

**Fort Nelson Timber Supply Area
Timber Supply Review**

Updated Data Package

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1. Introduction

Under Section 8 of the *Forest Act* the chief forester must review the timber supply and determine an allowable annual cut (AAC) for each timber supply area (TSA) at least once every 10 years. The chief forester may also extend the current AAC an additional five years if the current timber supply is stable and recent developments would unlikely change the AAC.

The purpose of the timber supply review program (TSR) for a Section 8 AAC determination is to gather information about the TSA land base and current forest management practice and to use this information in a timber supply analysis. During the TSR, two documents are published for public review: a data package and a discussion paper about the timber supply analysis. Following the TSR, the chief forester makes an AAC determination that is documented and publicly released in a written rationale statement. For more information about the AAC determination and the TSR, please visit the following internet site: <https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/timber-supply-review-and-allowable-annual-cut>.

This data package summarizes the information and assumptions that are proposed to conduct timber supply analysis for the Fort Nelson Timber Supply Area (TSA). The information and assumptions represent current performance, which is defined by:

- the current forest management regime, the productive forest land available for timber harvesting, the silviculture treatments, the harvesting systems and the integrated resource management practices used in the area, including objectives and practice requirements under the *Forest Practices Code Act of British Columbia* (FPC), *Forest and Range Practices Act* (FRPA) and the Land Act, and their associated regulations;
- the Fort Nelson Land and Resource Management Plan (LRMP) which guides resource management activities;
- the *Muskwa-Kechika Management Area Act* which identifies how operational activities are conducted within the Muskwa-Kechika Management Area in the TSA; and
- orders issued through the FRPA Government Actions Regulation (GAR).

The TSR gathers and models information about the “what is” for the AAC determination, as opposed to the “what if” of current forest management. Changes in forest management or land use objectives that will occur after the AAC determination will be captured in future AAC determinations. Nevertheless, to assist future resource management some alternative management may be investigated separately during the TSR but which are not considered during the AAC determination.

The information in this data package represents the best available knowledge at the time of publication but it subject to change as better information becomes available. To assist with information gathering, a First Nation consultation and public review period has been established to allow submission of comments and concerns about the information in the data package to the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRO). Input from the consultation or public review that has timber supply implications may be incorporated into the timber supply analysis or identified separately to the chief forester for consideration in her AAC determination.

2. Overview of the Fort Nelson Timber Supply Area

The Fort Nelson TSA is the second largest TSA in British Columbia and covers an area of almost 9.9 million hectares in the north-eastern corner of the province, within the Northeast Natural Resource Region (Figure 1). The TSA is bordered to the east by Alberta, to the north by the Northwest Territories and the Yukon Territory, to the west by the Cassiar TSA and the Rocky Mountains, and to the south by the Fort St. John and Mackenzie TSAs. The TSA is administered from the Fort Nelson Natural Resource District office in Fort Nelson.

The Fort Nelson Natural Resource District, which encompasses the Fort Nelson TSA, is located entirely in the Boreal forest. Forests in this area consist mainly of old and mature stands of spruce, pine, aspen, cottonwood, and birch, in a wide variety of landscapes. The topography of the TSA forms a gradient of increasing relief from east to west, encompassing parts of the Alberta plateau, the Rocky Mountain Foothills, the Liard Plateau, the Liard Plain, the Kechika River Valley and a portion of the Cassiar Mountains. The entire region lies within the Arctic watershed and is largely drained by the Liard River and its major tributaries, including the Fort Nelson, Prophet, Muskwa, Toad, Kechika and Petitot rivers.

The southwestern portion of the TSA overlaps a large portion of the more than six-million-hectare Muskwa-Kechika Management Area, where wilderness and wildlife habitat support sizeable populations of a diverse range of large mammals. This area is designated for various levels of protection, conservation and use, to permit economic development under high management standards while protecting a large, intact, predominantly unroaded wilderness. The Fort Nelson TSA contains 33 parks, protected areas and ecological reserves, including Muncho Lake Park, Stone Mountain Park, and the Northern Rocky Mountains Park, totalling over 10% of the area of the TSA.



Figure 1. Location of Fort Nelson Timber Supply Area.

Three biogeoclimatic zones occur in the TSA: the Boreal-White-and-Black-Spruce (BWBS), which is the dominant zone covering about two-thirds of the total TSA land base; the Spruce-Willow-Birch (SWB); and the Alpine Tundra (AT). The BWBS zone is very important for wintering ungulates; frequent forest fires over the years have formed a mosaic of upland forests of different ages, providing a variety of habitats. The zone has the least snowfall of all the northern zones in BC. The extensive deciduous forests, which frequently achieve advanced ages here, are important for ungulates, birds and small mammals.

While the severe climate of this TSA does limit wildlife occurrence in some isolated portions or at certain times of year, the TSA contains vast tracts of relatively undeveloped land that support abundant, diverse and internationally significant wildlife populations. Large mammals, including moose, black bear and grizzly bear, are common, as are smaller furbearers such as wolverine, wolf, lynx, weasel, mink, river otter, beaver and coyote. The TSA also contains a unique range of bird species including the Bay-breasted Warbler, Black-throated Green Warbler, Cape May Warbler, Connecticut Warbler, Nelson's Sharp-Tailed Sparrow, Trumpeter Swan, and others, many of which are not found elsewhere in BC. The abundant rivers, lakes, and wetlands provide important staging grounds during the migration of water birds such as Pintails, Widgeons, Geese and Teal. Fish species in the TSA include trout, whitefish, burbot, arctic grayling, northern pike and walleye, with rare occurrences of salmon. Approximately 15 fish species occur only in this area of the province. There are few species of reptiles and amphibians.

The TSA is home to 11 endangered or threatened species, and 16 species of concern. Demographically, three-quarters of the population in the TSA reside in the town of Fort Nelson, away from which the region is sparsely populated but does contain a number of smaller settlements, all situated adjacent to the Alaska Highway-Prophet River, Toad River, Muncho Lake, Liard River, Coal River and Fireside.

Eight First Nations reside in or have traditional territory within the Fort Nelson TSA. Four of these—the Fort Nelson First Nation, the Dene Tsa Tse K’Nai (Prophet River) First Nation, the Dena Tha’ First Nation, and the Halfway River First Nation—are signatories to Treaty 8, which covers three-quarters of the TSA. Two Kaska-Dena First Nations—the Daylu Dena (Lower Post) First Nation, and the Dease River First Nation, the Tahltan First Nation, and the Fort Liard First Nation, which is part of Treaty 11 in the Northwest Territories—all have traditional territory in the TSA.

The current AAC of 1 625 000 cubic metres was determined in November 2006. The 2006 AAC determination did not include deciduous and coniferous partitions as had earlier decisions.

3. Current Forest Management Considerations and Issues

3.1 Major forest management issues

Table 1 lists major forest management issues for the Fort Nelson TSA. Where possible, the issues are assessed directly in the timber supply analysis within the base case scenario. If the issue does not fall within the definition of current management as modelled in the base case scenario, the related timber supply impacts may be assessed in a sensitivity analysis. There also may be significant uncertainties in defining some current management issues. In such cases, sensitivity analysis can also assist in assessing the timber supply implications and assigning degrees of risk to timber supply during the allowable annual cut determination.

Table 1. Major forest management considerations and issues

Consideration/issue	Description
Land use zones	The Fort Nelson Land and Resource Management Plan was approved in 1997. The plan identified resource management zones under four categories: protected areas, special management, general resource development and enhanced resource development.
Biodiversity	In 2010 a ministerial order under the <i>Land Act</i> established in non-spatial landscape biodiversity objectives for old forest retention specific to the Fort Nelson Natural Resource District.
Visual resources	About 800 000 hectares of scenic areas are assigned with visual quality objectives in the TSA.
Boreal Caribou	In 2010 ungulate winter range and wildlife habitat areas were established to protect boreal caribou habitat.
Harvest history	Since 2008, much of the harvest in the TSA has been associated with oil and gas related activities (e.g., seismic lines, well sites, sand and gravel pits) and minor forest tenures rather than forest industry activity.
Operability	Operability in the TSA has historically been simply defined and deficiencies were noted. A new operability map will be developed based on slope, elevation, and the distance (cycle time) from a processing facility.
Fort Nelson West	The western portion of the TSA is remote and has questionable economic operability. The past AAC determination did not consider these stands to contribute to timber supply.
Deciduous harvest	Aspen-leading stands represent a large portion of the land base but have traditionally been harvested at a rate significantly lower than their proportion.

3.2 Base case development

The assumptions described in this data package reflect the best available information with respect to the status of forest land, current and estimated future performance for forest management practices, resource management objectives and knowledge of timber growth and yield. The harvest forecast developed from these assumptions is called the base case harvest forecast and is used as a baseline for assessing the impacts of uncertainties (See Section 7, ‘Sensitivity Analysis’).

The base case harvest forecast is developed using the following harvest flow objectives and priorities:

- a. Ensure sustainability¹ by establishing the maximum even-flow harvest level as a floor in all periods of the forecast.
- b. Maximize a steady long-term harvest level with stable long-term growing stock.
- c. Maintain current AAC as long as possible to support communities.
- d. Limit declines to the mid-term harvest level to 10% per decade.

¹ Sustainability means managing to meet present needs without compromising the needs of future generations. For harvest forecasting, this means that short-term harvest levels do not compromise future harvest levels. Thus, any increase in short-term harvest level above the mid-term harvest level is only allowed when doing so does not impact the mid-term harvest level.

4. Inventories

Table 2 lists the main data sets that will be used to determine the timber harvesting land base (THLB) and to model forest management activities in either the base case management scenario or sensitivity scenarios.

Table 2. *Inventory and data set information*

Data	Source	File Name	Vintage/ Update
TSA Boundary	BCGW	WHSE_ADMIN_BOUNDARIES.FADM_TSA	2015
LRMP – RMZ, ERDZ, SMZ	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_NON_LEGAL_POLY_SVW	2007
Vegetation Resources Inventory	BCGW	WHSE_FOREST_VEGETATION.VEG_COMP_LYR_R1_POLY	2015
Biogeoclimatic classification	BCGW	WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY	2014
Natural Disturbance Units	BCGW	REG_LAND_AND_NATURAL_RESOURCE.NATURAL_DIST_UNI_TS_RPG_POLY	2014
Karst Potential Map	BCGW	WHSE_LAND_USE_PLANNING.RKPM_KARST_POTENTIAL_AREA_SP	2011
Budworm Incidence Mapping	RPD	HFF_Poly_2015.shp	2015
Land Ownership	BCGW	WHSE_FOREST_VEGETATION.F_OWN	2015
Woodlots	BCGW	WHSE_FOREST_TENURE.FTEN_MANAGED_LICENCE_POLY_SVW	2003
Operating Areas	FNRD	FTN_OPAREA1_POLYS	2015
Landscape Units	BCGW	WHSE_LAND_USE_PLANNING.RMP_LANDCAPE_UNIT_SVW	2015
Agricultural Land Reserve	BCGW	WHSE_ADMIN_BOUNDARIES.ALC_AGRI_LAND_RESERVE_POLYS	2015
Current Wildfire Burns	BCGW	WHSE_LAND_AND_NATURAL_RESOURCE.PROT_CURRENT_FIRE_POLYS_SP	2015
Consolidated Cutblocks	FAIB	Consolidated_Cutblocks_2015	2015
Caribou Information Planning	FAIB	Proposed_revised_core_areas_Feb19 & Proposed_revised_range_boundaries_Feb19	2016
Terrain Stability	FAIB	ESA_TSM1_POLYS	2000
ESA	FAIB	ESA_TSM1_POLYS	2002
Range Burns	FNRD	RANGE_BURN_POLYS	2016
Unsalvaged Volumes	FAIB	VolumeLossesByTSA_NRL.xls	2013
Domestic Water Licences	BCGW	WHSE_WATER_MANAGEMENT.WLS.POD_LICENCE_SP	2015
Ungulate Winter Rages	BCGW	WHSE_WILDLIFE.MANAGEMENT.WCP_UNGULATE_WINTER_RANGE_SP	2015
Wildlife Habitat Areas	BCGW	WHSE_WILDLIFE.MANAGEMENT.WCP_WILDLIFE_HABITAT_AREA_POLY	2015
Visual Landscape Inventory	BCGW	WHSE_FOREST_VEGETATION.REC_VISUAL_LANDSCAPE_INVENTORY	2015
Recreation Sites and Trails	BCGW	WHSE_FOREST_TENURE.FTEN_RECREATION_POLY_SVW WHSE_FOREST_TENURE.FTEN_RECREATION_LINES_SVW	2015
Road Networks	BCGW	WHSE_FOREST_TENURE.FTEN_ROAD_SECTION_LINES_SVW WHSE_MINERAL_TENURE.OG_PETRLM_DEV_ROADS_GOV_S P WHSE_MINERAL_TENURE.OG_PETRLM_DEV_RDS_PRE06_G OV _SP WHSE_MINERAL_TENURE.OG_PETRLM_ACCESS_ROADS_GO V _SP WHSE_BASEMAPPING.DRA_DGTL_ROAD_ATLAS_MPAR_SP	2015
Oil and Gas Surface Land Use	OGC	OGCSLU2014_GRP_NOGEO	2015
Archaeological Sites	BCGW	WHSE.ARCHAEOLOGY.RADD_RESOURCE_MGMT_POLY	2015

Data source and comments:

The sources are BCGW – British Columbia Geographic Warehouse, FAIB – Forest Analysis and Inventory Branch, FNRD – Fort Nelson Resource District, OGC – Oil and Gas Commission and RPD – Resource Practices Branch.

TSA Boundary – the provincial timber supply area administrative boundary.

LRMP – RMZ, ERDZ, SMZ - the Fort Nelson Land and Resource Management Plan (LRMP) management zones: Resource Management Zone (RMZ), Enhanced Resource Development Zone (ERDZ), and Special Management Zone (SMZ). The LRMP was approved October 1, 2007 (see www.for.gov.bc.ca/tasb/SLRP/plan32.html)

Vegetation Resources Inventory – the provincial forest inventory for the Fort Nelson TSA is based on interpretation of aerial photography. About 41% of the photography is from 1972-73, 40% from 1997 and 16% from 2006. The most recent projection of the inventory that has been updated for harvest and fire depletions and projected for stand attributes to January 2016 will be used.

Biogeoclimatic Classification – Provincial biogeoclimatic ecosystem mapping updated in 2014 (version 9).

Natural Disturbance Units - Natural disturbance units for North Eastern British Columbia based on a project completed in 2014.

Karst Potential Map - provincial mapping originally published in 2011 and updated in 2015.

Budworm Incidence Mapping – FLNRO Resource Practices Branch provincial health overview mapping updated in 2015.

Land Ownership – Provincial spatial ownership layer developed by FLNRO FAIB based on information from the Crown Land Registry and the Integrated Cadastral Information Society

Woodlots - Provincial spatial woodlot layer updated in 2015.

Operating Areas - The Fort Nelson Resource District provided mapping of operating areas.

Landscape Units - Provincial mapping published in 2011 and updated in 2015. Sliver polygons at the TSA boundary are eliminated.

Agricultural Land Reserve - Provincial mapping of preservation of agricultural lands and the promotion of agricultural uses. This spatial representation of provincial land use zones was published in 2014 and updated in 2015.

Current Wildfire Burns - Provincial data set of spatial polygon data that represent the perimeter areas of current fire incidents.

Consolidated Cutblocks - FAIB annually produces a layer of consolidated cutblocks from three sources: VRI, RESULTS and satellite imagery used for change detection. This layer is limited to cutblocks harvested after 2015. Earlier logging history is recorded in the VRI.

Caribou Information Planning – FAIB conducted Boreal Caribou Information Planning analysis to support investigation on further Boreal Caribou protection.

Terrain Stability and ESA - Terrain stability mapping (TSM) and Environmentally Sensitive Areas (ESA) data from an existing 2006 data set that was archived by the FAIB.

Range Burns - Fort Nelson Resource District provided a spatial data set of current and past range burn areas.

Unsalvaged Volumes - Forest Analysis and Inventory Branch has estimated average non-recoverable losses by forest health issue based on provincial forest health overview surveys for 1999 to 2013.

Domestic Water Licences - The provincial data layer that identifies domestic water licences. There are 12 water licences with legal status as Current Domestic Water Use. Fort Nelson town water comes from Muskwa River, while Prophet River First Nation water comes from Adsett Creek and Toad River First Nation water comes from Toad River.

Ungulate Winter Range - Provincial data layer of ungulate winter ranges established under the Government Actions Regulation.

Wildlife Habitat Areas - Provincial data layer of established wildlife habitat areas.

Visual Landscape Inventory - Provincial data layer of the visual landscape inventory (VLI) that identifies scenic areas and visual quality objectives.

Recreation Sites and Trails - Provincial data layers that contain recreation polygons (i.e., recreation sites) or recreation lines (i.e., recreation trails)

Road networks – Provincial data layers of information with respect to forests, minerals and other permanent access roads.

Oil and Gas Surface Land Use – Oil and Gas Commission data set of oil and gas infrastructure such as facilities, wells, pipelines, seismic lines and oil and gas tenure roads.

Archaeological Sites – Provincial data layer of archaeological sites as contained within the Remote Access to Archaeological Data (RAAD) data base.

5. Division of the Area into Management Zones

5.1 Management zones

Management zones are used to differentiate areas for the application of management objectives or the reporting of information. Zones may be based on legal definitions (e.g., ungulate winter range, landscape units) or a descriptive definition (e.g., pine-leading forests). For the Fort Nelson TSA timber supply analysis, management zones are identifiable from the Fort Nelson LRMP, GAR orders and other AAC decision considerations. Zones are not unique and may overlap other zones.

Descriptions of the specific management zones can be found throughout the data package. Section 6, ‘*Land Base Classification*’ describes land base exclusions used to meet objectives for some values where harvesting is not permitted such as wildlife habitat areas and ungulate winter ranges for boreal caribou habitat. Section 7.4, ‘*Resource management objectives*’ describes the zones and forest cover requirements used to meet objectives where harvesting is permitted but forest cover requirements must be met, e.g., visual quality.

Additional zones that are to be considered for information or sensitivity purposes within the timber supply analysis of the Fort Nelson TSA are noted in Table 3.

Table 3. *Management zones to be tracked*

Zone	Definition	Purpose
Fort Nelson West Opportunity harvests	The western operating units (Grayling, Smith, Hilgren, and Tsia)	Identify possible harvest volume
Deciduous/coniferous harvests	Coniferous and deciduous volumes	Monitor harvest volume

Data source and comments:

Opportunity harvests: the western part of the TSA that is currently considered inoperable due to economics. However, local First Nations have indicated potential interest and for sensitivity analysis where the four operating areas will be treated as operable and the potential timber supply implications explored.

Deciduous/coniferous: historically in mixed stands both coniferous and deciduous species are harvested, but only one group has been utilized. This analysis needs to consider the contribution of both to the timber supply.

5.2 Analysis units

An analysis unit simplifies or defines the forest for growth and yield modelling purposes. An analysis unit is typically composed of forest stands with similar tree species composition, timber growing potential and treatment regimes. Each analysis unit is assigned its own timber volume projection (yield table).

For the Fort Nelson TSA analysis units are divided based on the regeneration source into natural stands and managed stand analysis units. Natural stand analysis units have typically regenerated by natural means following either a natural disturbance or following harvesting (e.g., for aspen-leading stands). Managed stand analysis units, where through management better stand growth is expected, are typically regenerated through planting of conifers.

Table 4 shows the forest inventory criteria used to define analysis units for existing natural stands (deciduous leading only) in the Fort Nelson TSA. These analysis units are divided by leading species, percentage of the first leading species, and site productivity classes.

Table 26 shows the regeneration characteristics of the managed stand analysis units. Given the history of harvesting and plantations in the Fort Nelson TSA, only spruce- and pine-leading managed stand analysis units have been developed. The managed stand analysis units are further classified by when the stand was harvested (i.e., if the stand currently exists or is to be harvested in the future) and by site productivity (i.e., 5 site index classes <10 , ≥ 10 and <15 , ≥ 15 and <20 , ≥ 20 and <25 , and ≥ 25 m).

There is not sufficient scientific information to develop aspen leading stand successes to mixed aspen-coniferous stand, or eventually to coniferous stand (i.e., spruce or pine) during this round of timber supply review, thus, the original natural stand analysis unit will be assumed. Harvested aspen-leading stands will be maintained on the original natural stand analysis unit. Other stands types that are not harvested but in the analysis may be naturally disturbed will be maintained on the original natural stand analysis unit.

Each analysis unit or stand is assigned its own timber volume projection (yield table). Yield tables for “natural stand” stands are derived using the Variable Density Yield Prediction (VDYP) model version 7. Yield tables for “managed stand” analysis units (e.g., recent plantations) are derived using the Table Interpolation Program for Stand Yields (TIPSY) version 4.3. These models are further described in Section 8.

Table 4. Definition of existing natural stand analysis units

Analysis unit	Leading species	Site index range
S-Poor	Spruce	<10
S-Medium	(S, Se, Sx or Sw)	≥10 and <15
S-Good		≥15 and <20
S-Very Good		≥20 and <25
S-Extremely Good		≥25
SB-Poor	Black Spruce	< 10
SB-Medium	(Sb)	≥10 and <15
SB-Good		≥15 and <20
SB-Very Good		≥20 and <25
SB-Extremely Good		≥25
B-Poor	Subalpine fir	< 10
B-Medium	(B or Bl)	≥10 and <15
B-Good		≥15 and <20
B-Very Good		≥20 and <25
B-Extremely Good		≥25
P-Poor	Pine	< 15
P-Medium	(P, Pj, Pl, or Pli)	≥15 and <20
P-Good		≥20 and <25
P-Very Good		≥25 and <30
P-Extremely Good		≥30
A-Poor	Aspen/Cottonwood	< 15
A-Medium	(Ac, Acb, Act, At)	≥15 and <20
A-Good		≥20 and <25
A-Very Good		≥25 and <30
A-Extremely Good		≥30
E-Poor	Birch	< 10
E-Medium	(E, Ea, Ep, Ws)	≥15 and <20
E-Good		≥20 and <25
E-Very Good		≥25
L-Poor	Larch	< 10
L-Medium	(L, La, Lt, T)	≥10 and <15
L-Good		≥15 and <20
L-Very Good		≥20 and <25
L-Extremely Good		≥25

Data source and comments:

Existing natural stand analysis units are defined by leading species, secondary species, and site index by five metre classes. Pure stands are defined as leading species with greater than 80% species composition. Analysis units maybe aggregated further where there is not significant area in the THLB.

6. Land Base Classification

The boundary of the Fort Nelson TSA encompasses many land types and ownerships, not all of which are applicable to the chief forester's Section 8 AAC determination. Land may be unavailable for timber harvesting for four principle reasons:

- not administered by the FLNRO for timber supply purposes (e.g., private land, parks, etc.);
- not suitable or uneconomic for timber production purposes (e.g., non-forested areas);
- unavailable for timber harvesting (e.g., recreation areas);
- where timber harvesting is incompatible with management objectives for other resource values.

For modelling and information purposes, the TSA land base is described based on four nested categories: Gross Land Base, Crown Forest Management Land Base (CFMLB), Gross Harvesting Land Base (GHLB), and Timber Harvesting Land Base (THLB). Table 5 defines CFMLB, GHLB and THLB and identifies example exclusions from each category.

CFMLB is the land base applicable to the chief forester's Section 8 AAC determination within the Fort Nelson TSA for modelling purposes and includes areas that will be harvested and areas that will not be harvested due to restrictions for other resource objectives. The THLB is the modelled land base where the productive forest is expected to support harvesting. These definitions are land base simplifications used for modelling purposes and given data uncertainties, operationally areas classified as THLB may never be harvested and those areas that are classified as non-THLB are sometimes harvested.

Table 5. Summary of land base classification

Classification step	Definition	Exclusions
Gross land base (GLB)	All area within the TSA boundary.	<ul style="list-style-type: none"> • None.
Crown forest management land base (CFMLB)	Area with forest cover that contributes to Crown forest management objectives in the context of TSA timber supply.	<ul style="list-style-type: none"> • Private land (including Treaty land). • Federal land and reserves (except federal protected areas). • Long-term leases. • Area-based forest tenures (Tree Farm Licences [TFL], Community Forest Agreements [CFA], Woodlot Licences [WL] and First Nations Woodland Licences [FNWL]); and, • Non-forested and non-productive forest land.
Gross harvesting land base (GHLB)	Area within the CFMLB where timber harvesting is permitted, subject to forest management objectives and constraints.	<ul style="list-style-type: none"> • Miscellaneous provincial crown land not contributing to timber supply. • Provincial protected areas, including conservancies. • Biodiversity/mining/tourism areas. • Areas with legally established boundaries and objectives that prohibit timber harvesting e.g., wildlife habitat areas.
Timber harvesting land base (THLB)	Area within the GHLB where timber harvesting is projected to occur over the long term.	<p>Areas that are not suitable or uneconomic for timber production:</p> <ul style="list-style-type: none"> • Environmentally sensitive areas; • Inoperable areas; • Areas with low site productivity; • Non-merchantable forest types surrogate areas for legally established management objectives for resources values that may prohibit timber harvesting but for which the location is decided operationally (e.g., riparian management areas).

6.1 Identifying the Crown forest management land base (CFMLB)

6.1.1 Private and alienated Crown land

Lands that are not administered by FLRNO for timber supply or for other TSA objectives (e.g., biodiversity) are excluded from the modelled CFMLB.

Table 6 shows land ownership types and identifies private land (land ownerships 40), Federal lands other than protected areas (land ownerships 52 and 53), and long-term leases (land ownership 99) that are excluded from the CFMLB.

Table 6. Land ownership type

Land ownership code	Crown forest management land base	Gross harvesting land base	Area (hectares)
40 Private – Crown Grant	No	No	19 632
52 Indian Reserve	No	No	10 448
53 Military Reserve	No	No	4 400
60 Crown Ecological Reserve	Yes	No	3 952
61 Crown Reserves for Use, Recreation and Enjoyment of the Public (UREP)	Yes	No	1 040
62 Crown Forest Management Unit (TSA)	Yes	Yes	5 935 140
63 Crown Provincial Park Class A	Yes	No	1 048 480
64 Crown Conservancy areas	Yes	No	4 720
67 Crown Provincial Park equivalent or Reserve (includes Conservancies)	Yes	No	2 827 230
68 Crown Biodiversity, Mining and Tourism Area (BMTA)	Yes	No	880
69 Crown Miscellaneous Reserves	Yes	Yes	800
77 Crown and Private Woodlot Licence	No	No	4 256
99 Crown Miscellaneous lease	No	No	4 720

6.1.2 Area-based forest tenures

Area-based forest tenures such as woodlot licences (land ownership 77 in Table 6) are removed from the CFMLB because their AAC is determined independently of the Section 8 AAC determination for the TSA.

6.1.3 Non-forest and non-productive forest areas

Areas without forest or with non-productive forest that does not contribute to other modelled forest objectives are not considered part of the CFMLB.

Table 7 shows the criteria used to remove non-forested areas and non-productive forest from the CFMLB.

Table 7. Description of non-forest and non-productive areas

Attributes	Description	Reduction (%)	Area (ha)	Net area removed (ha)
VRI attribute fmlb = 'N'	Not in VRI forest management land base	100%	3,777,546	3,777,546
Existing roads, trails and landings	As mapped	100%	39,270	39,270
Existing oil, gas, wells, facilities and seismic lines	As mapped	100%	131,620	102,791

Data source and comments:

The VRI forest management land base attribute identifies non-forested and non-productive forest areas. Non-vegetated areas, non-treed areas, alpine areas, water bodies, wetlands and areas with site index less than five metres (m) are excluded from the CFMLB unless they have been logged. They do not contribute to objectives for wildlife habitat or biodiversity.

For the current analysis, excluded road polygons will be created by buffering highway and paved roads to a width of 30 m; operational roads, mainlines, and petroleum development roads to a width of 20 m; and gravel, rough, overgrown and spur roads to a width of 10 m. Reductions for future roads are described in Section **Error! Reference source not found.**

In this analysis, the reduction for existing oil and gas infrastructure was based on OGC land surface use analysis data. The buffer distance was used by the following specifications: wells to a width of 100 m; oil and gas pipelines to a width of 15 m; and seismic lines to a width of 3 m.

6.2 Identifying the gross harvesting land base (GHLB)

6.2.1 Protected areas and miscellaneous Crown reserves

Harvesting is not permitted in protected areas such as provincial parks and ecological reserves (land ownerships 60, 63, 64 and 67 in Table 6). For this analysis UREP and non-contributing Crown parcels (land ownerships 61, 62N and 69N in Table 6) are also excluded (Table 8).

Table 8. Description of protected areas and miscellaneous crown reserves

Attributes	Description	Reduction (%)	Area (ha)	Net area removed (ha)
Ownership attribute own = (60,61,63,67,99)	No harvesting is permitted in the protected areas and reserves	100%	3,886,117	1,391,148

6.2.2 Agricultural land reserve

Province mapped preservation of agricultural lands and the promotion of agricultural uses. This spatial representation of provincial land use zones was published in 2014 and updated in 2015.

Harvesting is not permitted in legally established recreation sites or trails (Table 9).

Table 9. Description of protected areas and miscellaneous crown reserves

Attributes	Description	Reduction (%)	Area (ha)	Net area removed (ha)
Status = 'ALR'	No harvesting is permitted in the agricultural land reserves	100%	48,466	30,284

6.2.3 Wildlife range burns

Range burns are carried out using prescribed fire (i.e., the knowledgeable and controlled application of fire) to a specified land area to accomplish planned resource management objectives. This technique is used to create forage (grass land forest complexes) for wildlife and domestic livestock (e.g., horses used by commercial backcountry operators). The majority of range burns occur in the western portion of the TSA. These burns are conducted by FLNRO (Resource Management – Fish and Wildlife) and range tenure holders.

Table 10. Description of protected areas and miscellaneous crown reserves

Attributes	Description	Reduction (%)	Area (ha)	Net Area Removed (ha)
Range burn locations	burn_loc = 'alicia', 'g99088', 'gataga', 'prophet', 'racing', 'range2011', 'range2013', 'russ', 'toad_river', 'turnagain'	100%	22,388	491

6.2.4 Recreation areas

Harvesting is not permitted in legally established recreation sites or trails (Table 11).

Table 11. Recreational values

Category	Criteria	Reduction (%)	Area (ha)	Net area removed (ha)
recreation trail/sites	"project_name"='Gathto Creek Recreation Site' & 'Beaver Lake Recreation Site' & 'West Lake Recreation Site' & 'Muskwa Boat Launch Recreation Site' & 'Teetering Rock Recreation Trail' & 'Parker Lake Recreation Site' & 'Fort Nelson Demo Forest'	100	4,381	1,837

Data source and comments:

Section 16 of Forest Recreation Regulation specifies that industrial activities are not permitted within the boundaries of legally established forest recreation sites or trails, thus, the District Recreation Officer does not expect harvesting to occur.

In Fort Nelson, the following recreation sites and trails are legally designated or established but without objectives yet:

- Gathto Creek Recreation Site (March 17, 1994);
- Beaver Lake Recreation Site (June 9, 2005);
- West Lake Recreation Site (June 9, 2005);
- Muskwa Boat Launch Recreation Site (June 9, 2005);
- Teetering Rock Recreation Trail (June 9, 2005);

- Parker Lake Recreation Site (January 28, 2008);
- Fort Nelson Demo Forest (March 25, 2008).

The boundary for the established recreation sites and trails in the Fort Nelson TSA are 100 m wide. The recreation lines are buffered by 50 m on each side to create 100 m wide recreation trail polygons, while the recreation sites are buffered by 100 m on the outside of the site polygon to create 100 m wider recreation site polygons.

There are additional recreation sites and trails that have been developed, but have not been established under legislation. Forest licensees have also respected these unlegislated recreation sites and trails and thus for the current analysis these sites which are not part of the GHLB, will be excluded from the THLB. These are: Parker/Evie Lake Trail, Alaska Highway 372 Km Rec Site, Alaska Highway 384 Km Rec Site, Alaska Highway Borrow Pit 3, Alaska Highway 391 Km Rec Site, Alaska Highway Borrow Pit 5, Alaska Highway Borrow Pit 6, Alaska Highway Borrow Pit 7, Alaska Highway 416 Km Rec Site, Alaska Highway Borrow Pit 9, Alaska Highway Borrow Pit 10, Muskwa River Bridge Recreation Site, Dunedin Trail, Smith River FSR Trail, Teeter Creek Trail, Tetsa River Trail, Poplar Hills Emergency Warming Shelter, Fort Nelson Motorized Community Trail System, Wokpash Trail, Tetsa River Recreation site, West Toad Recreation Site.

6.2.5 Wildlife habitat reserves

Wildlife habitat may be identified and managed through several tools including ungulate winter range (UWR), wildlife habitat areas (WHA) and management practices specified in plans that establish legal objectives. Where the objective prohibits timber harvesting these areas are excluded from the GHLB.

Table 12. Wildlife habitat exclusion from GHLB

Category	Criteria	Reduction (%)	Area (ha)	Net area removed (ha)
Wildlife habitat areas	Tag = '9-074', ..., '9-088', '9-101', '9-147', ..., '9-150', '9-155', '9-158', '9-159', '9-162', '9-165', '9-172', and '9-180'	100	338,441	16,794
Ungulate winter range	UWR_NUMBER='u-9-005' and 'u-9-010'	100	723,848	401,103

Data source and comments:

- **Wildlife habitat areas:** A Government Actions Regulation July 27, 2010 Order to establish Wildlife Habitat Areas 9-074 to 9-088 for Boreal Caribou includes a General Wildlife Measure that prohibits timber harvesting. Government Actions Regulation October 12, 2017 Order to establish Wildlife Habitat Areas 9-101, 9-147 to 150, 9-155, 9-158, 9-159, 9-162, 9-165, 9-172, 9-180 for wildlife habitat core area, in which harvesting is prohibited.
- **Ungulate winter range:** The Government Actions Regulation, July 27, 2010 Order to establish Ungulate Winter Range UWR_NUMBER u-9-010 for Boreal Caribou includes a General Wildlife Measure that prohibits timber harvesting and silviculture activities within the Type A units. The Government Actions Regulation, October 12, 2017 Order to establish Ungulate Winter Range UWR_NUMBER u-9-005 for Boreal Caribou includes a General Wildlife Measure that prohibits timber harvesting and silviculture activities.

6.2.6 Cultural heritage resources and archaeological sites

A cultural heritage resource is an object, a site or the location of a traditional societal practice that is of historical, cultural or archaeological significance to British Columbia, a community or an aboriginal people. The objective set by government for cultural heritage resources in the Forest Planning and Practices Regulation is to conserve or, if necessary, protect cultural heritage resources that are the focus of a traditional use by an aboriginal people that is of continuing importance to that people, and not regulated under the *Heritage Conservation Act*.

The *Heritage Conservation Act* provides for the protection and conservation of certain types of cultural heritage resources by prohibiting any disturbance, alteration or destruction. In situations where heritage resources are not automatically protected under the *Heritage Conservation Act* the appropriate protection or management measures are developed in consultation with First Nations.

Cultural heritage resources are often protected informally through accounting for existing resource management zones, protected areas, wildlife habitat areas, riparian, and wildlife tree retention areas.

Table 13. Cultural heritage resources and archaeological site

Location or analysis units	Buffer (m)	Reduction (%)	Area (ha)	Net area removed (ha)
Archaeological sites	100 m	100%	4,684	2,753

Data source and comments:

There are 968 archaeological sites within the Fort Nelson TSA these are buffered according to Resource Management Criteria. Those sites that have no other form of protection are buffered 100 m.

Fort Nelson First Nation has identified several village sites that have significant value to the First Nation and have had historical or current usage. A number of the sites are in parks or protected areas, or have been identified as archaeological sites.

Kaska Dena (Lower Post First Nations) has areas identified through a Significant Areas Strategy, part of the Strategic Engagement Agreement between the Province of British Columbia and the Kaska Dena Council.

6.2.7 Community water resources

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development under the *Water Act* issue domestic water licences that allow acquiring water from the nearby surface water at specific locations. These areas are protected under the Forest Planning and Practices Regulation which states that a person carrying out a forest activity must ensure that no damage to a licensed water work occurs.

Within the Fort Nelson TSA there are no legally designated community watersheds; however, there are 12 sources of domestic water intakes or points of diversion (POD).

Table 14. Domestic water licence intakes

Name	Criteria	Buffer (m)	Reduction (%)	Area (ha)	Net area removed (ha)
Domestic water intakes	LIC_STATUS="CURRENT" & PURPOSE="DOMESTIC"	100	100	9.4	9.4

Data sources and comments:

For domestic watershed intake each POD has been given a buffer width of 100 m to recognize the special consideration to maintain water resources (Table 14). No harvest is planned within these areas.

Since the previous timber supply review some water licences have been dropped.

6.3 Identifying the timber harvesting land base**6.3.1 Environmentally sensitive areas and terrain stability**

Operationally there are sensitive areas (e.g., steep slopes with high risk of land slide) from which harvesting is excluded. Terrain stability mapping (TSM) has been developed to provide a more standardized assessment of slope stability than the older environmentally sensitive area (ESA) mapping for soil sensitivity. ESA mapping that was developed to identify terrestrial and aquatic places that have special environmental attributes worthy of retention or special care is no longer maintained and for the current timber supply analysis will only be used where TSM is absent.

Table 15 identifies areas considered to be unavailable for timber harvesting due to their environmental sensitivity.

Table 15. Description of environmentally sensitive areas

Category	Description and criteria	Reduction (%)	Area (ha)	Net area removed (ha)
Ep1	High regeneration problems	100	409,055	194,809
Ep2	Moderate regeneration problems	50	802	337
Es1	High soil sensitivity	100	190,286	90,622
Es2	Moderate soil sensitivity	50	2,325	978
P or IV	Potentially unstable	100	12,650	12,398
U or V	Unstable terrain	100	6,473	6,344

Data source and comments:

Mapping of environmentally sensitive areas (ESA) was conducted in the 1970s and 1980s and included in the forest inventory to identify forested areas that are considered environmentally sensitive and/or significantly valuable for other resources. ESA mapping is not included in the current vegetation resource inventory. Reductions for recreation and wildlife ESA mapping are addressed by newer mapping described in other sections of this data package.

Several terrain reconnaissance mapping (Level D²) study areas have been completed throughout the Fort Nelson TSA, mostly in areas where there is significant terrain related concerns. As the terrain reconnaissance mapping is considered best available information, it will replace the ESA soils mapping. The assigned 100% reduction is consistent with the previous Fort Nelson TSA timber supply review.

² Level D refers to the Terrain Survey Intensity Level, where the scale ranges from A (most checked) to E (least checked). The level is a measure of the reliability of mapping, where 1 to 20% of the polygons are ground-checked (*Mapping and Assessing Terrain Stability Guidebook*, 1999)

6.3.2 Inoperable areas

Areas are considered inoperable where there are physical or economic barriers or limitations to harvesting. Physical barriers include steep slopes or other site conditions that physically prevent harvesting. Economic barriers include stand and site conditions such as low timber value or high operating cost that make harvesting uneconomic, even though the stands are physically operable. Changing technology and economic conditions can affect both physical and economic operability (Table 16).

Table 16. Description of inoperable areas

Category	Criteria	Reduction (%)	Area (ha)	Net area removed (ha)
Inoperable	Based on historical harvest activity relative to slope, elevation and cycle-time.	100	7,156,357	2,103,748

Date source and comments:

In this timber supply review, inoperable areas were defined based on minor revisions to the Prince George Timber Supply Review's methodology (April 2015). To determine indicators of physical and economic operability, this method analyses historical harvest activity compared to slope, elevation and cycle-time (distance from a processing facility³).

The operability analysis was conducted on the 34 current operating zones⁴ and four zones⁵ in the northwestern part of the TSA where future potential harvesting activities will be investigated in a sensitivity analysis.

The analysis indicates that the historic upper threshold for harvesting (for 95% of all area harvested) is 664 metres in elevation (1a), 14.4% in slope (1b, Figure 1), and 20.12 hours for cycle time (Figure 3). For the purpose of defining operability, polygons with a slope steeper than 14.14%, or an elevation greater than 664 metres, or a cycle time greater than 20.12 hours were considered inoperable.

Sensitivity analyses will investigate the implications of changes in the operability parameters.

³ The haul distance was derived from cycle time analysis conducted by Forest Analysis and Inventory Branch (personal communication with Adrian Walton).

⁴ Beaver, Nelson Forks, Sandy, Zus, Catkin, Irene, North Dunedin, Torpid, Obole, Odayin, Etane, Pine, Kledo, Steamboat, Emile, Capot-Blanc, Patry, Kiwigana, Klentah, Sahtaneh, Cabin, Tsoo, Raspberry, Tsimeh, Snake, Clarke, Kotcho, Parker, Akue, Milo, Jackfish, Goguka, Tenaka, Bougie.

⁵ Grayling, Smith, Hilgren, and Tsia.

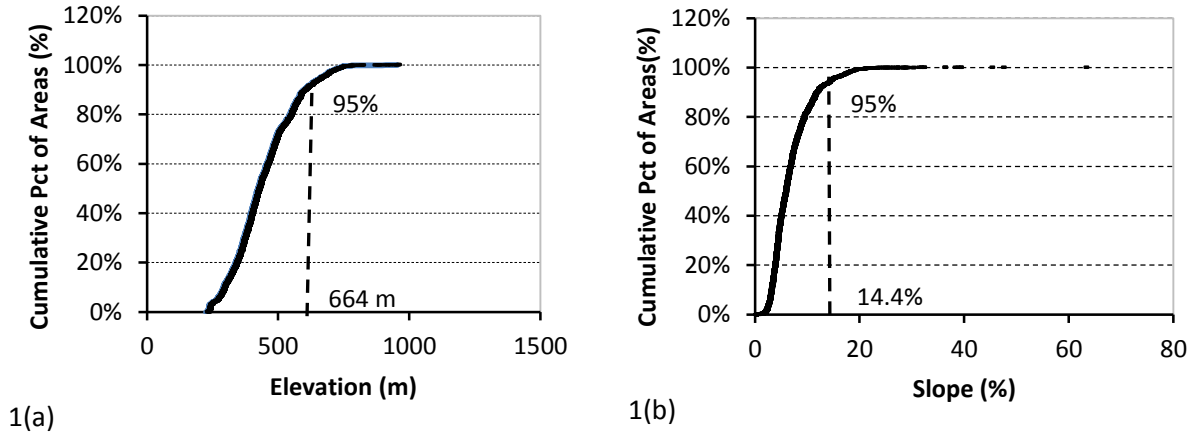


Figure 2. Percentage of cumulative historical harvest areas by elevation (a) and slope (b).

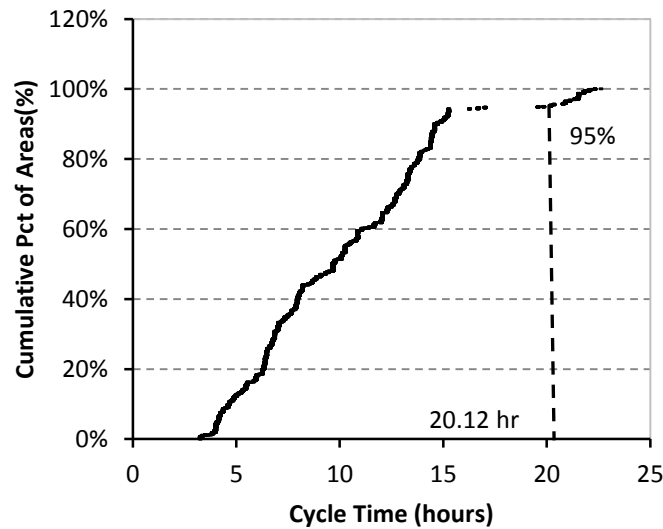


Figure 3. Percentage of cumulative historical harvest areas by cycle time.

6.3.3 Sites with low timber productivity

Sites may have low productivity either because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.), or because they are not fully occupied by commercial tree species. As these stands are typically not harvestable they are removed from the THLB using the criteria listed in Table 17 unless there is previous harvest history.

Table 17. Description of sites with low timber growing potential

Description	Leading Species	Logging History	Characteristics		Area (ha)	Net Area Removed (ha)
			Minimum SI	Reduction (%)		
Low site index	Spruce	No	<10	100	808,864	808,728
Low site index	Pine	No	<15	100	1,110,778	1,109,183
Low site index	Aspen	No	<15	100	399,542	398,001
Low site index	Balsam	No	<10	100	112,725	112,704

Data source and comments:

Throughout the Fort Nelson TSA there are stands that contain commercial tree species but have not, or are not, expected to achieve a productive condition within a reasonable growing period and are therefore excluded from the THLB. Existing mature stands (age being equal to or older than the ‘reference age for maturity’), must achieve the minimum volume per hectare and height to be included in the THLB.

Stands with logging history are identified in the VRI or within the consolidated cutblock inventory. Stands with logging history will not be excluded from the THLB.

6.3.4 Non-merchantable forest types

Table 18 describes forest types that are physically operable and exceed low site criteria but contain tree species that are not currently utilized or have timber of low quality, size or volume. These stands are excluded from the THLB.

Table 18. Non-merchantable forest types criteria

Leading species	Age	Reduction (%)	Area (ha)	Net area removed (ha)
Birch	All	100	350,168	342,093
Black Spruce	All	100	2,993,709	2,989,573
Larch	All	100	112,033	112,030
Other Deciduous	All	100	220	220

Data source and comments:

Historically, birch, black spruce and larch have not been utilized in the Fort Nelson TSA. A sensitivity analysis will consider birch harvesting.

6.3.5 Aquatic and riparian areas

Aquatic and riparian areas generally have two management requirements: a riparian reserve zone (RRZ) immediately adjacent to the water within which harvesting is prohibited; and a riparian management zone (RMZ) beyond the RRZ within which harvesting is permitted subject to retention requirements. **Error! Reference source not found.** lists the area reductions to be applied to account for both RRZ and MZ.

Table 19. Riparian area exclusions

Feature	Reduction (%)	Net area removed (ha)
Aquatic and riparian RRZ & RMZ	2.32	1,752

Data source and comments:

Although there are legal objectives for aquatic and riparian areas, the legally required RRZ and RMZ are not mapped. As such for analysis, interpretation of the objective is required to identify their size and associated location. This means that riparian areas are not considered to be excluded from the GHLB, however, they must be treated as THLB exclusions. An analysis of retention practices derived from the Forest and Range Evaluation Program (FREP) stand-level biodiversity data from 2006-2011 has been utilized to estimate total aquatic and riparian retention for Fort Nelson Timber Supply Area.

- The Forest and Range Evaluation Program (FREP) provided stand-level biodiversity data from 2006-2011 from which the retention for aquatic and riparian RRZ and RMZ was calculated.

- The FREP data has been validated against BC Timber Sales retention data and the RESULTS database to ensure its ability to represent the TSA.

6.3.6 Stand level retention

Stand-level biodiversity is managed in part by retaining reserves of mature timber or wildlife tree reserves (WTR) within cutblocks.

Table 20. Stand level retention

Location or analysis units	Reduction (%)	Net area removed (ha)
Existing spatial WTP (from FSPs)	7.0%	73,764

Data source and comments:

An estimate of stand level retention for Fort Nelson Timber Supply Area was derived from 2006-2015 FREP Stand-level Biodiversity data.

- The FREP data showed that the WTR was 7.0% for Fort Nelson Timber Supply Area.

6.3.7 Future roads, trails and wells, oil and gas seismic lines

A reduction for future loss of productive forest is required to account for future access structures, logging roads, trails, and landings, wells, seismic lines and transmission lines.

Table 21 shows the reductions made to reflect future losses in productive forest land due to roads, trails and seismic lines.

Table 21. Estimates for future roads-seismic activities

Roads, trails and seismic	Spatially Identified	Location	Reduction (%)	Net Area Removed (ha)
Future	No	Future conventionally operable area (2016covn='future')	4.6%	32,465

Data source and comments:

The current TSR will use the percentage of 4.6%. This percentage was determined by identifying the impact of current road and oil and gas activities and applying that future reduction to future harvesting of stands outside of a 200 m buffer of current activity (i.e., non-roaded area).

7. Current Forest Management Assumptions

7.1 Harvesting

7.1.1 Utilization limits

The merchantability limits in Table 22 specify the maximum stump height, minimum top diameter (inside bark) and minimum diameter at breast height for harvested tree species. They are used in the analysis to calculate merchantable volume.

Table 22. Utilization limits

Leading species	Minimum DBH (cm)	Maximum stump height (cm)	Minimum top DIB (cm)
Pine	12.5	30	10
Others	17.5	30	10

Data source and comments:

The Interior Timber Merchantability Specifications outlined in Table 1-2 of the *Provincial Logging Residue and Waste Measurement Procedures Manual—Waste Manual* effective August 1, 2016.

The growth and yield models used to create volume tables require merchantability specifications based on diameter at breast height. The specifications in the *Waste Manual* for minimum stump diameter are converted to the nearest corresponding breast height diameter for use with yield models. The specification for minimum top diameter inside bark is ignored because the yield models do not address it.

7.1.2 Volume exclusions for mixed-species stands

Table 23 identifies any species in mixed species stands that are non-merchantable and are not harvested. The unharvested portion of a stand does not contribute to estimated stand volumes (timber yield curves).

Table 23. Volume exclusions for mixed-species types

Species	Volume exclusion (%)
Alder	100
Cedar	100

7.1.3 Minimum harvest ages

The minimum harvest age is the earliest age at which a stand is considered to be harvestable. While harvesting may occur in stands at the minimum age in order to meet forest level objectives (e.g., maintaining overall harvest levels for a short period of time or avoiding large inter-decadal changes in harvest levels), most stands are not harvested until well beyond the minimum harvest ages because of management objectives for other resource values (e.g., visual objectives).

Table 24 shows the criteria used to determine minimum harvest ages. The timber supply model calculates minimum harvest ages using volume and diameter yield tables for each analysis unit, so minimum harvest ages are not calculated here.

Table 24. Minimum harvestable age criteria

Analysis unit type	Minimum volume (m ³ /ha)	CMAI %
Natural stand analysis units	140	95
Managed stand analysis units	140	95

Data source and comments:

The minimum harvest criteria are the same as used in the last Fort Nelson timber supply review.

7.1.4 Harvest scheduling priorities

Harvest priorities or minimum harvest levels are set for certain management zones or analysis units to reflect current licensee practices in response to recent harvest performance, forest health issues, operational pressures and/or license requirements. Priorities will be developed upon further discussion and review of past harvesting. The ability to model priorities will also be dependent on the choice of forest estate model to be used.

7.1.5 Silviculture systems

The only silviculture system currently used in the Fort Nelson TSA is clearcuts with reserves.

7.2 Unsalvaged loss

Non-recoverable losses (NRL) are timber volumes destroyed or damaged on the THLB by natural causes such as fire, wind, and disease that are not recovered through salvage operations and remain unutilized. These timber volumes do not include endemic losses that are incorporated within growth and yield model projections.

For the Fort Nelson TSA timber supply analysis these future losses are accounted for by estimating an average annual unsalvaged loss and deducting this amount from the harvest projection throughout the planning horizon of the TSR.

Table 25. Average (1999-2017) volume losses due to forest health issues that are not harvested

Cause of loss	Annual total loss (m³/year)	Annual un-salvaged loss (m³/year)
Drought	6 582	6 547
Fire	22 008	22 002
Flooding	25 103	25 072
Lodgepole pine beetle	33	33
Mountain pine beetle	6 902	6 896
Spruce beetle	1 690	1 690
Western balsam bark beetle	371	371
Total	62 689	62 611

Data source and comments:

Values in Table 25 were calculated based on forest health monitoring report for the period 1999 to 2017 by the FLNR Resource Practices Branch (https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest_Health/NRLs/). The estimates were based on the TSR III's THLB areas of 1,432,269 hectares, however, in this analysis, the THLB area is 705,761 hectares, and thus, a factor of 0.49 was applied to the published data to account for the loss estimates. These values and the applicability will be reassessed as updated information becomes available and upon further consideration of modelling techniques.

7.3 Silviculture

7.3.1 Regeneration activities in managed stands

Yields for all managed stands currently existing and those harvested in the future, are projected using managed stand yield tables produced by the Table Interpolation Program for Stand Yields (TIPSY) model. Table 26 shows the inputs required to produce managed stand yield tables for the analysis.

Table 26. *Regeneration assumptions*

Leading species for natural analysis units	Regen delay	OAFs (%)		Stem distribution	Species composition	Density
		1	2			
Future managed stands						
Spruce	1	15	5	Planted	S100	1416
Pine	1	15	5	Planted	P100	1285
Existing managed stands						
Spruce	2	15	5	Planted	S100	1472
Pine	2	15	5	Planted	P100	1624

Data source and comments:

Analysis unit and regeneration assumptions may be revised upon further analysis and consideration of inventory and RESULTS information. In particular mixed spruce- or pine-leading stands with aspen may be developed.

The information in Table 26 is based on a query of RESULTS data to calculate area-weighted average regeneration delay and density specifications for existing and future managed stands:

- Free-growing survey data were used because they represent the most likely path of development for managed stands, compared with regeneration survey data.
- Prior analysis unit assumption was developed by linking the RESULTS data to the leading species of the pre-harvest forest cover.
- Regeneration assumptions for existing managed stands were developed using the current leading species in RESULTS.

The harvest of existing natural and existing managed stands creates future managed stands. Both existing natural and existing managed stand analysis units for spruce- and pine-leading stands are assumed to move to future managed stand analysis units following harvest. Other existing natural analysis units are assumed to remain on the same analysis unit following harvest or natural disturbance.

Regeneration delay - this is the time elapsed between harvesting and the time when stand growth begins. The delay incorporates both the time taken to establish a stand, and the age of seedling stock planted, if applicable. Information from the RESULTS data base indicates an average regeneration delay of 1.9 years for blocks harvested since 2003. The value from the RESULTS query by leading species is shown in Table 26.

Operational adjustment factors (OAFs) – these are used to adjust timber yield estimates to account for operational factors. OAF 1 is a constant percentage reduction to account for small non-productive areas within stands, uneven stem distribution and endemic losses that do not increase with age and random risk factors. OAF 2 accounts for losses that increase with stand age, such as decay due to disease. In this case OAF 2 increases from 0 at stand establishment and passes through 5% at 100 years of age. There is no local information so provincial default values are used for OAF 1 (15%) and OAF 2 (5%).

Stem distribution – TIPSY identifies a ‘planted’ and ‘natural’ stem distribution where ‘planted’ has stems distributed more evenly whereas natural stems distributed clumpier. Although not all planting is evenly distributed and not all stems are planted, a planted distribution was assumed.

Species composition – this is the regenerated species composition. In general the pure regenerated species composition generally represents the average condition for all RESULTS records contributing to the specifications for the analysis unit.

Density – reliable estimates of planting density are difficult to obtain from RESULTS. Planting may occur over several years and the database does not differentiate between initial planting *versus* fill planting. Since regeneration specifications are derived from free-growing surveys, density is the total stems per hectare which is used in conjunction with the ‘natural’ stem distribution.

The use of seed since the last TSR is provided by the report, *Seed Use: Seedlings Requested by Species and Genetic Class for Sowing Years 2006-2016*. The report shows that predominately (99%) Class B seedlings have been used for the plantations in the Fort Nelson TSA. Class B seedlings have no effective genetic gain, thus genetic gain will be considered zero for TIPSY inputs.

The site index used in TIPSY for each analysis unit is the area-weighted mean site index obtained from the provincial forest site productivity layer.

Regeneration characteristics of future managed stands analysis units are those areas within the TSA that have been harvested and planted after 2002.

7.3.2 Not satisfactorily restocked areas

Backlog Not Satisfactorily Restocked (NSR) is any area that was denuded prior to 1987 (when basic silviculture became the obligation of licensees) and is not yet fully stocked. There is no backlog NSR in the Fort Nelson TSA.

Not satisfactorily restocked (NSR) areas are identified in the Reporting Silviculture Updates and Land Status Tracking System (RESULTS) data base. As of June 2016, there is no NSR in the Fort Nelson TSA.

7.4 Resource management objectives

7.4.1 Summary of forest cover objectives

Within the Fort Nelson TSA there are many resource management objectives that affect forest management. In this sections, resource management objectives that are not addressed in the above sections and which be modelled with forest cover requirements, such as a maximum allowable disturbance or a minimum area retention are discussed.

Table 27 Table 27 summarizes the resource objectives that will be modelled in the base case by a forest cover requirement.

Table 27. Forest cover requirements

Resource objective	Area target	Condition target	Affected land base
Adjacency/green-up	Maximum 39%	Minimum height 3 m	THLB by landscape unit
Landscape biodiversity- old forest retention	See Table 28 28		CFMLB by landscape unit
Visual quality objectives	Maximum allowable disturbance in plan view	Height \leq mean visually effective green-up height	CFMLB for each visual quality objective by landscape unit

7.4.2 Adjacency/green-up

The forest cover rules for enhanced, general resource development and special management zones provided in Table 26 approximate the operational block adjacency rules for the Fort Nelson TSA. Operationally, adjacency requires a logged block to reach a certain height target (green-up) before a neighbouring area can be harvested. Based on direction provided in the *Landscape Unit Planning Guide 1999* and by the Fort Nelson Natural Resource District, licensees are able to alter adjacency rules to achieve target patch sizes. It is understood that this is current management in the Fort Nelson TSA. No specific patch size targets will be modelled in the base case.

7.4.3 Landscape biodiversity

The Fort Nelson TSA contains 30 landscape units (LU), which have been established by Ministerial Order (October 20, 2010 www.for.gov.bc.ca/tasb/slrp/legal-direction/). The old forest retention requirement objective by landscape unit is shown in Table 28.

Table 28. Old forest retention requirements by natural disturbance unit and landscape unit

Natural disturbance unit	Landscape units	Age of old	Minimum % of CFLB retained as old forest
Alluvial	1. Liard River; 2. Liard River Corridor Park; and 3. Nelson Forks	Conifer 140 years Deciduous 100 years	44
Northern Boreal Mountains	4. Sharktooth; 5. Major Hart; 6. Boreal; 7. Kechika; 8. Rabbit; 9. Netson; 10. Muncho; 11. Churchill; 12. Sulpher 8 Mile; 13. Tuchodi; 14. Gathto; 15. Prophet; 16. Smith; 17. Hyland; 18. Beaver; 19. Irene; 20. Kledo; and 21. Holden	140 years	37
Boreal Plains Uplands	22. Klowee; 23. Cridland; 24. Klua; 25. Clarke; 26. Sandy; 27. Kiwigana; 28. Petitot; 29. Kotcho; and 30. Shekilie	Conifer 140 years Deciduous 100 years	17

7.4.4 Visual quality objectives

Scenic areas and their visual quality objectives (VQO) were established under the *Forest Practices Code Act* and grandparented under the *Forest and Range Practices Act* in 2006.

Modelling of visuals quality objectives is complicated given objectives operationally are based upon perspective views upon a diverse topography from viewpoints. For TSR procedures adapted by the Northern Visual Resource Specialist in 2007 from *Procedures for Factoring Visual Resources into Timber Supply Analysis* (1998) and *Modelling Visuals in TSR III* (2003) will be used.

Plan to Perspective (P2P) ratios and Visually Effective Green-up (VEG) heights will be determined for 5% slope class increments for each individual scenic area polygon by area-weighting across all slope classes within the polygon using the data from

Table 30. The area-weighted P2P ratio is multiplied by the maximum percent alteration in perspective view to calculate the maximum allowable percent alteration in plan view for each VQO polygon (Table 29). The mean Visually Effective Green-up (VEG) height is determined for each VQO polygon by area-weighting the VEG across all slope classes within the polygon using data from Table 27.

Visually sensitive polygons are aggregated by landscape unit and VQO. The forest cover constraint for each VQO aggregate limits the area with height at or below the mean VEG height to be no more than the mean maximum allowable percent alteration in plan-view.

Table 29. Slope classes for calculating P2P ratio and VEG height

	Slope classes (%)														
	0 – 5	5.1 – 10	10.1 – 15	15.1 – 20	20.1 – 25	25.1 – 30	30.1 – 35	35.1 – 40	40.1 – 45	45.1 – 50	50.1 – 55	55.1 – 60	60.1 – 65	65.1 – 70	70.1+
P2P ratios ²	4.68	4.23	3.77	3.41	3.04	2.75	2.45	2.22	1.98	1.79	1.6	1.45	1.29	1.17	1.04
VEG height (m)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	6.5	7.0	7.5	8.0	8.5	8.5	8.5

Table 30. Maximum percent alteration by visual quality objective

VQO	Maximum % alteration	
	Perspective view	Plan view ¹
Preservation	0	0
Retention	1.5	1.5 x P2P ratio
Partial retention	7	7 x P2P ratio
Modification	18	18 x P2P ratio

¹ P2P ratio is the plan-to-perspective ratio as determined in Table 29.

7.4.5 Disturbance outside of the timber harvesting land base

Some forest cover requirements described in Table 27, Forest cover requirements apply to the CFMLB, which includes forest outside of the THLB (i.e., non-THLB or NTHLB). Forest outside of the THLB can undergo natural disturbance that affects its age class distribution and its contribution to forest cover requirements. This natural disturbance outside the THLB must be accounted for, to prevent this forest from aging continually and contributing inappropriately to forest cover requirements.

Table 31. Natural disturbance parameters applied to NTHLB within each NDUI

NDU	Stand replacement disturbance cycle	Old threshold	Time since disturbance distribution
	(Return interval)	(Years)	(% of forest area)
Boreal Plains-Alluvial	200	140	41-61
Boreal Plains – Upland	100	140	17-33
Northern Boreal Mountains	180	140	37-60

¹NDU – Natural Disturbance Unit.

Data source and comments:

Various modelling assumptions have been used in the past to simulate the role of natural disturbance in altering NTHLB forest conditions. In this analysis a disturbance function will be applied in the base case to prevent NTHLB from continually aging and providing a disproportionate and often improbable amount of old forest cover conditions to satisfy landscape biodiversity requirements. The natural disturbance function utilizes the thresholds set out in Table 3 of *Land Units and Benchmarks for Developing Natural Disturbance based Forest Management Guidance for North-eastern British Columbia*. Stands exceeding the old forest thresholds utilized in the Fort Nelson Landscape Biodiversity Order will be selected for disturbance. The selection will be probabilistically based on the stand replacement disturbance cycle of the BEC variant and associated Natural Disturbance Unit (NDU).

8. Growth and Yield

8.1 Natural stand yield tables

Yield tables for natural stands will be derived using the Variable Density Yield Prediction (VDYP7) model. Input information for the VDYP7 model will be based on the VRI attributes of the individual polygons.

Natural stand analysis unit yield tables will be an area weighted average of those polygons that fall within the classification of an analysis unit. Table 4 shows the classification of natural stand analysis units.

Data source and comments:

Information on the VDYP model is available at

<https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/growth-and-yield-modelling/variable-density-yield-projection-vdyp?keyword=vdyp>

8.2 Managed stand yield tables

Yield tables for stands classified as managed (both existing and future) will be derived using the Table Interpolation Program (BatchTIPSYv4.3).

Input for BatchTIPSYv4.3 will be based upon associated regeneration, tree improvement, utilization and operational adjustment factors associated with managed stand analysis units and potential site index of the polygon to determine an average potential site index for the analysis unit.

Regeneration assumptions for analysis units for managed stands are described in Section 7.3.1 and analysis unit description in Section 5.2.

Data source and comments:

Information on the TIPSY model is available at

<https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/growth-and-yield-modelling/table-interpolation-program-for-stand-yields-tipsy?keyword=TIPSY>

Regeneration (species composition, regeneration delay, initial density) information is described in Section 7.3.1. Available genetic gain information will be incorporated from information of planted stock as reported through the FLNRO silvicultural data base (i.e., RESULTS), or the Seed Planning and Registry data base (i.e., SPAR). Potential site index information will be based upon the FLRNO provincial site index layer. Operational adjustment factors (OAF), that adjust the potential yields derived from BatchTIPSYv4.3, to reflect that a site may not be fully occupied (OAF 1) or be able to reach its potential yield (OAF 2) due for example to forest health issues were set to standard values of OAF 1 of 15% and OAF 2 of 5%.

9. Sensitivity Analysis

Sensitivity analysis can assess the timber supply impact of uncertainty in data and management assumptions and help to determine which variables have the greatest influence on timber supply forecasts. Further, sensitivity analysis of a specific issue may be investigated to provide insight to that issue. Table 32 lists base sensitivity analyses to be performed. This list may change as the analysis progresses.

Table 32. Proposed sensitivity analyses

Issue to be tested	Sensitivity levels
General volume changes	Change VDYP volume tables by + 10%
	Change VDYP volume tables by -10%
	Change TIPSYP volume tables by +10%
	Change TIPSYP volume tables by -10%
General THLB change	Change THLB for all polygons by -10%
Deciduous leading volume	Use TIPSYP instead of VDYP to create managed stand volume tables
Opportunity in western TSA	Incorporate Grayling, Smith, Hilgren, and Tsia operating areas in THLB
Highest priority (volume)	Model harvest priority based on highest volume than older first stands
Caribou	Model components of the proposed boreal caribou protection plan
Non-mixed stands	Exclude all stands from harvest except for "pure stands" (leading species > 80%)
Spruce leading stands	Exclude all stands from harvest except spruce leading stands
Birch leading stands	Include birch-leading stands in THLB

Data source and comments:

- General volume changes: To confirm expected harvest flow dynamics, general increases or decreases to the volume tables were made. In general, an increase or decrease in the natural stands volume should enable a corresponding increase or decrease in the timber supply for the short terms while an increase or decrease in the managed stand volumes should enable a corresponding increase or decrease in the long-term volumes. However, given an even-flow modelling objective, the changes in volume will be dependent on the influence of the change on where the timber supply is most restrictive (i.e., the pinch point), likely in the mid term.
- General THLB decrease: To confirm expected harvest flow dynamics, a general decrease of 10% of the THLB within the base case was tested. The THLB decrease will decrease the current and future growing stock, thus, a decrease in the even-flow harvest is expected.
- Deciduous-leading volume tables: Uncertainty exists in our volume projections for aspen- and birch-leading stands, particularly for older stands that may transition to coniferous-leading stands. In the base case VDYPv7.0 was used to project the volume of aspen- and birch-leading stands to reflect volumes as the stands age. In a sensitivity analyses, the deciduous species were projected by using TIPSYP v4.3 to investigate the timber supply dynamics where no succession is assumed.
- Opportunity in western part of TSA: In the base case, the Grayling, Smith, Hilgren, and Tsia operating areas have been excluded from the THLB to reflect past harvest performance. Given interest to harvest within these operating areas, these areas will be added to the THLB. The

operability criteria for the western part of the TSA will be determined similar to the rest of the TSA, except that cycle time and historical harvesting activities will be not applied.

- Highest priority (volume): The modelled harvest priority rule should reflect current and expected harvesting practices as best as possible, otherwise future timber supply may be impacted. This sensitivity analysis investigated whether the change from an oldest first to highest volume first priority rule would impact timber supply.
- Boreal Caribou core habitats: Proposals for boreal caribou habitat protection suggest a reduction of the current THLB. A sensitivity that reduces the THLB based on proposed boreal caribou habitat management will be performed.
- Non-mixed stands: Mixed stand management is a challenge, at landscape or regional level, in the boreal forest landscape of the Fort Nelson TSA. A sensitivity analysis was performed to demonstrate the impact to timber supply if harvesting focused on stands in the THLB where the leading species was greater than 80% of the composition.
- Spruce-leading stands: Although little harvesting has occurred recently in the TSA, there are interests that suggest spruce may be a priority for future harvest. A sensitivity analysis was completed where harvest priority was focused on spruce-leading stands.
- Birch-leading stands: Opportunities for the harvest of birch stands have been proposed as such as a sensitivity birch-leading stands that are excluded simply because of their species composition will be included in the THLB.