Peace River and be transported to the dam construction site by river currents. This debris will occur as a result of natural spring freshets, as well as from timber clearing in the reservoir area. The presence of this debris at the dam site may pose a hazard to worker safety and to the activities at the construction site. A waterborne debris management strategy with regard to floating woody debris would be implemented to address this concern.

BC Hydro has considerable experience clearing debris from reservoirs through the use of debris catchment booms (i.e., annual programs carried out at the Dinosaur and W.A.C. Bennett dams). However, debris that occurs in moving water such as the Peace River, poses different challenges than those occurring in reservoirs. This challenge is further complicated by the fact that the Peace River would be diverted in two stages during dam construction. The first stage would occur approximately three years after construction commencement when river diversion tunnels are activated. The Peace River would be diverted through these tunnels, resulting in a headponding effect that would increase the river water upstream of the dam site to about 423 metres elevation. The second stage would occur approximately eight years after construction commencement when the reservoir is filled. What this implies is that water-borne debris management actions must adapt to these changes in river water elevations and associated currents.

The longest operating river debris collection site in Canada is in British Columbia on the lower Fraser River between Hope and Agassiz. In operation for the past 40 years, this debris trap is currently managed by the British Columbia Fraser Basin Council[11]. The Fraser River debris trap is a special waterborne facility that corrals uprooted trees and woody debris into a side channel where the wood can be collected and removed. The Fraser River trap relies on the hydraulics of the river at a certain location to concentrate and move woody debris into the trap. Generally, floating material moves to the outside of a river bend

[11] http://www.fraserbasin.bc.ca

due to helicoidal flow. The strength of the helicoidal flow increases with river velocity and decreases as the radius of curvature of the bend decreases. From a hydraulic perspective, a side channel that branches off the main channel at the downstream end of a bend passes proportionally more woody debris than delivered through the main channel. Such is the case for the location of the debris trap on the Fraser River (Hay 2012).

The amount of debris delivered to a side channel can be increased through the use of a shear boom or a fin boom, which lies at a very oblique angle to the stream flow and captures debris that would otherwise bypass the side channel. A shear boom is anchored in place at both ends in a desired location, whereas a fin boom is anchored at the upstream end and pushed across the stream lines in the main channel by a series of fins attached to the side of the boom.

Without the trap, an average of 25-60,000 cubic metres of debris, or between 600 to 1440 logging truck loads of wood each year (up to 100,000 cubic metres in years of high peak flows), would make its way into the lower reaches of the Fraser and the Strait of Georgia each year, threatening people and property (Thonon 2006). Without the trap, there would be much greater risk that debris would endanger boats, block beaches, litter shorelines, threaten public safety, interfere with commercial and recreational navigation, damage infrastructure such as docks, dikes, bridges, foreshore structures and submarine cables and damage sensitive habitat.

Photographs of the trap in operation are provided as Photographs H-1 through to H-5.

BC Hydro consulted with both the Fraser River debris trap contractor and the professional engineer involved in the original design of this trap (i.e., Oakwood Consulting Inc.). Both the contractor and the design engineer accompanied BC Hydro on a site visit of the Peace River in summer 2012. This visit was followed by a report to BC Hydro entitled *Site C Project Debris Control and Management River Engineering Report* (Hay 2012). The report identified locations in the Peace River suitable for debris management during the Site C construction phase. One such location, downstream of Wilder Creek, exhibited evidence of being a natural area for debris collection and having similar features to the Fraser River trap. Photographs H-6 and H-7 provide aerial views of the Fraser River trap, with

Photograph H-7 also providing an example of proposed fin boom placement on that location in the Peace River. The Wilder Creek site is believed to be highly suited for trapping woody debris up to, and including, the Stage 1 diversion. The feasibility of this site for trapping debris during Stage 2 diversions could only be assessed by future hydraulic or computational modeling of the site.

A second possible site was identified at Bear Flat, located approximately seven kilometres west of Wilder Creek. The site offered both advantages and disadvantages to trapping woody debris. The largest disadvantage is the limited operational space at the site.

A third location was identified along the north bank of the river downstream of the Halfway River. This site appeared both operational and hydraulically suited for collection of woody debris and would not be influenced by the backwater induced during the Stage 1 and Stage 2 diversions. Its only disadvantage is its distance from the proposed dam.

It is anticipated that the placement of a fin boom near Wilder Creek, up to and during the Stage 1 diversion, would be followed by a move of the debris trap to the Halfway River site during the Stage 2 diversion.

These debris traps would catch much, but not all of the waterborne woody debris. Some debris would bypass the trap, additional debris would accumulate downstream of the trap and debris would enter the Peace River from the Moberly River. Catchment booms would be required immediately upstream of the proposed dam construction site and across the Moberly River near its confluence with the Peace River. Information on the use of debris booms for the protection of spillways is described further in a 1999 report by W.N. Rea Engineering Ltd and I.R. Kerr for BC Hydro (Kerr 1999). Photograph H-8 shows the collection of debris at the Dinosaur dam site.

Credit: BC Hydro

Photograph H-1 Fraser River debris trap and fin boom

Credit: BC Hydro

Photograph H-2 Fraser River debris trap

Credit: BC Hydro

Photograph H-3 Fraser River fin boom

Credit: Industrial Forestry Service Ltd.

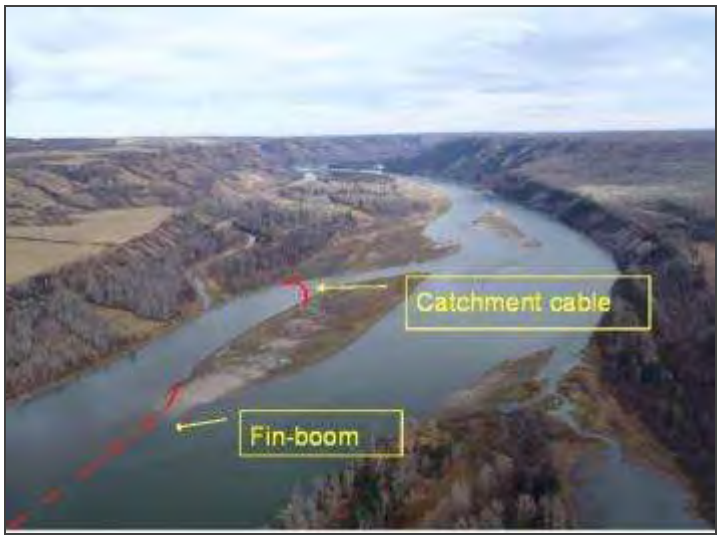
Photograph H-4 Fraser River fin booms

Credit: Industrial Forestry Service Ltd.

Photograph H-5 Drift sock on Fraser River fin boom

Credit: Industrial Forestry Service Ltd.

Photograph H-6 Proposed location of the Peace River debris trap (summer)



Credit: BC Hydro

Photograph H-7 Proposed location of cable and fin boom on Peace River

Credit: BC Hydro

Photograph H-8 Grapple crane removing debris from Dinosaur reservoir trap

APPENDIX I

ROADS AND BRIDGES

ROADS

A variety of road systems would be utilized in this clearing plan. Many of the existing roads that would be accessed are public roads under the jurisdiction of the Ministry of Transportation and Infrastructure. Other existing roads are under the jurisdiction of the British Columbia Ministry of Forests, Lands and Natural Resource Operations (BC MFLNRO). These roads include Forest Service Roads and Road Permit roads. Forest Service Roads are the responsibility of the BC MFLNRO or assigned to another jurisdiction that is active on the road for the purpose of harvesting timber. Road Permit roads are the responsibility of an assigned Road Permit holder; most common are British Columbia Timber Sales licensees or major forest license holders who have the right to harvest timber under a forest license or other license. Additional information regarding road use can be found in the British Columbia *Forest Act:*

http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/96157_00 .

Many of these roads are presently built to an industrial standard that is suitable for transporting the equipment and materials prescribed within the clearing plan. These include the Project Access, North and South Monias, 200, 400, Beaver Loop, Wilder and Medicine Woman roads.

Other existing roads, including active Road Permit roads and deactivated Road Permit roads, would require upgrades including road surface widening, vegetation brushing, and upgrades to water crossings, danger tree removal and signage. The development of four new roads would be required on the south side of the Peace River to access the Reservoir.

The roads that require upgrades or full development are grouped into three classes: existing upgrade; proposed new (temporary) all-season; and proposed new (temporary) winter. All of the existing roads and new all-season road developments would be assigned Road Permit roads. The proposed new all-season roads include all access routes outside of the reservoir site. The proposed new winter roads include all new roads within the reservoir site except for at the dam site, where additional access information is provided in Volume 1 Section 4. Table I-1 is a summary of the type, length and location of the roads to be utilized. Table I-2 is a summary of road schedule by year of development.

Table I-1 Summary of total road distances

Access Road Type	Access to Reservoir	Trans-mission ROW	Reservoir	Dam Site	Portage Mt. Quarry	Total
	Distance (kilometres)					
Existing Upgrade	37.6	13.2	0.0	0.0	3.3	54.1
Proposed New – All Season	19.9	30.5 [1]	0.0	17.1	2.5	70.0
Proposed New - Winter	0	0.0	115.9	0.0	0.0	115.9

Note:
Note 1 this includes part of the Project Access Road

Table I-2 Summary of year of activity

Access Road Type	Year 1	Year 2	Year 3	Year 4
	Distance (kilometres)			
Existing Upgrade	16.6	19.9	17.8	0.0
Proposed New – All Season	52.7	2.9	14.4	0.0
Proposed New - Winter	22.4	26.4	21.7	45.4

Following are examples of an existing road and a seismic trail requiring upgrades south of the Peace River – the most common upgrade would be brushing and road surface gravelling.

Credit: Industrial Forestry Service Ltd. (2011)

Photograph I-1 Existing road requiring upgrades

Credit: Industrial Forestry Service Ltd. (2012)

Photograph I-2 Existing Seismic Trail

BRIDGES

A variety of water crossing structures would be built as part of the clearing plan. The majority of the required structures are located within the reservoir to access numerous islands and isolated patches of merchantable timber. An estimated 98 crossings would be required.

The water crossings are grouped into three classes: (1) winter crossing; (2) abutment bridge; and (3) piling bridge. The winter crossings would include snow or gravel covered box culverts placed across the drainages, snow-filled dry back channels or log-filled, fabric-covered ephemeral drainages. Abutment bridges would be utilized in areas where narrow stream channels and open water exists. Piling bridges would be utilized over all large water-body crossings. A number of metal culverts may also be required in areas were the road system crosses non-fish bearing and ephemeral streams. The following is a summary of the type, length and general location of water crossings to be utilized. Photograph I-3 provides an example of an existing abutment bridge over a stream crossing south of the Peace River – several stream/creek crossings would require the installation of a new culvert or abutment bridge. Figure I-2 provides example of various bridge pilings (the most common of which are driven piles). Figure I-3 provides example of various bridge abutments - the most commonly used in forest road applications are timber sill.

Table I-3 Water crossings

Crossing Type	Crossing Distance (metres)				
	Access to Reservoir	Transmission Line	Reservoir	Dam Site	Total
Winter Crossing	0	0	2,861	0	2,861
Abutment Bridge	9	0	296	0	305
Piling Bridge	0	0	1,703	0	1,703
Required Culverts >500millimetre	9	0	37	0	46

Credit: Industrial Forestry Service Ltd. (2011)

Photograph I-3 Existing abutment bridge

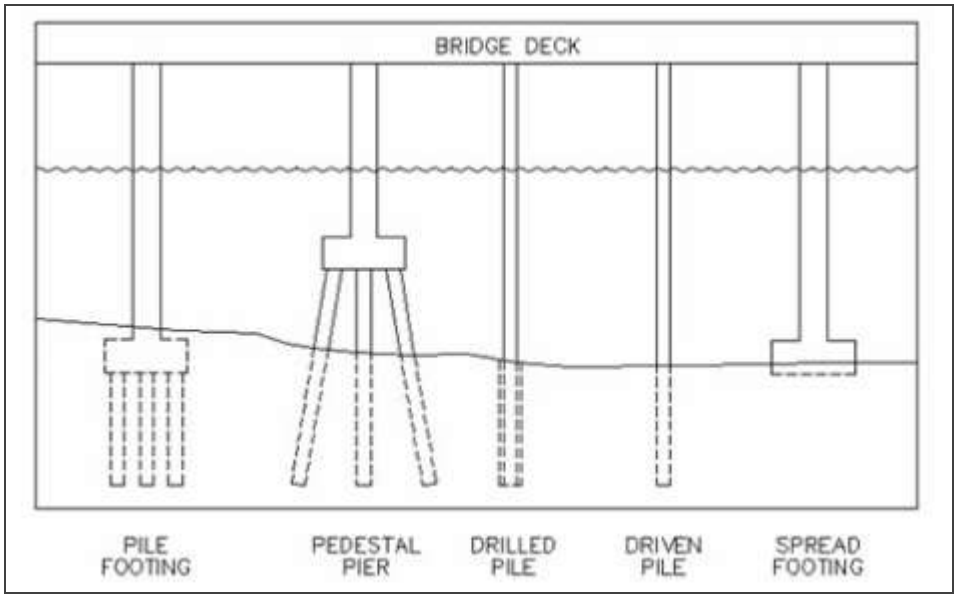


Figure I-2 Example of various bridge pilings

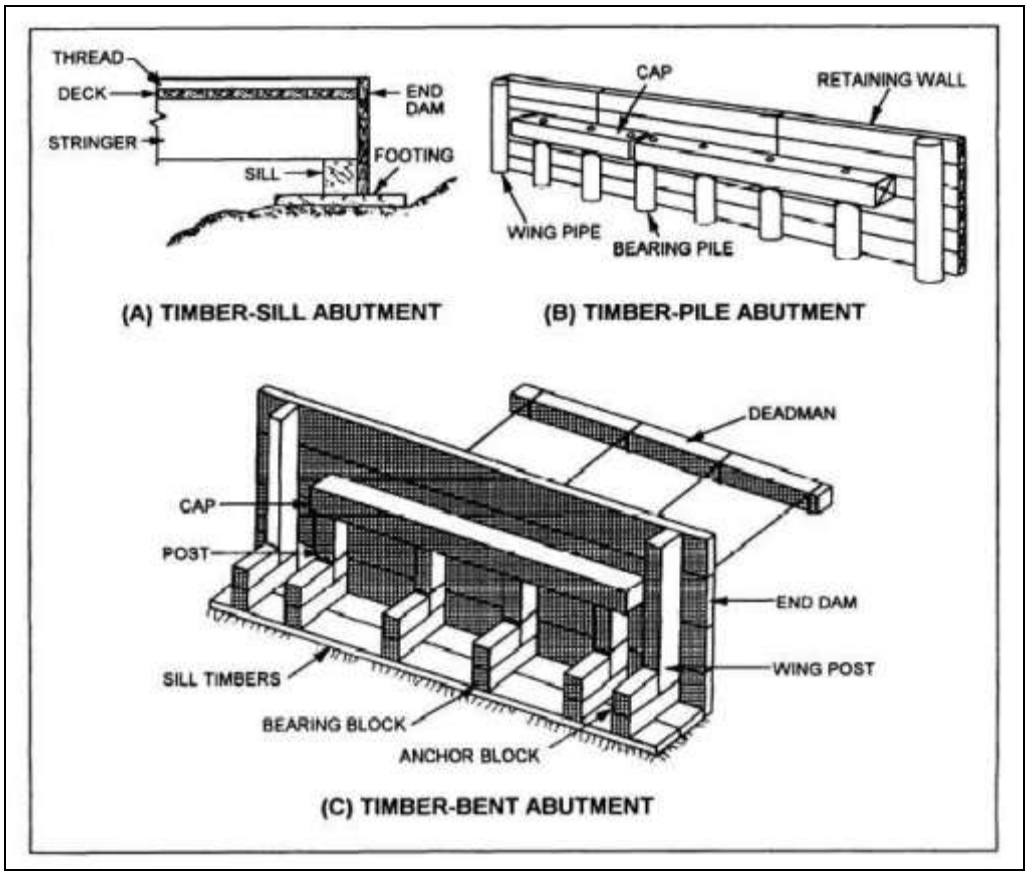


Figure I-3 Example of various bridge abutments