Mackenzie Timber Supply Area
Timber Supply Review

Data Package

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Ministry of
Forests, Lands and
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1. Introduction

This data package summarizes the information and assumptions that were used to conduct timber supply analysis for the Mackenzie 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 contained in the *Forest and Range Practices Act*;
- land-use plans approved by Cabinet (i.e., Mackenzie Land and Resource Management Plan);
- legal objectives established under the *Forest and Range Practices Act* and the *Land Act* (i.e., wildlife habitat areas, and ungulate winter ranges).

The purpose of the timber supply review program is to model "what is", as opposed to "what if." Changes in forest management objectives and data, when and if they occur, will be captured in future timber supply analyses.

In most cases, each section of this data package contains:

1) a short explanation of the data required,
2) a data table or list of modelling assumptions, and
3) a description of data sources and other comments.

1.1 Description of the Timber Supply Area

The Mackenzie timber supply area (TSA) is situated in the northeast interior of the province and is the fourth largest TSA in the province, covering approximately 6.41 million hectares. The TSA is one of 2 in the Omenica Region and is administered by the Ministry of Forest Lands and Natural Resources Operations District office located in Mackenzie.

The Rocky Mountain Trench, with flat to gentle terrain, runs north-south through the center of the timber supply area, with the rugged Rocky Mountains on the east side and the more rounded Omenica Mountains to the west. Within the central portion of the TSA and within the Rocky Mountain Trench is the Williston Lake. This hydro power reservoir and dominate feature, was created by the W.A.C Bennett Dam on the Peace River, is approximately 360 kilometres long and is the largest fresh water body in the province.

Despite the diverse terrain of mountains and river valleys, which contributes to the distinct ecological features and high biodiversity values, the forests of Mackenzie are fairly homogeneous. The primary tree species are lodgepole pine, spruce and subalpine fir. These along with several deciduous species make up the forests of the TSA. For example, forests of hybrid white spruce, lodgepole pine, alpine fir and boreal black spruce characterize the lower elevation areas. In flat terrain, the forest typically consists of hybrid spruce, and lodgepole pine with trembling aspen. The high elevation mountain-tops are blanketed with alpine shrubs, herbs, mosses and lichens.

The dominant factor influencing forest management and harvest activities in the TSA is the unprecedented mountain pine beetle infestation. This infestation has devastated hundreds of thousands of hectares of lodgepole pine stands. Due to the vast numbers of mountain pine beetle within the TSA, extreme behaviours by the beetle have occurred. Previously harvested stands, as young as 25 years, have been successfully attacked and killed. To date no large infestation in spruce, the alternate host tree, have been noted within the TSA.

The Mackenzie timber supply area is sparsely populated. Most of the population lives in the community of Mackenzie. Small settlements within the timber supply area include Germansen Landing, Manson Creek, Tsay Keh, and Fort Ware. There is very little dispersed rural settlement within the area. Roads access extends along both sides of Williston Lake. Most of the northern third of the TSA is without road access and is mainly contained in the Muskwa-Kechika Management Area.

Ten First Nations have asserted traditional territory within the Mackenzie timber supply area. The timber supply area almost entirely encompasses the traditional territories for the Kwadacha and Tsay Keh Dene First Nations, and includes their main communities of Fort Ware and Tsay Keh, respectively. The traditional territories of the McLeod Lake Indian Band, Takla Lake First Nation, and Nak'azdli First Nation, overlap a portion of the timber supply area as do small portions of West Moberly First Nation, Saulteau First Nation and Halfway River First Nation. In addition, significant portions of the Treaty 8 disputed area ofWest Moberly First Nation, Saulteau First Nation and Halfway River First Nation also overlap the timber supply area. Finally, small portions of the timber supply area near Thutade Lake are asserted to be within the traditional territories of the Gitxsan and the Tahltan First Nations.

2. Current Forest Management Considerations and Issues

2.1 Base case management assumptions

The assumptions described in this data package reflect current performance with respect to the status of forest land, forest management practices and knowledge of timber growth and yield. The harvest forecast developed from these assumptions is the reference harvest forecast – or base case - and is used as a baseline for assessing the impacts of uncertainties on the projected harvest. Section 7, "Sensitivity Analysis" identifies areas of uncertainty in the data and assumptions and outlines sensitivity analyses that are carried out.

2.2 Major forest management considerations and issues

Table 1 (overleaf) lists major forest management issues and considerations. Where possible, the issues are assessed directly in the timber supply analysis. If the issue does not fall within the definition of current management as described in Section 1, "Introduction", the related timber supply impacts are assessed in a sensitivity analysis. There may be significant uncertainties in defining some current management issues. In such cases, sensitivity analysis can assist in assessing the timber supply implications and assigning degrees of risk to timber supply during allowable annual cut (AAC) determination.

Table 1. Major forest management considerations

Consideration/issue	Description
Insects and Disease	
Mountain Pine Beetle(MPB) impacts in mature stands	District observations indicated that the British Columbia Mountain Pine Beetle (BCMPB) Version 9 model under predicts pine mortality within the TSA. The issue is a lack of aerial overview information in 2007, 2008 and 2009 in the TSA preventing adequate calibration of the model for the TSA. Instead local estimates of mortality based on repeated aerial reconnaissance will be used.
Mountain pine beetle impacts in immature stands	Mortality in immature pine stands, mortality in immature pine stands (< 60 years old) was not modeled in the previous TSR. Data collected 2011, sampling immature stands, will be used in the analysis.
Balsam Decline	Significant mortality in balsam-leading stands will be examined in this TSR.
Management of pine/non-pine resource and the need for a non-pine partition	The efficacy of a partition to ensure non-pine leading stands are harvested at sustainable levels will be assessed during the analysis. The Mackenzie forest district has created a mid-term mitigation strategy, and a component of this strategy is a report card. This report card will indicate on the amount of pine/non-pine that is harvested within the district by year.
Other issues	
Bio-energy opportunities	The amount of non-sawlog fibre within 100 km of Mackenzie township will be examined.
Utilizing marginally economic stands	As per the August 2012 report titled “Growing Fibre, Growing value” by the Special (legislative) Committee on Timber Supply explore opportunities for utilizing marginally economic stands within the TSA.
Operability	A new operability study based on practice to date within the TSA will define the area available for harvest.
Harvest availability	The availability of harvest volumes from different geographic areas of the TSA will be reported.
Site Productivity in regenerating stands	The site productivity of young stands and their impact on forecasted timber supply will be considered using Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) new provincial biophysical site index model.
Land use zones	The Mackenzie Land and Resource Management Plan (LRMP) received final approval in July 2002. It recommends the establishment of new protected areas, which were legally established in 2001.
ADAs	A portion of the Mackenzie timber supply area has been removed for the purposes of agriculture development and rural living. These areas will be removed for this Timber Supply Review.
Community Forest Agreement	A portion of the Mackenzie Forest District has been removed from the Timber Supply Area. This is the first Timber Supply Review done after the creation of the Community Forest and the area will be reduced to reflect the removal of this area from the Timber Harvesting Land Base.
Biodiversity	Biodiversity within the TSA is managed via the establishment of old growth management areas in seven landscape units or landscape unit groupings in 2010. Biodiversity in the remainder of the TSA is managed in accordance to non-spatial biodiversity objectives established in 2008 and subsequent 2010 amendments. Both the spatial and non-spatial objectives will be accounted for in the analysis.

Consideration/issue	Description
Visual resources	The Mackenzie LRMP describes the goal and summarizes the guidelines for managing visual resources.
Riparian areas	Riparian reserve and management zones have management requirements under the *Forest and Range Practices Act*.
Wildlife habitat	The Ministry of Environment has established objectives and targets for Ungulate Winter Ranges (UWR) for mountain goat and Wildlife Habitat Areas (WHA) for Caribou have been established under the *Forest and Range Practices Act*.
Muskwa Kechika Management Area Special Resource Management Zone	Muskwa Kechika Management Area MKMA Act enacted in 1998 set objectives to ensure resource development and other human activities take place in harmony with wilderness quality, wildlife and dynamic ecosystems on which they depend.
Grizzlies	Sensitivity analyses will be conducted to examine the impact of implementing best practices for the management of grizzly bears within the TSA.
Caribou	Sensitivity analyses will be conducted to examine the impact of implementing best practices for the management of caribou within the TSA.
Bull Trout	Critical stream habitat within the Davis River, Graham River, Chowika River, Point Creek, Scott Creek and Misinchinka River watersheds will be buffered 200 metres of either side of the watercourse.
Kaska Traditional Territory	The *Strategic Engagement Agreement between the Kaska Dena Council* and the Province established a Shared Decision Framework that applies to AAC determinations for TSAs within the Kaska Traditional Territory. The contribution of the forest within the Kaska Traditional Territory to the timber supply forecast for the TSA will be reported.

3. Inventories

Table 2 lists the inventories that are used to determine the timber harvesting land base (THLB) and to model forest management activities. They are listed in no particular order.

Table 2. Inventory information

Data	Source	Vintage	Update
Timber supply area boundary	BCGW[a] WHSE_ADMIN_BOUNDARIES.FADM_TSA	2003	
Ownership	BCGW WHSE_FOREST_VEGETATION.F_OWN	2010	
Vegetation resource inventory	BCGW (WHSE_FOREST_VEGETATION. VEG_COMP_LYR_R1_POLY)	1956-2010	2011
Provincial managed stand site productivity	MFLNRO Forest Analysis and Inventory Branch	2012	
Depletion layer	LRDW/RESULTS and MFLNRO Forest Analysis and Inventory Branch	2010	
Digital elevation model slope data	GEOBC	2002	
Forest recreation sites and trails	BCGW WHSE_FOREST_TENURE. FTEN_RECREATION_LINES_SVW WHSE_FOREST_TENURE. FTEN_RECREATION_POLY_SVW	2008	
Terrain stability mapping	MOE (soilterrain@victoria1.gov.bc.ca) Geographic location: Tudyah lake, Philip Lakes, Philip Creek, Morfee Lakes, Cut Thumb Creek, Blackwater Creek, Mount Selwyn and Point Creek Project ID: 4444	1976-2009	
Existing Roads, Rail, Power Lines and airstrips	BCGW WHSE_BASEMAPPING. TRIM_TRANSPORTATION_LINES WHSE_FOREST_TENURE. FTEN_ROAD_SEGMENT_LINES_SVW MFLNRO Mackenzie District	2003-2012	
Wildlife habitat areas	BCGW WHSE_WILDLIFE_MANAGEMENT. WCP_WILDLIFE_HABITAT_AREA_POLY	2008	

[a] BCGW – British Columbia Geographic Data Warehouse

Data	Source	Vintage	Update
Ungulate winter ranges	BCGW WHSE_WILDLIFE_MANAGEMENT. WCP_UNGULATE_WINTER_RANGE_SP	2003-2008	
Proposed ungulate winter range (u-7-025)	MFLNRO Northern Interior Forest Region	2009	
High value grizzly habitat	MFLNRO Mackenzie District	2012	
Caribou migration corridors	MFLNRO Mackenzie District	2012	
Fish sensitive watersheds	MFLNRO Mackenzie District	2011	
Visual landscape inventory	MFLNRO Northern Interior Forest Region WHSE_FOREST_VEGETATION. REC_VISUAL_LANDSCAPE_INVENTORY	1991-2008	
Old growth management areas	BCGW WHSE_LAND_USE_PLANNING. RMP_OGMA_LEGAL_CURRENT_SVW	2010	
Landscape units	BCGW WHSE_LAND_USE_PLANNING. RMP_LANDSCAPE_UNIT_SP	2004-2008	
Biogeoclimatic ecosystem classification	BCGW WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY	2012	
Assessment Watersheds	BCGW WHSE_BASEMAPPING. FWA_ASSESSMENT_WATERSHEDS_POLY	2009	
Mountain Pine Beetle infestation mapping	MFLNRO Mackenzie District	2011	
Agricultural Development Lands and Settlement Reserve Areas	MFLNRO Mackenzie District	2012	
Mugaha Marsh Sensitive Area	MFLNRO Mackenzie District	2001	
Muskwa Kechika Management Area	BCGW WHSE_TANTALIS. TA_MGMT_AREAS_SPATIAL_SVW	2008	
Log Dumps	MFLNRO Mackenzie District	2012	
Regeneration Data	RESULTS(Reporting Silviculture Updates and Landstatus Tracking System)	2011	
Kaska Traditional Territory	MFLNRO Mackenzie District	2012	

Data source and comments:

Ownership is a custom layer created by Forest Analysis and Inventory Branch using information from the Crown Land Registry and the Integrated Cadastral Information Society. It includes woodlot licences and community forest licences (which have their AACs set outside of the timber supply review process for TSAs), UREP/recreation reserves, private lands, federal lands, Indian Reserves, and parks and protected areas.

Despite the fact that the photography upon which the inventory is based was acquired as far back as 1956 in some areas of the TSA, 67% of the TSA has photography acquired between 1999 and 2010. This photography covers the southern two thirds of the TSA. Using a growth model, the inventory attributes have been projected to 2011. The inventory is updated for recent harvest and fire using a forest cover depletion layer created from RESULTS openings and harvest history and a remote sensing change detection layer.

Provincial managed stand site productivity mapping will be used to assign site indices to managed stands. Terrain stability mapping only existed for a small area along the eastern boundary of the TSA, south of the Peace Arm of Williston Lake.

In the absence of terrain stability data slope data from GEOBC's digital elevation model (DEM) used in conjunction with the location of existing cutblocks to determine the maximum slopes that licensees have historically logged.

Existing Roads, Rail, Power Lines and airstrips are required as they form part of the non-forested portion of the TSA. The roads are also used to help estimate future roading requirements for harvesting.

Wildlife habitat areas and ungulate winter ranges are mapped and established by Ministry of Environment and have various harvest restrictions within them.

High value grizzly habitat mapping and caribou migration corridor mapping commissioned by FLNRO staff will be used in sensitivity analyses to determine the impact on timber supply of implementing best management practices with regard to these species.

Visual landscape inventory identifies areas to be managed using visual quality objectives. Slope data from GEOBC's DEM are used to determine the maximum allowable disturbance for each area.

Old growth management areas (OGMAs) established in 2010 through the Sustainable Resource Management Plan (SRMP) will be accounted for in the analysis. The OGMA's represent 'old seral' requirements of the SRMP for the following landscape units or landscape unit groups: Twenty Mile, Gaffney-Manson River, Misinchinka-Tudyah B, Gillis-Klawli, Parsnip, Connaghan Creek-Eklund-Jackfish South Germansen-Upper Manson and Kennedy. Old seral requirements for the remaining landscape units within the TSA will be modeled in accordance to the *Amendment Order for the Non-spatial Landscape Biodiversity Objectives in the Mackenzie Forest District* signed September 23, 2010.

Landscape unit (LU) and Biogeoclimatic ecosystem classification (BEC) mapping will be used to implement the Non-spatial Landscape Biodiversity objectives within the forest estate model.

Assessment watersheds will be used to control and monitor the model runs at a finer scale than a landscape unit. They will be managed to track the impact of harvesting on grizzly bear habitat.

Estimates of the extent, severity and timing of the mountain pine beetle epidemic (MPB) provided by the Mackenzie Resource District will be used to represent the impacts dues to MPB.

4. Division of the Area into Management Zones

4.1. Management zones and objectives

Management zones are used to differentiate areas with distinct management emphasis. For example, a zone may be based on a harvesting or silviculture system, visual quality objective or wildlife consideration. Sometimes an area of forest is subject to more than one management objective. In the timber supply model, each type of zone can be tracked separately, thereby allowing application of overlapping management objectives. Forest land that is unavailable for timber harvesting may contribute toward meeting objectives for other forest values.

Table 3 outlines the zones or objectives incorporated into the timber supply model and the inventory area to which each objective will be applied. Further information on the forest cover requirements to be applied to these areas can be found in Section 6.7., "Integrated resource management."

Table 3 also describes various strata, within which the contribution to the overall projected timber supply will be tracked.

Table 3. Objectives to be tracked

Objectives	Inventory definition
Grizzly bear habitat	Forested land base by Watershed assessment polygon.
Ungulate winter range and caribou migration corridors	Forested land base by UWR and caribou migration corridors.
Visual quality objectives	Forested land base in each visual unit.
Mature + old and early seral stage distributions	Forested area by landscape unit and BEC variant.
Harvest by leading species	Leading species as per the inventory.
Harvest by landscape unit	Landscape units.
Harvest of live versus dead	As per mountain pine beetle infestation mapping.
Harvest by slope class	As per DEM based slope data
Harvest by volume per hectare	As per inventory projected volumes

4.2. Analysis units

An analysis unit is 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 existing and future stands. Yield tables for existing natural stands are derived using the Variable Density Yield Prediction (VDYP7) model. Yield tables for recent plantations and future stands are derived using the Table Interpolation Program for Stand Yields (TIPSY v4.2).

Table 4 shows the criteria for defining the analysis units for existing natural stands. Site index ranges for analysis units have been determined for the entire forested land base.

Table 4. Definition of analysis units for existing natural stands

Analysis Unit #	Leading Species	5 m Site Index Class mid-point	Area of Forest(ha)
12	Aspen	7.5	11,203
13	Aspen	12.5	74,810
14	Aspen	17.5	97,246
15	Aspen	22.5	30,880
16	Aspen	27.5	1,557
17	Aspen	32.5	49
22	Balsam-fir	7.5	745,010
23	Balsam-fir	12.5	176,060
24	Balsam-fir	17.5	47,799
25	Balsam-fir	22.5	3,720
26	Balsam-fir	27.5	251
27	Balsam-fir	32.5	78
32	Birch	7.5	733
33	Birch	12.5	5,461
34	Birch	17.5	12,892
35	Birch	22.5	6,060
36	Birch	27.5	171
42	Birch	7.5	482
43	Birch	12.5	86
44	Birch	17.5	385
52	Larch	7.5	17
53	Larch	12.5	8
54	Larch	17.5	7
62	Lodgepole Pine	7.5	123,566
63	Lodgepole Pine	12.5	458,068
64	Lodgepole Pine	17.5	491,440
65	Lodgepole Pine	22.5	83,380
66	Lodgepole Pine	27.5	1,989
67	Lodgepole Pine	32.5	205
72	Spruce	7.5	416,241
73	Spruce	12.5	337,291
74	Spruce	17.5	262,440
75	Spruce	22.5	40,365
76	Spruce	27.5	2,475
77	Spruce	32.5	572
78	Spruce	37.5	90
79	Spruce	42.5	14
82	Willow	7.5	189
83	Willow	12.5	461
84	Willow	17.5	27

Data source and comments:

The forested hectares in the above table refer to the forested stands within the Mackenzie Resource District regardless of tenure. That said the District is overwhelmingly dominated by the TSA, so the TSA is dominated by pine, spruce and balsam leading stands. Inventory polygons with a site index of less than five metres were deemed non-forest. Recently logged stands that have no assigned species label or site index are assigned to analysis units based upon the BEC variants within which they reside. To facilitate this assignment the

predominant leading species by BEC variant was determined and an area weighted site index calculated for each variant.

Analysis units have been created for both 'natural stands', and 'managed stands'. It has been assumed that existing 'natural stands' will regenerate as 'managed stands' if harvested and will remain as 'natural stands' if disturbed by a natural agent and are not salvaged.

The same assumption applies to 'managed stands'. If harvested they will regenerate to 'managed stands'. If attacked by a natural agent and not salvaged they will revert back to 'natural stands'.

The definition of managed stand analysis units are described in Section 6.6.1., "Regeneration activities".

5. Timber Harvesting Land Base Definition

This part of the data package outlines the steps used to identify the Crown forested land base and the timber harvesting land base (THLB). The Crown forested land base consists of provincial Crown land with forest cover that is either available for harvest or satisfies a non-timber objective. The Crown forested land base excludes:

- community forests;
- tree farm licences;
- woodlot licences;
- federal lands; and
- private lands.

The THLB is that portion of the Crown forested land base that is available for timber harvesting. The THLB excludes:

- parks and protected areas;
- areas that are not suitable for timber production; and
- areas where timber harvesting is incompatible with management objectives for other resource values.

Land is considered outside the THLB only where harvesting is not expected to occur. Any area in which some timber harvesting will occur remains in the THLB, even if the area is subject to other management objectives, such as wildlife habitat and biodiversity. These objectives are modelled in the timber supply analysis. The Crown forested land base outside of the THLB contributes to these non-timber objectives.

Land may be added to the THLB in the following situations:

- where management activities improve productivity or operability (e.g., the stocking of land currently classified as non-commercial brush with commercial tree species);
- through the acquisition of productive forest land (e.g., timber licence reversions).

After identifying all areas that are not part of the THLB, any additional lands are added to the THLB. The result defines the current timber harvesting land base.

5.1. Non-forest

The British Columbia land cover classification scheme (bclcs) and site index within the Vegetation Resource Inventory was used in conjunction with past logging to identify areas of non-forest. Table 5 shows that criteria used.

Table 5. Description of non forest

Attributes	Description
bclcs level 2 = "W" or bclcs level 5 = "LA","RE","RI" or "OC"	water, lake, reservoir, river or ocean
bclcs level 3 = "W" or "A"	wetland or alpine
bclcs level 4 = "SI" or "RO" or (bclcs level 4 = "EL" and the majority of the polygon has not been harvested)	snow/ice, rock/rubble or (exposed land provided the majority of the polygon has not been harvested)
bclcs level 4 = "ST", "SL", "HE", "HF", "HG", "BY", "BM", "BL"	tall or low shrubs, herbs, forbs, graminoids, bryoids, mosses or lichens
bclcs level 5 = "GL","PN","BR","TA","BI","MZ","LB"	glacier, snow cover, bedrock, talus, blockfield, rubbly min spoils or lava bed
bclcs level 5 = "RS", "LS", "RM", "BE", "LL", "RZ", "MU", "CB", "MN", "GP", "TZ", "RN", "UR", "AP" or "MI%" or (bclcs level 5 = "ES%" and the majority of the polygon has not been harvested)	river sediments, pond or lake sediments, reservoir margin, beach, landing, road surface, mudflat sediment, cutbank, moraine, gravel pit, tailings, railway surface, urban, airport or open pit mine or (exposed soil provided the majority of the polygon has not been harvested)
site index < 5 metres	once inventory corrected for missing site indices
Existing transportation lines and their buffers	See Section 5.2.— Existing Roads, Rail, Airstrips and Powerlines
Future Roads	See Section 5.3. —Future Roads

Data source and comments:

All of these areas are excluded from both the Crown forested land base and the THLB; they do not contribute to objectives for wildlife habitat or biodiversity.

Logged areas (excluded from the THLB reductions) are identified using the depletion layer described in Section 3, "Inventories".

Treed areas with a site index less than five metres are considered non-productive, rather than being sites with low timber growing potential because they are not considered to contribute to objectives for wildlife habitat or biodiversity.

5.2. Existing Roads, Rail, Airstrips, Powerlines and Pipelines

Assumed non-forested widths associated with existing roads, rail, power and pipe lines are detail in Table 6. Non-forest associated with airstrips were digitized from ortho-photography and google earth.

Table 6: Non-forested widths for existing roads, rail, airstrips, power and pipe lines

Category	Non-forested width (metres)
Existing Roads	
Public Roads	45
Mainlines	25
Operational	20
Cutblock	10
Rail	45
Powerlines	
Town power line	50
Kemess (above Parsnip River)	70
Mt Milligan (above Parsnip River)	70
Below Parsnip River to merger with town powerline	120
Connection to main power line	170
Main powerline	200
Pipelines	18

Data source and comments:

Information from the LRDW's "WHSE_BASEMAPPING.TRIM_TRANSPORTATION_LINES" and "WHSE_FOREST_TENURE.FTEN_ROAD_SEGMENT_LINES_SVW" layers was used to identify road and rail lines across the district. The former layer was used to distinguish between road and rail and public (paved) versus forestry/mining roads. The forestry/mining roads were classified using latter layer and the known occurrence of harvesting to date. Roads in the "FTEN_ROAD_SEGMENT" layer tagged with the District manager as the client were assumed to be the main-lines. No reliable coding existed to distinguish between an operational road that ran through a cutblock versus roads built purely for the extraction of timber from that particular cutblock. Therefore it was assumed that (non-mainline/non-public) dirt roads within a cutblock were cutblock roads and those portions of the roads between the known cutblocks were operational roads.

The non-forested width associated with mainlines is composed of a 6-8 m running surface, a 1.5m ditch line on either side. Safety clearing widths vary between 5-8 m depend on licensee and whether the road segment is straight, an inside or outside corner. Operational roads are similar to mailines only the running surface is 4-5 m.

Non-forest associated with power-lines and airstrips were digitized from ortho-photography.

5.3. Future Roads

259,874 ha of roaded cutblocks were identified. Assuming a 10 metres non-forested road width, 4% of each hectare harvested is consumed by road. This figure is consistent with information from 120 RESULTS openings[b]. The area weighted average from the RESULTS query was 4.6%.

[b] The attribution used to determine the roaded area from RESULTS was: stocking_status_code LIKE "NP%" ←(NP not productive) AND (stocking_type_code LIKE "RD%" OR stocking_type_code LIKE "UN%"); ←(unnatural or road)

This 4% reduction will be made for that portion of the THLB in excess of 300 metres from the existing road network upon first harvest. After harvest this area would then be classified as non-forest.

5.4. Ownership/Tenure contributions to CFLB and THLB

Land not administered by the BC Forest Service for timber supply in the TSA includes private land, municipal land, federal land, Indian Reserves, Community Forest Agreements, and Woodlot Licences. .These areas are all excluded from both the Crown forested land base (CFLB) and the THLB; they do not contribute to the non-timber objectives for the TSA.

Parks and protected areas within the TSA are part of the Crown forested land base and contribute to objectives for biodiversity and wildlife. However, they are not administered by the BC Forest Service for timber supply, so they are excluded from the THLB. New parks and protected areas were created as a result of the Mackenzie LRMP, the parks include: Muscovite Lakes, Heather - Dina Lakes, Finlay Russel, Ed Bird - Estella Lakes, Dune Za Keyih, Chase, Pine Lemoray, Tatlatui, Kwadacha Wilderness, Omineca, Bijoux Falls, and the Tudyah Lake Park. The ecological reserves include: Ospika Cones, Heather Lake, Raspberry Harbour, Blackwater Creek, Patsuk Creek, Chunamon Creek. The protected areas include: Omineca, Finlay - Russel, Dune Za Keyih, Pitman River and the Denetiah Corridor Protected Area.

The Muskwa-Kechika Management zone is partially within the Mackenzie Timber Supply Area and permits timber extraction outside the protected areas that reside within the management zone.

A spatial data set of land ownership has been developed using information from the Crown land Registry and the Integrated Cadastral Information Society. Table 7 shows the contribution of each ownership category to the CFLB and the THLB.

Table 7. Ownership contributions

Ownership code	Crown forested land base	Timber harvesting land base
40 Private – Crown Grant	No	No
50 Federal Reserve	No	No
51 National Park	Yes	No
52 Indian Reserve	No	No
53 Military Reserve	No	No
54 Dominion Crown Block	No	No
60 Crown Ecological Reserve	Yes	No
61 Crown Use, Recreation and Enjoyment of the Public (UREP) Reserves	Yes	No
62 Crown Forest Management Unit (TSA) or Crown Timber Agreement Lands	Yes	Schedule C: Yes Schedule N: No
63 Crown Provincial Park Class A	Yes	No
67 Crown Provincial Park equivalent or Reserve	Yes	No
69 Crown Miscellaneous Reserves	Yes	Schedule C: Yes Schedule N: No
70 Crown Active Timber Licence in a TSA or TFL	Yes	Schedule N: Yes Schedule C: No

Ownership code	Crown forested land base	Timber harvesting land base
72 Crown and Private Schedule “A” and “B” Lands in a TFL	No	No
75 Crown Christmas tree permit	Yes	No
77 Crown and Private Woodlot Licence	No	No
79 Community Forest	No	No
99 Crown Misc. lease (Fairground, R&G Club site, recreation cottage site)	No	No

5.5. Areas with high recreation values

Recreation, trails and recreation sites will remain in the timber harvesting land base. This way, District and Regional staff believe they can best keep the trails and recreation sites clean from any mountain pine beetle related blow down or other forest health factors. As done in the past staff will harvest within each recreation site as required and at the recommendation of staff at Recreation Sites & Trails Branch.

5.6. Inoperable areas

Areas are considered inoperable where there are physical barriers or limitations to harvesting, where appropriate logging methods (e.g. cable) are not available or deemed to be too costly, or where stands are not merchantable due to low volumes or low value species or have a high cost of harvest (primarily excessive haul distances). Excessive slope or unstable ground are examples of physical operability. Low volumes, low value species and excessive haul distance are examples of economic operability. Changing technology and economic conditions can affect both physical and economic operability.

In this analysis the limits of historical harvest activity will be used as indicators of physical and economic operability. Specifically, four attributes have been assessed:

- slope;
- distance;
- volume per hectare; and
- the leading species

Where terrain stability mapping does not exist, slope was used as a surrogate for physical operability. Distance will be the indicator of variable harvest cost. Finally, volume per hectare and leading species were used as indicators of value. It was assumed south of the Peace Arm and Omineca Park distance was not a limiting factor. The distances north of the Peace Arm and Omineca Park consist of both a road distance and a barge distance component.

To be consistent with the neighbouring Prince George TSA, the area weighted 99^{th} percentile will be used for slope and distance cut-off and the 1^{st} percentile will be used for the volume cutoff. Tables 8 and 9 list the operability classes that are excluded from the THLB. The cutoffs are highlighted in yellow.

Table 8: Distribution of slope and haul (including barge) distance across harvested cutblocks in the Mackenzie TSA. The cutoffs used to define the timber harvesting land base are highlighted.

	Area weighted percentile						
Attribute	50%	75%	90%	95%	97.5%	*99%*	100%
Slope(%)	14	22	30	35	40	*46*	125*
Distance(km)	189	227	261	280	286	*293*	304

See Data source and comments below.

Table 9: Distribution of maximum inventory, stand volume across harvested cutblocks in the Mackenzie TSA. The cutoffs used to define the timber harvesting land base are highlighted.

	Area weighted percentile						
Attribute	0%	*1%*	2.5%	5%	10%	25%	50%
Volume (m3/ha)	77	*151*	187	209	253	312	312

As previously mentioned, in addition to the distance volume criteria discussed above, leading species will also be used to define what is economically operable. District staff examined harvest billing and appraisal data over the past decade and determined that none of the balsam dominated stands have been harvested during this time. Considerable amounts of balsam have been billed to date but as a minor species within a stand.

Data source and comments:

Where terrain stability mapping was available, areas typed as either "U" or "V" were deemed physically inoperable.

In the "future road analysis" both the cutblock and the roading within had to be identified for the cutblock to be considered in the analysis. In this analysis the requirement to find all the roading was relaxed. The only criteria was the cutblock could be identified in May 2011 using via either MFLNRO's RESULTS or Tenures databases or were identified via satellite change detection. This relaxation increased the number of total area of the blocks used in the slope and volume per hectare assessments to 296,688 ha and 114819 ha in the case of the distance assessment. These cutblocks were used to spatially clip the slope, distance and volume per hectare surfaces to determine the cutoffs.

Slope data was derived from provincial digital elevation data portrayed as a one hectare raster. The reader should notice the 100th percentile (the maximum) for slope was 125%. Clearly licensees do not harvest such slopes. This value is an artifact that the analysis used the gross boundary of the cutblocks and within a cutblock there are portions that are not logged for a variety of reasons. This is an example of why the 1st and 99th percentiles rather than the absolute maximums and minimums were used as the measure of the lower and upper-limits of observed logging behaviour.

The distance analysis was limited to the area of the TSA north of Omineca Provincial Park (see Figure 1 overleaf) on the western side of Williston Lake and north of the east arm on the eastern side of Williston Lake (the Peace Arm). It was assumed that south of these geographic features distance would not be a limiting factor on timber harvest. The distances reported in Table 8 above include the barging distance down the lake to the township of Mackenzie. From the north tip of Williston Lake that barge distance was estimated (using a GIS) to be 220 km. The total distance assigned to each cutblock was the road distance to the nearest log dump (on Williston Lake) plus the barge distance. The location of the log dumps and cutblocks are shown in Figure 2 (overleaf). Points 13, 14 and 12 are not log dumps but known hauling exist points from the TSA. The estimated barge distances are listed in Table 10 (overleaf).

If the road to a cutblock could not be located the distance from the known road network was calculated with a preference for lower slopes. Specifically, a penalty equal to the square of the slope in percent was applied. In this way the distances calculated represented travel along valley bottoms. While the absolute distances may not be correct, because the information is being used in a relative sense (i.e.: the 99th percentile of modeled distance) the result reasonably depicts an outer envelope the harvest experience to date. Further, the impact on timber supply of this modeled distance will be subject to sensitivity analysis.

The volume cut-offs was calculated as follows. Natural stand analysis units were developed for each forested hectare in the TSA (section 4.2). The maximum natural stand yield was calculated for each analysis unit. Each cutblock was spatially located in the appropriate natural stand analysis unit. The volumes presented in Table 9 reflect the distribution of those maximum stand yields. The cut-off 151 m^3/ha means 99% of the hectares harvested to date came from stands where the maximum yield expected for that stand was 151 m3/ha or greater.

This is consistent with the area weighted 1st percentile of appraised volumes (158 m^3/ha) from 888 marks appraised between 1988 and 2011. Seventy five percent of those marks have been logged since 1996.

Table 10: Estimated barge distance for each log dump in the analysis area.

Dump #	*Estimated Barge Distance(km)*
1	220
2	155
3	158
4	181
5	206
6	206
7	163
17	157
18	105
19	117
20	137

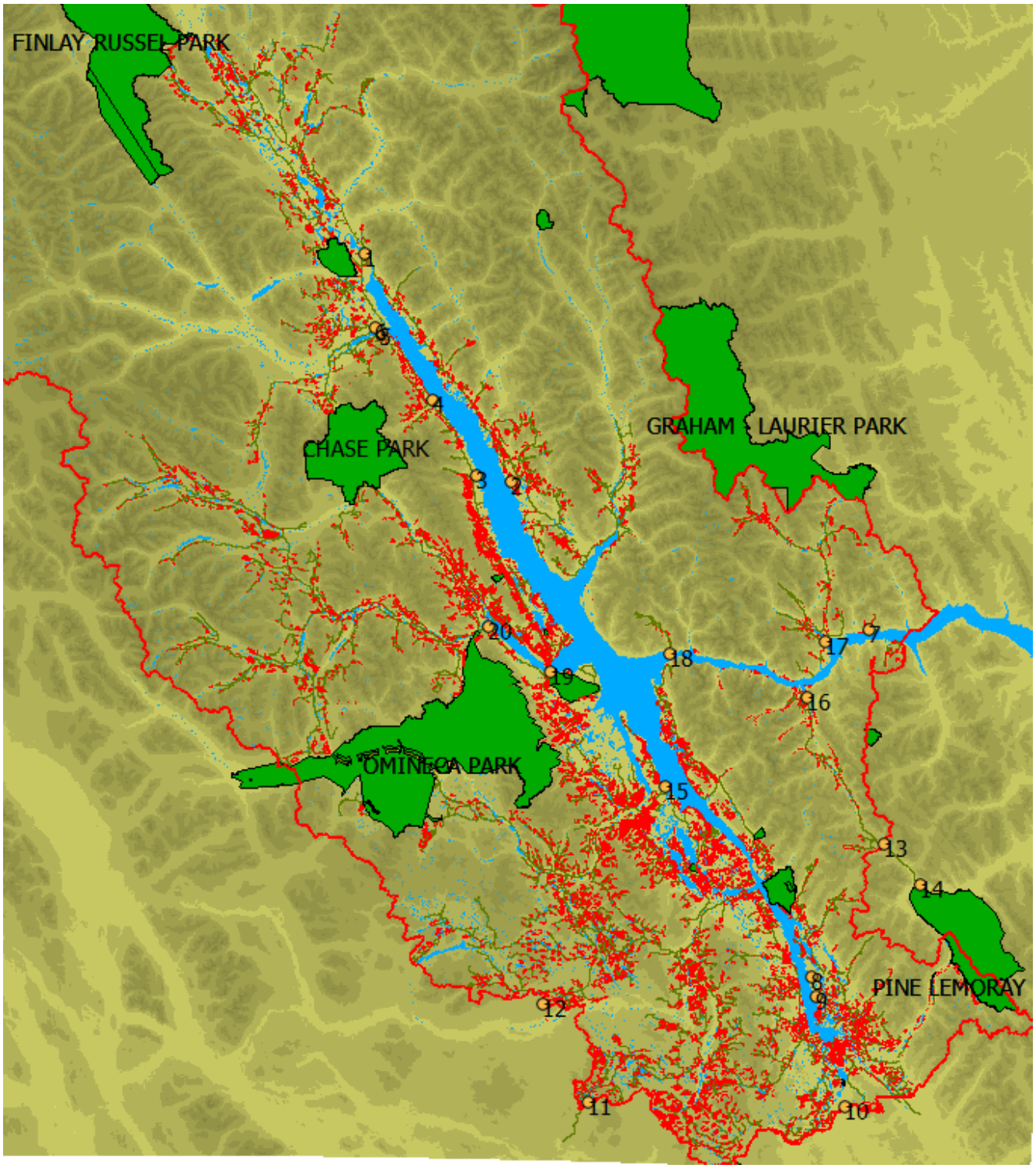

Figure 1. Known log dumps and exit points (both numbered), cutblocks (red) and protected areas within the Mackenzie TSA.

Again, the implications of using these cutoffs to determine operability will be examined via sensitivity analysis.

5.7. Problem forest types

Unlike previous Timber Supply reviews there is no specific accounting for problem forest types. It is believed they have been adequately accounted using the criteria to define inoperable areas (section 5.6).

5.8. Wildlife habitat reductions

Wildlife habitat may be identified and managed through several processes including the *Identified Wildlife Management Strategy*, identification and approval of ungulate winter range (UWR), and management practices specified in plans that establish legal objectives, such as the Mackenzie LRMP. Management may include "no harvesting" in core areas around nesting sites or other valuable habitats for endangered species, as well as modified harvesting in management areas outside of the core areas (see Section 6.8.1.3). Table 11and 12 describes the areas to be removed from the timber harvesting land base to protect ungulate winter ranges and wildlife habitat areas respectively.

Table 11. Ungulate Winter Range reductions to the timber harvesting land base

UWR#	UWR names and wildlife species	Reduction (%)[1]
U-7-001	Kennedy Siding (Northern Caribou)	0
U-7-004	Peace Arm (Mountain Goat)	100
U-7-005	Peace Arm (Elk)	0
U-7-006	Peace Arm (Stone Sheep)	100
U-7-007	Northern Caribou (Low Elevation)	0
U-7-008	Ingenika (Elk)	0
U-7-009 (PP-003)	Pine Pass (Northern Caribou)	0
U-7-009 (PP-001, PP-002 and PP-004)	Pine Pass (Northern Caribou)	100
U-7-017 (AP1 and AP2)	Akie-Pesika (Moose, Elk, Mountain Goat)	0
U-7-017 (AP3, AP4, AP5 and AP6)	Akie-Pesika (Moose, Elk, Mountain Goat)	100
U-7-025	High Elevation UWR (Northern Caribou-Wolverine and Chase Herds)	100

[1] UWR areas with 0% netdown will be modeled using forest cover constraints described in Section 6.8.1.3.

Table 12. Wildlife Habitat area reductions to the timber harvesting land base

Wildlife species	Inventory description	Reduction (%)
9-001	Brewster Salt Lick (Mountain Goat)	100
9-035	Graham Laurier (Northern Caribou)	100
9-036	W. Nabesche (Northern Caribou)	100
9-037	Emerslund Cr E. (Northern Caribou)	100
9-038	Upper Schooler Cr N. N. (Northern Caribou)	100
9-039	Upper Schooler Cr S. S. (Northern Caribou)	100
9-040	Schooler Cr W. (Northern Caribou)	100
9-102	Meadow Creek N. (Northern Caribou)	100
9-103	Meadow Creek S. (Northern Caribou)	100

Data source and comments:

Ungulate Winter Ranges for Mountain Goat, Stone Sheep , Elk and Caribou. These include UWRs' and Wildlife Habitat Areas have been legally established under the *Forest and Range Practices Act*. They are also documented in the Mackenzie LRMP. Harvest requirements are specified in the legal orders.

There are currently no habitat exclusions for grizzly bear. Management requirements for grizzly bear are described in Section 7, "Sensitivity Analyses". Wildlife habitat areas for grizzly bear will be established in the near future. A sensitivity analysis tests their impact on timber supply.

Licensees are also required to manage for other red- and blue-listed species and plant communities. In most cases these are being addressed at an operational level using wildlife tree patches (WTP) and other reserves, or by managing access construction. Where additional reserves are required, they are generally small and have insignificant impacts.

5.9. Cultural heritage resources

A cultural heritage resource is and object, site or location of a traditional societal practice that is historical, cultural or archaeological significant to the province, a community, or an aboriginal people. Cultural heritage resources include archaeological sites, structural features heritage landscape features and traditional use sites. Features associated with past and current human use, including aboriginal use, are found throughout the Mackenzie Timber Supply Area (MTSA).

An Archaeological Overview Assessment for the MTSA was completed in 1997. Because of the nomadic nature of the first nations and the flooding of the Williston Reservoir the many areas previously used by the First Nations sites are now under water. The surviving locally known trails and areas of First Nations significance are managed through mitigating operational designs, silviculture systems and timing of operations.

Areas of high recreational value, Provincial Recreation Reserves, are currently being managed through operational planning and in conjunction with local licensees. Many of these areas have been partially cut to remove the standing dead pine trees. These actions have been taken to prevent both forest fire hazard and potential future blow down hazard.

With the limited amount of area associated with the cultural resources negligible impact is foreseen on the timber harvesting land base.

5.10. Exclusion of specific, geographically defined areas

Table 13 describes additional areas to be excluded from the timber harvesting land base to account for area exclusions not discussed in previous sections.

Table 13. Exclusion of specific, geographically defined areas

Category	Area description	Reduction (%)
Muskwa Kechika Management Area MKMA Act	Muskwa Kechika Management Area Special Resource Management Zone (excluding RMZ#4 = Obo River and RMZ#6 = Fox where harvesting is regulated by legal order for those two landscape units)	100
OGMAs	Old growth management areas	100
Mugaha Marsh	Sensitive Area in the Mugaha and Tutu Creek watersheds	100
Research installations and growth and yield plots		0
Agriculture Development Areas and Settlement Reserve Areas		100 after first pass

Data source and comments:

Although the Muskwa Kechika Management Area (MKMA) Act allows resource extraction in parts of the MKMA will likely be netted out in its entirety due to the excessive distance from Mackenzie township.

The September 2010 Ministry of Agriculture and Lands Ministerial Order established old growth management objectives in the Twenty Mile, Gaffney-Manson River, Misinchinka-Tudyah B, Gillis-Klawli, Parsnip, Connaghan Creek-Eklund-Jackfish South Germansen-Upper Manson, and Kennedy landscape units or landscape units groups. Although the Ministerial Order permits minor forestry activity within the old growth management areas for sake of simplicity a 100% reduction has been applied.

While the 2001 Sensitive Area Plan for Muguha Marsh allows a maximum of 10% of the commercial forest cover within the area to be harvested for sake of simplicity a 100% reduction has been applied.

For sake of simplicity, due to the small area occupied by research installations and growth and yield plots within this 6.4 million hectare TSA no attempt will be made to identify and net-out these features from the timber harvesting land base.

There are 1026 and 1244 hectares of Settlement Reserve and Agricultural Development lands within the TSA. After initial harvest these lands will be transferred out of the timber harvesting and crown forest land bases.

5.11. Riparian reserve and management areas and wildlife tree patches

Under the Forest and Range Practices Act, Forest Planning and Practices Regulation there are specified management requirements for riparian reserve zones and riparian management zones along streams and around lakes and wetlands. It also details the requirements for wildlife tree retention. The regulation specifies riparian requirements by stream, wetland and lake class. However, there is no mapping of these classes, making it impossible to explicitly model those riparian requirements in the Timber Supply Review. Further, areas excluded from harvesting for riparian purposes can also function as wildlife tree patches.

Given the above problems, Ministry staff decided to consider riparian and wildlife tree requirements by assessing the total amount of within cut block retention. Two sources of data were used—RESULTS data and FREP data. FREP is British Columbia's Forest and Range Evaluation Program led by the Ministry of Forests, Lands, and Natural Resource Operations (MFLNR) in partnership with the Ministry of Environment (MOE).

The "retention" FREP program surveyed 61 cutblocks within the Mackenzie Resource District and reported out 5.8% of the gross cutblock area as either riparian and/or wildlife related retention of mature forest. Given on average 4% of the cutblock is consumed by roads this implies approximately 6% of the forested area within the forest portion of the cutblock being retained as mature forest cover.

RESULTS is FLNRO's Reporting Silviculture Updates and Landstatus Tracking System. It is used to track licensee's regeneration obligations and to update the inventory for harvest depletions. 1339 cutblocks harvested in the Mackenzie Resource District since 2000 were identified using the database. On average, 4.7% of the forested area within the cutblock was identified as mature forest cover. Given the 1339 blocks was close to a complete enumeration while the FREP data was a sample, FLNRO staff decided the figure of 4.7% better represented current levels of retention for riparian and wildlife tree patches.

The 2002 "Order to Establish the Obo and Fox Landscape Units and Objectives" (Obo/Fox order) (http://archive.ilmb.gov.bc.ca/slrp/srmp/north/mackenzie/legalobj_Fox-Obo_Final.pdf) has specific requirements with regard to wildlife tree retention (Table 3 in that document). However, as discussed previously in this section there is no way of reliably differentiating between retention for wildlife tree patches (WTP) and riparian management. In light of this the specific WTP requirements for the Obo and Fox landscape units will not be modeled.

6. Current Forest Management Assumptions

6.1. Harvesting

6.1.1. Utilization levels

The utilization levels define the maximum stump height, minimum top diameter inside bark (inside bark) and minimum diameter at breast height by species. Table 14 shows the utilization levels used in the analysis to calculate merchantable volume.

Table 14. Utilization levels

Analysis unit	Minimum stump diameter (cm)	Utilization		
		Corresponding minimum DBH (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Pine	15	12.5	30	10
Deciduous	20	17.5	30	10
All other	20	17.5	30	10

Data source and comments:

Table 1-2 Interior Timber Merchantability Specifications of the *Provincial Logging Residue and Waste Measurement Procedures Manual* specifies the utilization levels for billing of harvested timber. These levels are also used in assessing cut control for licence AACs.

The specifications 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.

Utilization levels will be lowered to access bio-energy opportunities within 100 km of Mackenzie town-ship.

6.1.2. Volume exclusions for the deciduous component of stands

There is no specific volume exclusion for the deciduous component of stands. Its contribution to the harvest forecast will be tracked. For further details please refer to the next section.

6.1.3. Minimum harvestable volumes

The minimum harvestable volume is the minimum volume considered economic to harvest. While harvesting may occur in stands at the minimum volume 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 harvested with volumes well in excess of the minimum because of management objectives for other resource values (e.g., requirements for the retention of older forest). The minimum harvest volume assumed in this analysis will be the same as that calculated to derive the timber harvesting landbase—151 m^3/ha. Where deciduous is a minor component in the stand the deciduous component will be allowed to contribute to the harvest but the minimum harvest volume requirement will be based on the coniferous component.

6.1.4. Harvest scheduling priorities

As evidenced by Figure 2 (Section 5.6. Inoperable Areas) there would appear to be a significant preference for logging in the southern portion of the TSA (presumably due to proximity of the mills in Mackenzie and mills further south and west). There would also be a preference for logging stands in the valley bottoms and flatter ground which usually has high productivity and standing volumes. Normal skidders can work on slopes up to 35% and rubber tired skidders can go as high as 45 if the company has a Work Safe BC plan on how they will safely extract the wood. These plans are based on based on section 26.16 of the Work Safe BC harvesting guidelines.

Given to low value of dead pine stands, it will be assumed that no salvage of dead pine will occur on slopes in excess of 35%. Harvest in other stand types will be allowed to occur on slopes up to 46%--the historical 99th percentile.

Finally, economics would suggest that licensee will try and maximize the extraction of timber from the existing road network before expanding it. These factors in combination will determine the harvest queue. What weight each individual factor will be given in the final harvest queue will be detailed in the final technical record.

Layered over the harvest queue will be separate harvest targets for pine leadings stands versus non-pine leading stands. A limit will be placed on the harvest of non-pine leading stands in the short term (during the potential salvage period) based on recent harvest billing and stumpage appraisal data.

In 2011 (including waste) the total harvested scaled was 2.03 million cubic metres with 0.56 million cubic metres of the scaled volume being non-pine. During the salvage period the non-pine harvest would be capped either at this figure or some lower figure that better reflects recent harvest in non-pine leading stands.

6.1.5. Silvicultural systems

Most harvesting within the Mackenzie TSA involves a clearcut silviculture system. Although forest district staff anticipate some increased use of partial or selection harvest systems in the future, there is currently little partial cutting occurring, and accounting for these approaches in the Mackenzie TSA timber supply is not warranted at this time.

No commercial thinning has been carried out within the Mackenzie TSA in the past five years and none is forecast to be carried out based on licensee information. Considering the poor local market for small wood, the cost of commercial thinning, and the supply of larger mature wood for conventional harvesting, it is unlikely that the application of this harvest method will increase significantly in the near future.

6.2. Unsalvaged losses

Table 15 shows the estimated average annual unsalvaged volume loss to fires and wind damage on the timber harvesting land base. The unsalvaged loss column only reflects those areas in which the volume is not recovered or salvaged.

Table 15. Unsalvaged losses

Cause of loss	Annual total loss (m^3/year)	Annual unsalvaged loss (m^3/year)
Wind	60 000	30 000
Fire	220 000	165 000
Total	280 000	195 000

Data source and comments:

Over the past decade approximately 600,000 cubic metres of timber have blown down on the THLB and it is expected about half of it will be salvaged. A similar amount is assumed to occur outside the THLB as the THLB is approximately half the gross area of the TSA.

With regard to fire, between 2000 and 2010 within the Mackenzie TSA, 25,257 hectares have been mapped as inside fire perimeters. Using the 2001 analysis report figure of 75% of the TSA being forest the area of forest burned it estimated as 19,000 hectares. Again, using 2001 analysis report figures, approximately half of the TSA is expected to contribute to the THLB. The mapped fires are well distributed throughout the TSA, so it is estimated that the area of forested THLB consumed between 2000 and 2010 as 9500 hectares. Assuming an average volume of 250 cubic metres per hectare this translates to about 2,400,000 cubic metres or about 220,000 cubic metres per year. Historically only about one quarter of the burned timber within the THLB is salvaged.

The unsalvaged loss for Mountain Pine Beetle is explained in the section 6.4.

6.3. Balsam Decline

According to District staff, like the Fort Saint James Resource District, older balsam stands within the Mackenzie TSA are experiencing considerable mortality. However, no formal survey has been completed. To account for the observed mortality (in some fashion) it was decided to apply the average balsam mortality of 28% (from the Fort Saint James Resource District) to all balsam leading stands greater than 140 years of age within the TSA.

6.4. Mountain pine beetle

The Mountain Pine Beetle entered the Mackenzie Resource District in 2004 peaked in 2009 and has since sharply declined.

According to version nine of the British Columbia Mountain Pine Beetle model (BCMPBv9) approximately 56% of the pine volume (on what was thought to be THLB in 2002) was killed by 2011. An additional 12% mortality is forecast to occur before the projected end of the epidemic. However, weather conditions did not allow aerial overview surveys to be conducted across the entire TSA in 2007 and 2008. Similarly the northern half of the TSA was not surveyed in 2009. These surveys are fundamental to the calibration of the British Columbia Mountain Pine Beetle model, so it could be argued BCMPBv9 is poorly calibrated for the TSA. District estimates (based on repeated aerial reconnaisance by district staff) indicate the three quarters of the pine within the TSA has been killed to date.

This major discrepancy and lack of calibration data for the model has led staff to not use BCMPBv9 for this timber supply review. District estimates of mortality will be used instead.

It will be assumed that 75% of the pine trees within each mature forest stand have been killed by 2012. No further death will be assumed. According to District staff the development of the MPB epidemic had two distinct phases. The first phase predominately occurred in 2005 and was limited to the area of the TSA west of Williston Lake and south of the Omineca arm of the lake. The outbreak appeared contained in this area of the TSA until 2009. In 2009, it spread (essentially instantaneously) to the rest of the TSA.

Sensitivity analysis will be used to test the impact of these assumptions.

Pine mortality in stands less than 60 years old is discussed in the next section.

6.5. Young pine mortality

Observations by district staff suggest that death in younger stands less than 60 years old was considerably lower than that observed in mature stands. Stands less than 29 years old were formally surveyed. Consistent with the March 2008, "Mackenzie Forest District Midterm Mitigation Timber Supply Analysis" report pine mortality in age class 2 (and greater than 28 years) stands and age class 3 stands was assumed to be 55 and 70% respectively. Sensitivity analysis will be used to test the impact of these assumptions.

To determine rates of mortality in stands less than 29 years a helicopter survey of 42 randomly chosen pine leading openings was conducted in fall 2011. Stands surveyed were a maximum of 28 years old. Survey results are presented in Table 16 overleaf.

The survey showed 41 stands were of trace to light intensity with one stand at the moderate level. Very young stands (<24 years), even with adjacent pressure, were not being attacked. However, 25 to 28 year old stands were being damaged. The area weighted average mortality for stands less than 28 years was 1.4%. This figure will be applied to the yields of all pine leading stands 28 years or younger in 2011.

For stands 59 years or less no attempt will be made to project the development of the epidemic any further.

Table 16. Young pine stand mortality survey

Survey#	Map Sheet	Polygon	MPB impacted trees (%)	Opening Gross Area (ha)	Survey#	Map Sheet	Polygon	MPB impacted trees (%)	Opening Gross Area (ha)
1	93O075	13	5	41.2	22	94C009	42	2	78.2
2	94B035	2	0.5	124.3	23	93N099	30	0.5	179.9
3	94F033	44	0.5	157.5	24	93N099	54	0.5	51.1
4	94F033	43	0	303.3	25	93N069	10	0.5	56.9
5	94F033	39	0.5	28.9	26	93N059	26	0.5	48.6
6	94F005	7	0.5	141.7	27	93N059	25	0.5	56.5
7	94C095	10	0.5	44.1	28	93N060	53	0.5	52.7
8	94C085	10	0.5	148	29	93O071	34	0.5	16.4
9	94C076	2	0.5	137.7	30	93O052	68	0.5	46.6
10	94C065	8	0.5	99.1	31	93O052	59	0.5	11.3
11	94C065	17	0.5	70.8	32	93N060	21	0.5	1.1
12	94C015	1	0.5	105.2	33	93N060	20	0.5	1.7
13	94C004	14	0.5	147.8	34	93N050	18	0.5	36
14	94C004	5	0	109.6	35	93N050	16	0.5	40.5
15	94C004	6	0.5	159	36	93N039	3	0.5	13.4
16	94C004	4	0.5	91.9	37	93O031	7	0.5	36.4
17	93N094	6	0.5	103.4	38	93O002	4	0.5	103.2
18	93N095	4	0	77.3	39	93O015	34	5	98.4
19	94C049	20	0.5	110.8	40	93O015	7	20	145
20	94C019	42	0.5	200.9	41	93O015	10	5	12.7
21	94C008	7	0.5	27.8	42	93O035	7	0.5	66.6

6.6 Shelf life of Dead Pine

Over the past number of years and in various TSAs around the province, shelf life of dead pine has been discussed. Since each TSA time threshold has been different and due to the relative recent attack of the MPB coupled to current changes in milling technology, shelf life of pine was set to fifteen (15) years. Due to the size of and the local variation of the climate within the TSA the shelf life may vary. This 15 year shelf life is not necessarily a sawlog shelf life but rather the length of time the fibre may be available for some commercial purpose.

6.7. Silviculture

6.7.1. Regeneration activities

FLNRO's "Reporting Silviculture Updates and Landstatus Tracking System" (RESULTS) was queried to establish regeneration practices since 2000. RESULTS cutblocks were overlaid with a map of the analysis units to determine membership. The regeneration information was then summarized for each (natural stand) analysis unit. This summary is presented in Table 17 (overleaf).

Again, using RESULTS, a similar summary was produced for those stands harvested prior to 2000. Those results are presented in Table 18 (overleaf). Separate yield curves will be produced for both cohorts (pre and since 2000).

Data source and comments:

The following passages apply to both the pre-2000 and since 2000 managed stand cohorts.

Many analysis units have little (less than 100 hectares) or no history of logging. In that case, species composition, regeneration delay, and establishment density is substituted from the closest (in terms of attribution) known neighbour.

In the case of site index, the "Provincial site productivity layer" will be used. This layer was developed in 2011 and early 2012 as a collaborative effort between the Ministry of Environment and the Ministry of Forests, Lands and Natural Resource Operations. Where "Terrestrial Ecosystem Mapping" (TEM) or "Predictive Ecosystem Mapping" (PEM) exists the site indices are SIBEC (http://www.for.gov.bc.ca/hre/sibec/) based. Where neither TEM nor PEM mapping exist the source of the site indices is FLNROs biophysical site index model[c].

The density figures presented in Tables 17 and 18 are the well spaced number. Use of this density measure was advised by FLNROs TASS/TIPSY growth and yield research group. The well spaced number implies a regular spatial configuration. Therefore the appropriate regeneration method to assume is "planted" regardless of actual stand origin.

Historically, in the absence of any better information, an OAF1 of 15% and an OAF2 of 5% has been applied to the managed stand yield curves. The rationale behind OAFs is to scale the projected yields from those of research plots to typical stands. In 2011, under the Forest and Range Evaluation Program (FREP), 30 openings ranging in age from 14 to 31 years were surveyed in the Mackenzie TSA. It is hoped this information can be used to derive custom OAFs for managed stands in the TSA. If this attempt is unsuccessful the default OAFs of 15 and 5 will be used. The result of this analysis will be detailed in the technical report.

[c] Nigh, G. 2012. A Biophysical Model for Estimating Site Index for the Major Commercial Species in British Columbia. Draft.

Table 17. Regeneration assumptions for future managed stands and stands established since 2000.

Analysis Unit	Natural Stand Lead Species	Inventory Site Class(m)	Area (ha)	Substituted Analysis Unit if no data	Area reported in RESULTS (ha)	Genetic worth(%) Spruce	Genetic worth(%) Pine	Regen. Delay (yrs)	Desnity (well spaced sph)	Species Composition(%) Balsam	Species Composition(%) Spruce	Species Composition(%) Pine	Species Composition(%) Decid.
12	Aspen	7.5	11,203	AU 13		1.0	3.1	1	1,436	18%	9%	29%	44%
13	Aspen	12.5	74,810	N/A	201	1.0	3.1	1	1,436	18%	9%	29%	44%
14	Aspen	17.5	97,246	N/A	1,133	1.2	0.4	1	1,413	1%	23%	34%	41%
15	Aspen	22.5	30,881	N/A	387	0.6	0.7	1	1,382	1%	9%	36%	54%
16	Aspen	27.5	1,557	AU 15		0.6	0.7	1	1,382	1%	9%	36%	54%
17	Aspen	32.5	49	AU 15		0.6	0.7	1	1,382	1%	9%	36%	54%
22	Balsam	7.5	745,010	AU 23		4.5	0.0	1	1,311	26%	43%	29%	2%
23	Balsam	12.5	176,060	N/A	506	4.5	0.0	1	1,311	26%	43%	29%	2%
24	Balsam	17.5	47,799	N/A	353	4.2	0.1	1	1,168	18%	54%	26%	3%
25	Balsam	22.5	3,719	AU 24		4.2	0.1	1	1,168	18%	54%	26%	3%
26	Balsam	27.5	251	AU 24		4.2	0.1	1	1,168	18%	54%	26%	3%
27	Balsam	32.5	78	AU 24		4.2	0.1	1	1,168	18%	54%	26%	3%
32	Birch	7.5	733	AU 12									
33	Birch	12.5	5,461	AU 13									
34	Birch	17.5	12,892	AU 14									
35	Birch	22.5	6,060	AU 15									
36	Birch	27.5	171	AU 16									
42	Douglas fir	7.5	482	AU 62									
43	Douglas fir	12.5	86	AU 63									
44	Douglas fir	17.5	385	AU 64									
52	Larch	7.5	17	AU 62									
53	Larch	12.5	8	AU 63									
54	Larch	17.5	7	AU 64									
62	Pine	7.5	123,566	AU 63		2.3	0.0	1	1,204	7%	36%	48%	9%
63	Pine	12.5	458,069	N/A	2,502	2.3	0.0	1	1,204	7%	36%	48%	9%
64	Pine	17.5	491,440	N/A	9,064	2.8	0.2	1	1,287	5%	20%	68%	8%
65	Pine	22.5	83,380	N/A	2,870	2.5	0.1	1	1,231	3%	25%	67%	6%
66	Pine	27.5	1,989	AU 65		2.5	0.1	1	1,231	3%	25%	67%	6%
67	Pine	32.5	205	AU 67		2.5	0.1	1	1,231	3%	25%	67%	6%
72	Spruce	7.5	416,241	N/A	340	2.8	0.1	1	1,331	12%	46%	38%	4%
73	Spruce	12.5	337,291	N/A	2,544	1.6	0.1	2	1,221	15%	51%	28%	5%
74	Spruce	17.5	262,440	N/A	4,261	3.8	0.4	1	1,226	11%	44%	35%	10%
75	Spruce	22.5	40,365	N/A	1,177	4.1	1.0	1	1,237	6%	39%	41%	15%
76	Spruce	27.5	2,475	AU 75		4.1	1.0	1	1,237	6%	39%	41%	15%
77	Spruce	32.5	572	AU 75		4.1	1.0	1	1,237	6%	39%	41%	15%
78	Spruce	37.5	89	AU 75		4.1	1.0	1	1,237	6%	39%	41%	15%
79	Spruce	42.5	14	AU 75		4.1	1.0	1	1,237	6%	39%	41%	15%
82	Willow	7.5	189	VDYP7									
83	Willow	12.5	461	VDYP7									
84	Willow	17.5	27	VDYP7									

Table 18. Regeneration assumptions for managed stands established prior to 2000.

Analysis Unit	Natural Stand Lead Species	Inventory Site Class(m)	Area (ha)	Substituted Analysis Unit if no data	Area reported in RESULTS (ha)	Regen. Delay (yrs	Desnity (well spaced sph)	Species Composition(%) Balsam	Spruce	Pine	Decid.
12	Aspen	7.5	11,203	AU 13		1	1,148	1%	19%	34%	46%
13	Aspen	12.5	74,810	N/A	558	1	1,148	1%	19%	34%	46%
14	Aspen	17.5	97,246	N/A	1,817	2	1,074	5%	23%	31%	41%
15	Aspen	22.5	30,881	N/A	713	1	1,151	5%	17%	32%	46%
16	Aspen	27.5	1,557	AU 15		1	1,151	5%	17%	32%	46%
17	Aspen	32.5	49	AU 15		1	1,151	5%	17%	32%	46%
22	Balsam	7.5	745,010	AU 23	299	1	1,276	56%	29%	14%	1%
23	Balsam	12.5	176,060	N/A	819	2	1,097	59%	24%	17%	1%
24	Balsam	17.5	47,799	N/A	1,012	2	1,091	53%	19%	26%	2%
25	Balsam	22.5	3,719	AU 24	205	2	1,097	50%	24%	16%	10%
26	Balsam	27.5	251	AU 24		2	1,097	50%	24%	16%	10%
27	Balsam	32.5	78	AU 24		2	1,097	50%	24%	16%	10%
32	Birch	7.5	733	AU 34							
33	Birch	12.5	5,461	AU 34							
34	Birch	17.5	12,892	N/A	217	1	1,068	6%	43%	15%	35%
35	Birch	22.5	6,060	N/A	334	1	1,162	9%	46%	12%	34%
36	Birch	27.5	171	AU 35							
42	Douglas fir	7.5	482	AU 62							
43	Douglas fir	12.5	86	AU 63							
44	Douglas fir	17.5	385	AU 64							
52	Larch	7.5	17	AU 62							
53	Larch	12.5	8	AU 63							
54	Larch	17.5	7	AU 64							
62	Pine	7.5	123,566	N/A	108	1	1,299	14%	34%	44%	8%
63	Pine	12.5	458,069	N/A	2,071	1	1,193	16%	19%	46%	20%
64	Pine	17.5	491,440	N/A	9,926	2	1,117	10%	15%	58%	16%
65	Pine	22.5	83,380	N/A	2,661	2	1,175	7%	16%	55%	23%
66	Pine	27.5	1,989	AU 65							
67	Pine	32.5	205	AU 67							
72	Spruce	7.5	416,241	N/A	332	2	1,184	28%	45%	22%	5%
73	Spruce	12.5	337,291	N/A	3,992	2	1,180	27%	47%	15%	11%
74	Spruce	17.5	262,440	N/A	15,344	1	1,128	20%	53%	17%	10%
75	Spruce	22.5	40,365	N/A	3,454	1	1,115	14%	59%	12%	14%
76	Spruce	27.5	2,475	N/A	266	2	1,128	6%	52%	8%	34%
77	Spruce	32.5	572	AU 76							
78	Spruce	37.5	89	AU 76							
79	Spruce	42.5	14	AU 76							
82	Willow	7.5	189	VDYP7							
83	Willow	12.5	461	VDYP7							
84	Willow	17.5	27	VDYP7							

6.7.2. Immature plantation history

Areas of immature forest where there is evidence that the regenerating forest was established by planting are assumed to be managed. In the Mackenzie TSA, evidence of planting only exists in RESULTS back to 1987. Therefore stands established since 1987 were assumed to be managed and those prior to 1987 were assumed to exhibit the growth of naturally established forest. Only those stands deemed managed are assigned yield curves generated using the TIPSY growth and yield model. As mentioned in the previous section all managed stands are assigned site indices derived from FLNRO's "Provincial site productivity layer".

6.7.3. Hard Pine Rusts

Hard pine rusts are prevelant within the Mackenzie Resource District. However, it is deemed an operational issue not a modeling one.

6.8. Integrated resource management

Non-timber forest management objectives such as landscape biodiversity, visual quality and maintenance of ungulate winter ranges typically require management of forest cover. The management of forest cover typically comes in two forms:

- a minimum amount of forest cover above some height or age threshold;
- a maximum amount of forest denuded or below some height or age threshold.

The forest cover requirements associated with visual quality, ungulates and landscape biodiversity are discussed in the following sections.

6.8.1. Visual Quality Objectives

Scenic areas and visual quality objectives (VQO) have been legally established or grand-parented under the *Forest and Range Practices Act*. There are 658 legal visual polygons in the Mackenzie TSA. Modeling their requirements at the polygon level results in excessive execution times so visual polygons will be aggregated by VQO and landscape unit. Table 19 shows the maximum allowable percent alteration for each VQO in perspective view.

The percent alteration in perspective view from Table 19 must be converted to a measure in plan view for use in a timber supply model. A Plan to Perspective (P2P) ratio is calculated for each visual unit by area-weighting the P2P for each slope class within the visual unit, using the data in Table 20 (overleaf). The percent alteration in perspective view is multiplied by the area-weighted P2P ratio to calculate the percent alteration in plan view.

An area-weighted Visually Effective Green-up (VEG) height is determined for each visual unit using the data in Table 20. VEG heights refer to top height (average height of tallest 10% of trees).

Table 19. Assignment of visual quality objectives

Recommended VQO	% alteration by VAC[a] (perspective view)		
	Low	Medium	High
Retention	0.1	0.7	1.5
Partial retention	1.6	4.3	7.0
Modification	7.1	12.5	18.0

[a]VAC = visual absorption capacity.

Table20. Slope classes for calculating P2P ratio and VEG height

	Slope classes[1] (%)														
	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

[1] Adapted from *Procedures for Factoring Visual Resources into Timber Supply Analysis* (1998) and *Modelling Visuals in TSR III* (2003) by Luc Roberge, Visual Resource Specialist, NIFR – December 2007.

[2] A recent study shows a first approximation of the predicted P2P ratios for absolute slope classes in 10% increments. Although P2P ratios and slope classes did not show a linear relationship, the median value was used in this table to determine the ratios for slope classes in 5% increments.

6.8.2. Landscape Biodiversity

Requirements for the maintenance of landscape biodiversity are specified in April, 2008 Ministry of Agriculture and Land Ministerial Order titled "Non-spatial Landscape Biodiversity Objectives in the Mackenzie Forest District" (the order) and its September 2010 amendment titled "Amendment Order for the Non-spatial Landscape Biodiversity Objectives in the Mackenzie Forest District" (the amendment).

The amendment (http://www.ilmb.gov.bc.ca/sites/default/files/resources/public/PDF/SRMP/signed_mackenzie_non_spatial_amend_20100923.pdf) specifies the old forest requirement by biogeoclimatic group, biodiversity emphasis option and landscape units (landscape unit group) in Table 2 of the pdf. Biogeoclimatic group is defined in Table 21 overleaf. "Old forest" means

- forests within the SBSmk1 & 2 biogeoclimatic (BEC) variants greater than 120 years old;
- birch or aspen leading stands within the BWBS BEC zone greater than 100 years old;
- conifer leading stands within the BWBS BEC zone greater than 140 years old; and
- forest stands in all other BEC variants greater than 140 years old.

The order specifies that the old forest can be either "live old forest" or "natural forest area". The order defines "natural forest area" as forest in MPB impacted units that have not been harvested and can be either "live old forest", "dying forest", "dead forest" or "young natural forest". However the use of "natural forest" to meet the old forest requirement cannot exceed the percentage of the area impacted by the MPB epidemic.

The use of "natural forest" up to the percentage impacted effectively means that the old forest requirement has been prorated by the proportion of the landscape unit, BEC group combination impacted by MPB. This prorated requirement will be modeled in the timber supply analysis using the assumed 75% mortality of pine.

Table 21. Definition of the Biogeoclimatic groups

Biogeoclimatic Group	member Biogeoclimatic variants
1	ESSFmcp,ESSFmvp2,ESSFmvp3,ESSFmvp4,ESSFwcp3,SWBmks
2	ESSFmc,ESSFmv2,ESSFmv3,ESSFmv4,SWBmk
3	ESSFwc3,ESSFwk2
4	SBSmk1,SBSmk2,SBSwk1
5	SBSvk,SBSwk2
6	BWBSmw1,BWbswk2(Conifer)
7	BWBSdk1(Conifer)
6 & 7	BWBS (birch or aspen leading)

The order also has an old interior forest retention requirement (page 9 of the order). This requirement cannot be realistically modeled.

The September 2010, Ministry of Agriculture and Lands Ministerial Order titled "Spatial Land Use Objectives for part of the Mackenzie Forest District Area" replaces the non-spatial requirements for the Twenty Mile, Gaffney-Manson River, Misinchinka-Tudyah B, Gillis-Klawli, Parsnip, Connaghan Creek-Eklund-Jackfish South Germansen-Upper Manson, and Kennedy landscape units or landscape unit groups. No logging will be modeled inside the Old Growth Management Areas (OGMAs) specified in the aforementioned order.

It is assumed the old forest requirements of the 2002 Obo/Fox order have been replaced by the requirements of the 2010 amendment. Finally, the Fox/Obo order specifies a harvest exclusion (200 m buffer) around Weissener Lake and a further 50 m buffer with the following forest cover requirement:

- 50% of the (assumed pre-harvest) basal area or volume must be retained if harvesting occurs within this buffer.

However this lake is beyond the bounds of the assumed timber harvesting land base so these requirements will be ignored.

6.8.3. Ungulate Winter Ranges

This section documents the basic forest cover requirements of ungulate winter ranges (UWRs) and how these requirements will be approximated in the forest estate model (Table 22 overleaf).

Table 22. Modeling of ungulate winter range forest cover requirements

Ungulate winter range	Legal Requirement	Approximation to be modeled
#U7-001 Kennedy Siding (Northern Caribou) http://www.env.gov.bc.ca/omineca/documents/U-7-001.pdf	Log approximately half the entire area at a time on a 100 year rotation	Log half the UWR in the first decade and log the other half in the sixth decade
#U7-005 Peace Arm (Elk) http://www.env.gov.bc.ca/omineca/documents/U-7-005.pdf	Maintain a minimum of 40% of the forested portion of the UWR greater than 100 years old with a crown closure greater than 40%.	Maintain a minimum of 40% of the forested portion of the UWR greater than 100 years old.
#U7-007 Northern Caribou (low elevation) http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_007.pdf	Manage the Terrestrial Lichen Habitat area within the UWR on a two pass system over a 140 year rotation.	Harvest half the UWR area in decade one and the other half in decade 8.
#U7-008 Ingenika (Elk) http://www.env.gov.bc.ca/omineca/documents/U-7-008.pdf	Maintain a minimum of 40% of the forested portion of the UWR greater than 100 years old with a crown closure greater than 40%.	Maintain a minimum of 40% of the forested portion of the UWR greater than 100 years old.
#U7-009 Pine Pass (Northern Caribou) http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_009.pdf	Within unit PP-003 maintain 20% or more of the forested stands 100 years or greater and no more than 20% of this unit being less than 3m in height.	Within unit PP-003 maintain 20% or more of the forested stands 100 years or greater and no more than 20% of this unit being less than 3m in height.
#U7-017 Akie-Pesika (Moose, Elk and Mountain Goat) http://www.env.gov.bc.ca/wld/documents/uwr/u-7-017_order.pdf	Within units AP1 and AP2 a) Maintain 20% of the forested stands greater than or equal to 100 years old with a crown closure greater than or equal to 40%. b) Maintain 25% of the forested stands greater than or equal to 80 years old with a crown closure greater than or equal to 40%. c) A maximum of 20% of the forested stands can be less than 20 years old.	Within units AP1 and AP2 a) Maintain 20% of the forested stands greater than or equal to 100 years old b) Maintain 25% of the forested stands greater than or equal to 80 years old c) A maximum of 20% of the forested stands can be less than 20 years old.

6.9 Natural Disturbance

Harvesting is not the only stand disturbance agent on the land base. Mountain pine beetle would be the most spectacular example of this within the Mackenzie TSA. Other natural disturbance agents include fire, windthrow and other pests and diseases. The impact of these agents is to turn the forest over regardless of whether the forest is inside or outside the timber harvesting land base (THLB). Up until the current mountain pine beetle epidemic the primary stand replacement event within the TSA has been fire (Delong 2002[d]). The difference between disturbed stands inside versus outside the THLB is that those outside have a zero probability of salvage while those inside have some probability of salvage depending on the degree of disturbance, the value of the dead trees and the cost of salvage (proximity to milling centres).

Delong (2002 and 1998) divided the landscape into "natural disturbance units" with specific topographic, climatic and rates of natural disturbance (Table 23 below). Delong's research did not indicate differing rates of (stand replacing) disturbance with age.

The plan for this timber supply analysis is to use the proportions in Table 23 to allocate the annualized windthrow and fire rates in section 6.2 across the landscape assuming inside the THLB half the wind and a quarter of the fire disturbance will be salvaged. Stands that are not salvaged will by cycled back on natural stand height and volume curves.

Table 23. Annual probability of natural stand replacement by Natural Disturbance Unit

Natural Disturbance unit	annual probability of natural stand replacement
Boreal Foothills – Mountain	0.7%
Boreal Foothills – Valley	0.8%
Boreal Plains – Upland	1%
McGregor Plateau	0.5%
Northern Interior – Plateau	1%
Northern Boreal Mountains	0.6%
Omineca – Mountain	0.3%
Omineca – Valley	0.8%

(from Table 2, page 9, Delong 2002)

The reader is referred to Delong 1998[e] for his methodology.

[d] Delong, S.C. 2002 "Natural Disturbance Units of the Prince George Forest Region: Guidance for Sustainable Forest Management", B.C. Ministry of Forests (http://www.for.gov.bc.ca/hfd/library/documents/bib90746.pdf).

[e] Delong, S.C 1998, Natural Disturbance Rate and Patch Size Distribution of Forests in Northern British Columbia: Impactions for Forest Management, Northwest Science, Vol. 72. (http://www.vetmed.wsu.edu/org_nws/NWSci%20journal%20articles/1998%20files/Special%20addition%201/v72%20p35%20DeLong.PDF)

7. Sensitivity Analyses

Sensitivity analysis can assess the timber supply impact of uncertainty in data and management assumptions. It can also help determine which variables have the greatest influence on harvest forecasts. Sensitivity analyses can also be used to assess the timber supply implication of policy changes currently being considered by government. Finally, it can be used to explore new economic opportunities.

7.1. Data uncertainties

7.1.1. Operability:

Uncertainty regarding the operability assumptions and utilization assumptions will be explicitly examined. As previously mentioned, while the distance surface is qualitatively reasonable the accuracy of the metric is open to question. Its impact on the forecast requires examination. While, the calculation of the slope and volume thresholds is more robust, the choice of percentile to use as a threshold should and will be examined. To determine the implications of a more conservative landbase the 90th percentile will be used for distance and slope and the 10th percentile for volume. To determine the implications of a more optimistic landbase slope and distance values 10% higher than the 99th percentile and 10% lower than the 1st percentile of volume will be used. Further the impact of including balsam leading stands back in the THLB will be assessed.

7.1.2. Mountain pine beetle

Three other significant uncertainties that will be examined are:

- the amount of the dead pine across the landscape; and
- the amount of dead pine that will be salvaged.

7.1.3. Stand growth:

Vegetation Reosurce Inventory (VRI) phase 2 sample has been completed for the TSA. This will allow an assessment of the mature aerial inventory to be made. This will be discussed in the technical report. As discussed in section 6.7.1. the FREP sample collected in the TSA will allow some assessment of the growth of managed stands in the TSA for the early part of the rotation. However, the longer term growth of managed stands within the TSA is unknown. Uncertainties in timber supply associated with managed stand growth will be explored.

7.2. Possible policy changes

Four such policy sensitivities will be discussed in the pages that follow:

- Visual quality polygons that are not legal but are recommended;
- Best management practices for grizzly bear;
- Best management practices for caribou; and
- Best management practices for bull trout.

7.2.1. Non-legal but recommended visual quality polygons

There are 109 non-legal recommended visual quality polygons within the Mackenzie TSA. Before the District Manager can make them legal through the Government Actions Regulation (GAR) process if he/she decides to do so he/she must ascertain whether the proposed visual quality polygons would have an undue impact on timber supply. This assessment will be made during this timber supply review.

7.2.2. Best management practices (BMPs) for grizzly bear

The January, 2012 Wildlife Infometrics report[f] documented many measures to minimize the impact of harvesting on Grizzly Bears, many of those measures will not be modeled due to their operational nature and have to do with access management. However, the following measures will be modeled:

- Within mapped high value habitat mid-seral (40-80 years) forest will be limited to 33% of the forested area of an assessment watershed. Assuming a uniform age distribution within the watershed this will be approximated by limiting the area of early seral to 33% of the forested area of a watershed.
- On southern aspects within mapped high value habitat, plantation establishment densities will be limited to 500 sph within the ESSFwk1, ESSFwk2, ESSFwc3 and 600 sph within the SBSmk1, SBSwk1 and SBSvk.
- Southerly avalanche tracks will be have a 50 m buffer where harvest will be excluded. Avalanche tracks will be identified as follows:
    - bclcs_level_1 = "V";
    - bclcs_level_2 = "N";
    - bclcs_level_3 = "U";
    - area(ha)/ perimeter(km) < 5;
    - ave_slope >= 35%; and
    - the long axis of the polygon runs up and down slope rather than across slope.

7.2.3. Best management practices for caribou

The January, 2012 Wildlife Infometrics report[g] identified caribou migration corridors within the TSA. The goals of the best practices are to maintain the continuity of these migration corridors and minimize encounters between caribou and their predators within them. The corridors are composed of a core area and an area of influence surrounding that core. Like the Grizzly Bear BMPs some are operational in nature and will not be modeled while others will as follows:

- Within the core areas no harvest will be allowed
- Within the area of influence less than 35% of the forest can be less than 40 years old.

7.2.4. Best management practices for bull trout

Bull Trout are a Blue listed species provincially and a species of "Special Concern". Critical stream habitat within the Davis River, Graham River, Chowika River, Point Creek, Scott Creek and Misinchinka River watersheds will be buffered 200 metres on either side of the watercourse. A 100% reduction to the THLB will be applied within the riparian buffer.

7.3. Exploring new economic opportunities

7.3.1. Fibre opportunities

There has been considerable interest expressed regarding bio-energy within the Mackenzie TSA. Opportunity for bio-energy will be explored by utilizing a 4 cm top within 100 km radius of Mackenzie township.

[f] McCann, R.K. 2012; Best management practices for industrial operations affecting occupied grizzly bear range in north-central British Columbia. Wildlife infometrics Inc. Report No. 390. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

[g] Wright, C. and R.S. McNay. 2012. Best management practices for industrial operations affecting caribou migration corridors in north-central British Columbia. Wildlife infometrics Inc. Report No. 389. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

7.3.2. Utilizing marginally economic stands

The August 2012 report titled "Growing Fibre, Growing value" by the Special (legislative) Committee on Timber Supply recommended finding ways of utilizing marginally economic stands as a means of mitigating expected declines in timber supply in MPB-impacted TSAs. Some light should be shed on the possible opportunities that may exist within the Mackenzie TSA via the operability sensitivities discussed in section 7.1.1.