Ministry of Forests, Lands, Natural Resource Operations and Rural Development

BRITISH COLUMBIA

Provincial Guide for the preparation of Information Packages and Analysis Reports for Area-based Tenures

June 2021

Forest Tenures Branch

Forest Analysis & Inventory Branch

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Definition of terms used in this document

Note: these definitions apply to the context used in this document; they may not apply in other situations.

Allowable Annual Cut is the maximum amount of timber that the decision maker determines is reasonable to harvest from the tenure (usually specified as cubic metres per year).

Alternative harvest flows are different harvest projections made using the same assumptions as used for the base case. One of these alternatives is chosen as the base case harvest projection.

Analysis units are typically composed of forest stands with similar tree species composition, site productivity and treatment regime. A timber volume projection (yield table) is created for each analysis unit based on a growth and yield model. Analysis units can vary in size from a single forest cover polygon to several thousand polygons.

Base case harvest projection for a tenure is the timber supply for a specified time that results from applying the current forest management practices and the best available information applicable to the tenure area.

Current forest management practice (current practice) is based on the current legal framework, legally established land use objectives, and demonstrated forest management practices by the Licensee.

Forest management land base is the forested portion of the gross land base that contributes to meeting forest management objectives such as landscape-level biodiversity.

Green-up describes the condition of a harvested area where the average height of the regenerating trees have attained a specified minimum level.

Gross land base is the total land area within the boundaries of the tenure.

Legally harvestable land base is the subset of the forest management land base where timber harvesting is **legal**, subject to forest management objectives and requirements.

A **scenario** is a new harvest projection that results from different assumptions than the current practices used in the base case.

Sensitivity analysis is a comparison of the base case harvest projection to a harvest projection that results from making a single change to the model inputs to the base case. It is used to test the timber supply effect of uncertainties in data and management practices.

Timber harvesting land base is the subset of the legally harvestable land base where it is **economical** for timber harvesting to occur based on current forest management practices.

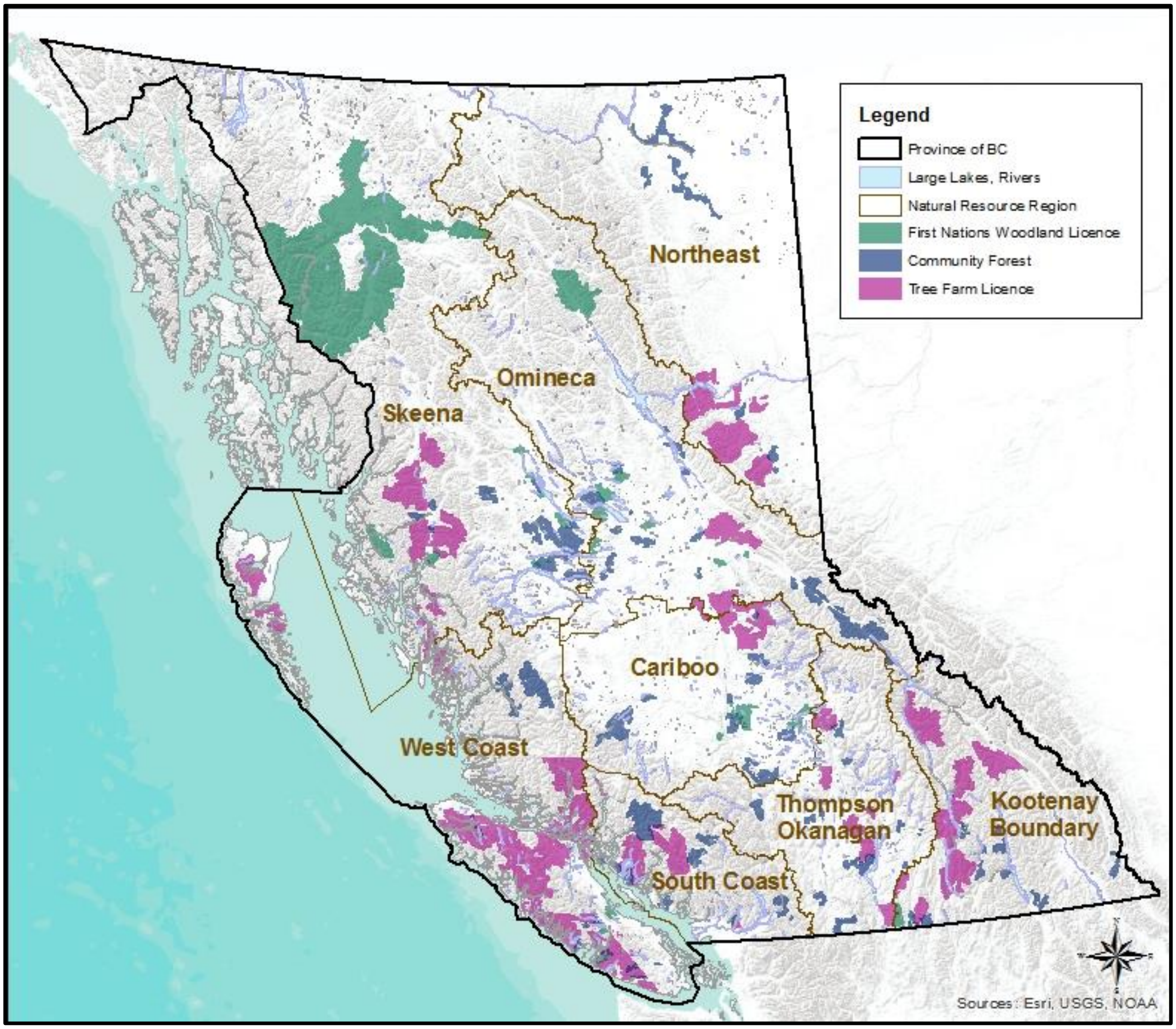
Timber supply is the amount of timber that is forecasted to be available for harvesting over a specified time and under a particular forest management regime.

1 PREFACE

1.1 PURPOSE OF THIS GUIDE

This guide is intended to assist area-based tenure holders such as Tree Farm Licences (TFL), Community Forest Agreements (CFA) and First Nations Woodland Licences (FNWL) prepare the information package and timber supply analysis report, which are the major components of a management plan.

Figure 1. Overview of CFAs, FNWLs and TFLs by Natural Resource Region (March 2021)



The scope of this guide excludes considerations related to new CFA or FNWL opportunities and initial management plan approval. While this guide may be of assistance for a new CFA or FNWL opportunity, applicants are advised to meet with the appropriate regional ministry contact and review the information available at https://www2.gov.bc.ca/gov/content/industry/forestry/forest-tenures/timber-harvesting-rights/community-forest-agreements.

Holders of Woodlot Licences may benefit from reading this guide and applying any pertinent ideas to their smaller tenures. *Woodlot for Windows* has been developed specifically to support the AAC process within the program, and the platform combines the processes described in this guide into a more efficient process. The basic principles of timber supply should still be considered in proposing a long-term sustainable AAC for a WL.

Section 8(1)(b) of the *Forest Act* requires the chief forester to determine an allowable annual cut (AAC) for each tree farm licence, and Section 8(8) specifies what the chief forester must consider in determining the AAC.

For CFAs and FNWLs, Section 8(7) of the *Forest Act* requires the minister to determine their AAC according to the licence agreement for the tenure. The ministerial authority is currently delegated to the regional executive director (RED) and may be sub-delegated to the chief forester, the deputy chief forester or the director, Forest Analysis and Inventory Branch. As the delegation authorities may change over time, the following link should be checked for the most current version of the delegation matrix: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-policy-legislation/transfer-of-authority-matrices.

A management plan is required before an AAC can be determined for these tenures. The content of the management plan is specified by the *Tree Farm Licence Management Plan Regulation*[1] for TFLs and in the licence agreement for CFAs and FNWLs. A common content requirement for the management plans is to provide information required to determine the AAC. This information is in the form of a timber supply analysis report (AR) and associated information package (IP) and the focus of this guide will be on preparing these two documents.

For CFA and FNWL holders, this guide supplements information that may be required by the RED to determine the allowable annual cut.

1.2 Management Planning Process

Preparing a management plan is a significant undertaking, as the plan describes the tenure area, inventories for resource values and the current legislation and plans that guide forest management and operations within the tenure. For CFAs and FNWLs, the management plan also includes the social, economic, and broad resource management goals for the licence area.

The management plan requirements for TFLs are specified in the *Tree Farm Licence Management Plan Regulation,* whereas the requirements for CFA and FNWLs are specified in the licence agreement. The management plan approval and AAC determination process for TFLs is shown in Appendix 1. The process for CFAs and FNWLs is shown in Appendix 2.

Information on Community Forest Agreements and First Nations Woodland Agreements can be found here:

- https://www2.gov.bc.ca/gov/content/industry/forestry/forest-tenures/timber-harvesting-rights/community-forest-agreements
- https://www2.gov.bc.ca/gov/content/industry/forestry/forest-tenures/timber-harvesting-rights/first-nations-woodland-licence

1.3 Allowable Annual Cut (AAC) Determination Process

The allowable annual cut (AAC) is the maximum amount of timber, expressed in cubic metres, that is deemed reasonable to harvest from a TFL, CFA or FNWL.

By law, the chief forester must determine the AAC for each TFL at least once every 10 years. The new determination may be postponed for an additional 5 years if the current AAC is not likely to change significantly.

Under CFA and FNWL agreements, the delegated decision-maker may request a new management plan when necessary. Once a CFA or a FNWL has been issued, tenure holders should expect to prepare a new management plan at least once every 10 years.

The AAC is determined after a careful review of the economic, environmental, and social information that reflects current forest management practices, including their effects on short- and long-term timber supply. The determination is assisted by a timber supply analysis that forecasts harvest levels over several decades or centuries.

Information supporting the timber supply analysis must be documented. For most units, the information will be summarized in the following documents:

1. An **information package** that describes and summarizes the inventories, information and assumptions that will be used to conduct a timber supply analysis; and
2. A **timber supply analysis report** that summarizes the results of the timber supply analysis on the short- and long-term availability of timber.

This guide describes the content of these documents and provides supporting information for their preparation.

[1] Tree Farm Licence Management Plan Regulation (gov.bc.ca)

2 Information Package

The Information Package (IP) describes and summarizes the information and assumptions that will be used to conduct a timber supply analysis for the licence area.

Although it is not required to have an approved IP before the submission of the management plan for CFAs and FNWLs, this practice is strongly recommended. Early preparation and approval of the IP ensures that errors or omissions in the data and assumptions regarding management practices can be identified and corrected prior to the timber supply analysis. This will reduce the likelihood that expensive and time-consuming changes to the analysis will be needed by the decision maker.

Information Package Pitfalls to Avoid
• Incomplete information that does not allow other analysts to verify the analysis and reviewers to fully understand the data and management assumptions • Analysis assumptions for the base case are not based on current practice or legal requirements • Analysis assumptions are not substantiated by evidence and/or the evidence may be biased • Lack of clarity around inclusion or exclusion of deciduous-leading stands and of the deciduous component of coniferous-leading stands • Incomplete description of harvest flow priorities • Incomplete list of appropriate or necessary sensitivity analyses • Area summaries do not add up to licence area • Forested area includes areas of very low density (alpine, wetlands)

The following sections describe the expected content of the Information Package that will facilitate prompt approval and provide examples. Appendix 3 contains a list of inventories and information that may be relevant to timber supply on the area.

2.1 Introduction

The introduction sets the context for the reader to understand what a timber supply review (TSR) entails and why it is being undertaken. The following is an example of setting the context:

> *The timber supply review and AAC determination is a multistep process that involves: 1) preparation of a draft information package that describes known information and current management practices; 2) completion of a timber supply analysis based on the information presented in the information package; 3) completion of a timber supply analysis report documenting the results of the timber supply analysis; 4) submission to the decision maker (chief forester, regional executive director or sub-delegate) of technical information, First Nations referral, and public review information; and 5) release of a rationale that describes the decision maker's AAC determination.*

The last AAC for this unit was determined in 2010 and since then, new forest inventories have been collected and the unit was affected by wildfires.

The introduction should also include a description of what to expect in the information package. The following is an example describing what the information package covers:

This draft information package summarizes the information and assumptions that are proposed to conduct a timber supply analysis for the tenure. The information and management assumptions represent current legal requirements and performance for the tenure and are defined by:

- *current land base information for land ownership, topography, forest inventories, etc.*
- *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 on the area.*
- *the Land and Resource Management Plan (LRMP) and other higher-level plans that were approved by Cabinet and guides resource management activities.*
- *other legal objectives established under the* Forest and Range Practices Act *(e.g., visual quality objectives, ungulate winter ranges).*

2.2 Overview of the Area

This section of the document should provide:

- A general description of the location of the tenure along with a suitable scale map.
- A description of the terrain, climate, biogeoclimatic (BEC) zones/subzones, leading tree species, wildlife.
- A description of First Nations that have asserted interests within the boundaries of the tenure.
- A description of other nearby communities.
- A short history of the AAC for the tenure.

2.3 Current Practice

The primary purpose of the TSR is to project the timber supply that could be obtained from the tenure based on **current practices and legal requirements**. This timber supply projection is known as the **base case**.

The purpose of the base case is to project the flow of timber from the tenure that reflects “what is” rather than what may happen in the future. In essence, the base case is a result of the current capacity of the tenure holder to carry out

Current Forest Management Practice
• Forest management practice assumptions must correspond, in extent and significance, to practices implemented on-the-ground at the time the information package is prepared • Base case must reflect legally established government objectives in effect for the area • The effect of future or marginal practice may be explored though sensitivity analyses.

management practices that affect timber supply. Management practices that may be implemented in the future do not belong in a base case.

Commitments around proposed management practices – for example, closer utilization or enhanced silviculture practices – can be incorporated into the management plan. Once the tenure holder has acted on those commitments, they become current practice for the next timber supply review. The effect of these proposed practices may be explored as sensitivity analyses in the current TSR.

The information in the draft information package should represent the best available data and knowledge at the time of publication. Future changes in knowledge, forest management practices and data, if and when they occur, will be captured in future timber supply analyses. This is one of the main reasons TSRs are generally conducted every 10 years, or earlier. It is strongly recommended that a TSR be conducted for all tenures every 10 years, or earlier, to reflect economic, environmental and social changes.

Timber Supply Review Schedule

- The *Forest Act* specifies that the chief forester must determine an AAC at least once every 10 years for each TFL. The new determination may be postponed for a further 5 years if the current AAC is not likely to change significantly.
- Under CFA and FNWL agreements, the delegated decision-maker may request a new management plan or an amendment when necessary. Tenure holders should expect this to occur at least once every 10 years.

Higher level plans, the *Forest and Range Practices Act* and *Regulations*, the *Forest Practices Code Act* and *Government Action Regulation* orders all stipulate the minimum requirements and targets for the management and conservation of forest resources. There will be instances when Licensees follow the minimum requirements and instances where good forest stewardship results in current management exceeding the minimum requirements. In all cases, evidence (e.g., cruise information, RESULTS data summary) must be provided in the IP for those practices to be accepted as current management.

All modelling assumptions related to current practices should align with management plan content requirement.

2.4 Inventories

This section of the IP provides a list of *all* the data files that will be used in the timber supply analysis. It should specify the type of data, the source of the data and the file name. This will enable someone reviewing the analysis to find the files used and verify the accuracy/currency of the data used in the analysis. It is important that the vegetation resource inventory be updated for disturbances such as recent harvesting activities and fires. The timber volumes and ages should also be projected to the current date. This date will be year 0 in the timber supply projections shown in the analysis report. The following is an example of a partial list of inventory data used in an analysis:

> *Table 1 lists the spatial data that will be used to define the land base, areas where specific forest management activities are currently applied, and areas where specific forest resource objectives must be accounted for in the timber supply analysis. Most data are available within the British*

Columbia Geographic Warehouse; see the BC Data Catalogue for further information on these datasets at https://catalogue.data.gov.bc.ca.

Table 1. Inventory information (Note – this list is illustrative rather than comprehensive)

Data	Source	File Name
Area-Based Tenures	BCGW	WHSE_FOREST_TENURE.FTEN_MANAGED_LICENCE_POLY _SVW
Biogeoclimatic Zones	BCGW	WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY
Forest Cover Openings (recent)	BCGW	WHSE_FOREST_VEGETATION.VEG_CONSOLIDATED_CUT_BLOCKS_SP
Landscape Units	BCGW	WHSE_LAND_USE_PLANNING.RMP_LANDSCAPE_UNIT_POLY_SVW
Ungulate Winter Range	BCGW	WHSE_WILDLIFE_MANAGEMENT.WCP_UNGULATE_WINTER_RANGE_SP
Old Growth Management Area	BCGW	WHSE_LAND_USE_PLANNING.RMP_OGMA_LEGAL_CURRENT_SVW
Vegetation Resource Inventory	BCGW	WHSE_FOREST_VEGETATION.VEG_COMP_LYR_R1_POLY
Visual Landscape Inventory	BCGW	WHSE_FOREST_VEGETATION.REC_VISUAL_LANDSCAPE_INVENTORY
Wildlife Tree Retention	BCGW	WHSE_FOREST_VEGETATION.RSLT_FOREST_COVER_RESERVE_SVW

Below the table there should be a brief description for every data layer listed and how the data will be used. See examples as follows:

Biogeoclimatic Zones

Biogeoclimatic zones, subzones, and variants are identified in this spatial layer. Together with data on landscape units and landscape unit biodiversity emphasis options, the biogeoclimatic zones will be used to account for seral stage requirements.

Wildlife Tree Retention

The spatial layer from the RESULTS dataset contains a representation of retention areas associated with a silvicultural system. Reserves are forest patches or individual trees retained during harvesting or other forestry operations to provide habitat, scenic, biodiversity, and other values.

2.4.1 LiDAR enhanced forest inventory

Many Licensees are now acquiring LiDAR (Light Detection and Ranging) coverage of parts on their licence area in an effort to have a more accurate representation of the forest than is provided by the vegetation resources inventory (VRI). Where LiDAR data is available, the Forest Analysis and Inventory Branch (FAIB) is currently requiring a three-tiered approach to either revise, enhance or create an entirely new forest inventory for the area covered by LiDAR. The degree of inventory adjustment depends on the quality of the LiDAR data available. Please see FAIB's website for more information regarding forest inventory practices in BC: https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory

In Tier 1, FAIB revises the inventory by using the LiDAR canopy height model to adjust stand heights for the leading species in existing VRI polygons. A Tier 2 inventory enhancement requires the delivery of more complex inventory raster products that are generated from measured ground sample data and modelled LiDAR data using the area-based approach developed by researchers at Natural Resources Canada. FAIB enhances the VRI by adjusting inventory attributes such as basal area, diameter at breast height and stem density. Tier 3 incorporates both Tiers 1 and 2 plus the creation of new forest cover polygons using the LiDAR canopy height model.

If a Licensee is proposing to use LiDAR data, there should be prior agreement with FAIB around the quality of data that is being used. Information can be accessed through https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/forest-cover-inventories/light-detection-and-ranging

2.5 Division of the Area into Zones and Analysis Units

2.5.1 Management zones

Management zones identify areas with differing management objectives. The delineation of management zones is guided by legally established objectives, such as those contained in Land and Resource Management Plans (LRMPs) and Government Action Regulation (GAR) orders, and by other forest management considerations. Where management zones overlap, the more stringent requirements take precedence.

Table 3 outlines some of the management objectives that are to be achieved in the timber supply analysis while still allowing trees to be harvested. Management objectives for which harvesting is not permitted (e.g., riparian reserve zones) are not listed in Table 3 as they are incorporated into the analysis through the netdown process described in Section 2.6.

Table 2. Example of management zones and objectives to be tracked

Management Zones/ Objectives	Purpose
Landscape corridors	Retention targets are applied by BEC zones in the spatially identified corridors.
Landscape-level biodiversity	Targets for seral stage distribution by LU have been established through the LRMP process. These targets apply at the landscape unit level based on the biogeoclimatic zone and biodiversity emphasis option.
Grizzly Bear Habitat	Specific forest cover requirements apply in areas identified as critical habitat for grizzly bear.
Riparian Management Zone	For some riparian features, a proportion of the volume present in riparian management zones will be retained to meet riparian management objectives. The reduction will be applied to the Crown forested portion of the RMZ.
Scenic Areas	Areas identified as visually sensitive, and established as scenic areas, require varying percentage of forest cover retention based on their associated visual quality class. The visual requirements apply to the crown forested area within a scenic area.
Dry belt Fir	Selection harvesting will be practiced in this BEC to adequately manage this resource. A maximum of 25 percent of the volume will be removed every 30 years.

2.5.2 Analysis Units

Creating analysis units (AU) simplifies or aggregates the forest for growth and yield modelling. The number of AUs created will depend on the size and heterogeneity of forests in the tenure and the type of timber supply model being used for the analysis. It is possible to complete an analysis where yield curves were assigned to every forest cover polygon (natural stands) rather than aggregate the land base into AUs.

An analysis unit is typically composed of forest stands with similar tree species composition, site productivity and treatment regime. A timber volume projection (yield table) is created for each analysis unit based on a growth and yield model. This projection is based either on an area-weighted average of yield tables from within the analysis unit or on a yield table derived from an area-weighted average of forest characteristics for the analysis unit. The growth and yield models used in BC are further described under Section 2.8.1 (G&Y models).

For almost every tenure, there are three categories of analysis units: existing natural stand, existing managed stand, and future managed stand analysis units.

Table 3 below shows examples of the criteria that can be used to define analysis units for existing natural stands. These analysis units are grouped based on species composition and site productivity classes. There is also one AU created to model selection harvesting in the dry belt Fir portion of the tenure. The growth and yield model and the source of initiation data for the models are identified for the current and future conditions. **Analysis units for existing managed stands (previously harvested stands) and future managed stands will be described later under Silviculture.**

Table 3. Example of definition of analysis units – existing natural stands analysis units with associated current and future volume table model and initiation information

		Current Stand			Future Stand		
AU Identifier	**Leading Species**	**Site Index Range**	**Model**	**Initiation Data**	**Model**	**Regeneration Species Composition**	**Weighted AU proportion**
NSG	Spruce	>20	VDYP	VRI	TIPSY	P50S50 S100 P70S30 S70P30	82% 1% 7% 10%
NSM	Spruce	15–20	VDYP	VRI	TIPSY	P50S50 S100 P70S30 S70P30	82% 1% 7% 10%
NSP	Spruce	<15	VDYP	VRI	TIPSY	P50S50 S100 P70S30 S70P30	82% 1% 7% 10%
NPG	Pine	>18	VDYP	VRI	TIPSY	P50S50 P100 P90S10	92% 1% 7%
NPM	Pine	12-18	VDYP	VRI	TIPSY	P50S50 P100 P90S10	92% 1% 7%
NPP	Pine	<12	VDYP	VRI	TIPSY	P50S50 P100 P90S10	92% 1% 7%
DBF	Dry belt fir	All	VDYP	VRI	VDYP	F100	100%

Comment:

In the AU identifier the first character refers to the general type of stand (i.e., N = Existing natural stands), the second character refers to the leading species (i.e., F = Balsam or Douglas-fir, S = Spruce, P = Pine), and the third character refers to the site index class (i.e., G = Good, M = Medium, P = Poor). These AU identifiers are for clarification purposes within the information package and may differ from identifiers used in the analysis.

The Regeneration Species Code refers to the initial species mix at regeneration. The percentage refers to the proportion of the analysis unit that will be regenerated according to the specified regeneration species code. For example, for AU NPP, 92 percent of existing pine natural stands on good sites will be regenerated as a mix of 50 percent pine and 50 percent spruce; 1 percent as pure pine; and the remaining 7 percent as a mix of 90 percent pine and 10 percent spruce.

2.6 LAND BASE CLASSIFICATION

In this part of the information package the ultimate objective is to identify the timber harvesting land base – the area where it is **both legal and economic** to harvest timber based on **current practices**. For modelling and information purposes, the land base in the tenure is classified based on four nested categories:

1. Gross Land Base (GLB), which is the total land area legally associated with the tenure.

 2. Forest Management Land Base (FMLB), which is the portion of the GLB, which contributes to forest management objectives such as landscape-level biodiversity.

  3. Legally Harvestable Land Base (LHLB), which is the portion of the FMLB where timber harvesting is **legal**, subject to forest management objectives and requirements; and

   4. Timber Harvesting Land Base (THLB), which is the portion of the LHLB where it is **economical** for timber harvesting to occur based on current forest management practices.

Table 4 defines the four categories and identifies areas that are excluded from each category. Figure 2 illustrates the four nested categories.

Table 4. Land base classification categories definition and exclusions

Classification Step	Definition	Exclusions
Gross land base (GLB)	Tenure area	▪ N/A
Forest management land base (FMLB)	Forested area that contributes to forest management objectives	▪ Large water bodies, salt water. ▪ Federal land and reserves. ▪ Long-term leases. ▪ Other tenures and areas considered part of the TSA; and ▪ Non-forested and non-productive forest land.
Legally harvestable land base (LHLB)	Area within the FMLB where timber harvesting is legal, subject to forest management objectives and requirements	▪ Miscellaneous provincial Crown land not contributing to timber supply. ▪ Provincial protected areas, including conservancies. ▪ Biodiversity, mining, and tourism areas. ▪ Areas with objectives that prohibit timber harvesting (e.g., old growth management areas [OGMA], riparian areas, wildlife habitat)

Timber harvesting land base (THLB)	Area within the LHLB where it is economical to harvest under current management practices	▪ Areas that are unsuitable or uneconomic for timber production, such as:
		  ▪ Environmentally sensitive areas.
		  ▪ Steep slopes.
		  ▪ Areas with low site productivity.
		  ▪ Non-merchantable forest types
		▪ Surrogate areas for legally established management objectives for resource values that may prohibit timber harvesting but for which the location is decided operationally (e.g., wildlife tree retention areas, riparian management areas)

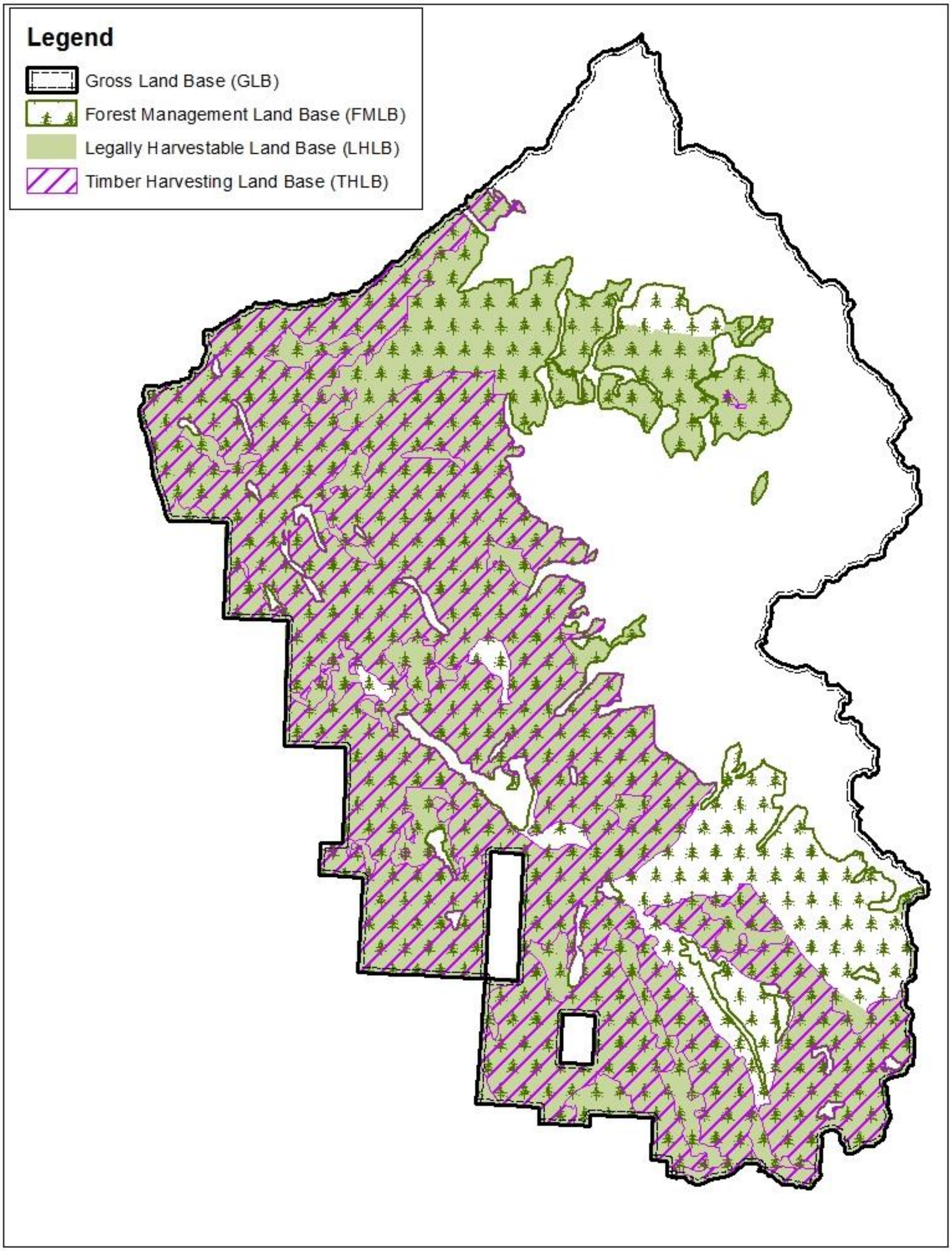


Figure 2. Map of a tenure showing the nested categories of the land base.

2.6.1 Identifying the forest management land base

The FMLB is the portion of the GLB that contributes to forest management objectives. Lands that do not contribute to the FMLB are identified in the sections below. A map showing the FMLB in the tenure would be helpful for First Nations and public reviewers as well as the analyst reviewing the IP.

2.6.1.1 Lands not managed by the tenure holder

There may be situations where the boundaries of the tenure contain lands not managed by the tenure holder. Some of these areas may contribute to the FMLB and there are others that do not. Table 5 provides an example of areas that contribute to the FMLB. In this example, the GLB was 77 450 hectares and of this there were 4643 hectares not managed by the tenure holder.

Table 5. Land ownership types that typically contribute to the forest management land base

Land Ownership Code	Forest Management Land Base
40 – Private Land	In some cases, when included within tenure
52 – Indian Reserves	In some cases, when included within tenure
54 – Federal Parcels	No
61 – Crown Reserves for Use, Recreation and Enjoyment of the Public (UREP)	Yes
62 – Crown Forest Management Unit (TSA)	No
66 – Crown Provincial Park Class C	Yes
67 – Crown Provincial Park or Equivalent	Yes
68 – Crown Biodiversity, Mining and Tourism Area (BMTA)	Yes
69 – Crown Miscellaneous Reserve	Yes
77 – Crown and Private Woodlots	No, except if the area is the woodlot
78 – Crown Tenure First Nation Woodland Licence	No, except if the area is the FNWL
79 – Crown Tenure Community Forest Agreement	No, except if the area is the CFA
80 – Municipal Parcels	No
91 – Unknown Ownership	No
99 – Crown Miscellaneous Leases	No

2.6.1.2 Non-forest and non-productive forest areas

Non-vegetated areas and areas with non-productive forest (e.g., wetlands) are excluded from the FMLB, unless they were logged in the past. Areas classified as non-forest and non-productive do not contribute to other forest management objectives such as seral stage distribution for landscape-level biodiversity. The IP should include a table such as the one below showing how non-forest and non-productive forest are identified.

Table 6 describes the broad classes of non-forested areas in the tenure. After accounting for overlap, the net area removed from the FMLB to account for non-forested areas is 8285 hectares.

Table 6. Example of a description of non-forest and non-productive areas

Attributes	Description	Logging History	Total Area (hectares)
Non-vegetated (BCLCS_lv_1 = ‘N’)	Waterbodies and areas where the total cover of trees, shrubs, herbs and bryoids is less than 5% of the total surface area	No	2 963
Non-treed (BCLCS_lv_1 = ‘V’ and BCLCS_lv_2 <> ‘T’ and BCLCS_lv_3 = ‘A’ or ‘W’)	Non-treed wetlands and alpine areas	No	1 395
Non-productive areas (BCLCS_lv_1 = ‘V’ and BCLCS_lv_2 <> ‘T’ and (BCLCS_lv_3 = ‘U’ and SITE_INDEX ≤ 5))	Non-treed areas with a site index equal to or less than 5	No	1 263
Treed wetlands (BCLCS_lv_1 = ‘V’ and BCLCS_lv_2 = ‘T’ and BCLCS_lv_3 = ‘W’)	Areas having the water table at or above the soil surface or which is saturated for a long enough period to promote wetland or aquatic processes	No	1 068
Non-productive brush (PROJ_AGE_1 IS NULL and SITE_INDEX IS NULL and BCLCS_LEVEL_1 = 'V' and BCLCS_LEVEL_3 = 'U' and BCLCS_LEVEL_2 = 'N')	Non-treed areas undisturbed by logging, fire or insects	No	1 233
Boreal altai fescue alpine (BAFA) biogeoclimatic zone	Vegetated areas within the BAFA are considered non-forested for the purposes of timber supply	No	363

Data source and comments:

The vegetation resource inventory (VRI) includes the British Columbia Land Cover Classification Scheme (BCLCS). Under the BCLCS, land is first classified based on the presence or absence of vegetation. Vegetated polygons are then classified as treed or non-treed. Non-treed polygons are classified as ‘non-forested areas’ if they correspond to wetlands, alpine areas or have a site index equal to or less than 5.0. Treed wetlands are also classified as non-forested areas. As the classification may identify recently harvested stands as non-treed, only polygons that were not previously harvested are classified as non-forest areas.

Vegetated areas classified as boreal altai fescue alpine (BAFA) in the biogeoclimatic ecosystem classification system are considered non-forested for the purpose of the TSR.

The areas shown in Table 6, above, represent the summary of all areas classified as non-forest or non-productive. As these areas may overlap with each other and fall within ownership categories (e.g., a wetland may be within a woodlot) excluded from the FMLB, the amount of net area that will be removed from the FMLB to account for non-forest or non-productive areas is different than the sum of the values shown above.

2.6.1.3 Existing and Future Roads, Trails and Landings

Existing roads, trails and landings are considered non-productive and are removed from the FMLB.

To estimate reductions associated with the existing road network, a GIS buffering process is typically applied to road data. The reduction for existing roads is often a contentious issue for Licensees and Ministry staff. **The best way to resolve issues regarding land base reductions or current practices is to provide unbiased (i.e., evidence-based) data pertinent to the issue.** In the example below the buffer widths used are based on data collected on 130 randomly selected sample points within the tenure.

There is a total of 1611 hectares of roads in the tenure. After accounting for overlap with land not administered by the tenure holder and non-forested areas, the net area of roads removed from the FMLB is 955 hectares.

For future roads, it is assumed that similar roads will be constructed in all unharvested stands (18 634 hectares in this example). For these stands, the THLB will be reduced by 2.2 percent – or 410 hectares – to account for permanent access structures (18 634 × 0.022 = 410). This percentage reduction is based on actual permanent access structures reported in RESULTS. It is assumed that unharvested stands will require the same percentage of permanent access structure as current managed stands.

Table 7 shows the estimated gross and net area by road type for this example.

Table 7. Estimates for existing and future roads, trails, and landings

Existing Roads, Trails and Landings	Road Width (m)	Reduction %	Total Area (hectares)	Net Area (hectares)
Forestry Mainlines	27.3	100	614	306
Operational Roads (e.g., branch)	19.0	100	531	335
In-block Roads	8.4	100	466	314
Future roads, trails, and landings				410

2.6.2 Identifying the legally harvestable land base (LHLB)

The LHLB is the portion of the FMLB where timber harvesting is legal but is subject to forest management objectives and requirements. The portions of the FMLB that must be removed (netted out) to identify the LHLB are described below. Provision of a map showing the LHLB would be very useful for reviewers of the IP.

2.6.2.1 Protected areas and miscellaneous reserves

Harvesting is not permissible in protected areas such as provincial parks and ecological reserves. These areas are identified as land ownership codes 63, 66 and 67 in the ownership code table presented earlier. In this example, there were 2500 hectares of protected areas and reserves. After accounting for overlaps, 2488 hectares were removed from the LHLB.

Provincial parks and ecological reserves contribute to meeting landscape level objectives (e.g., old growth requirements); however, there are situations where they may be excluded from the FMLB, and thus the LHLB.

2.6.2.2 Old growth management areas (OGMAs)

Old growth management areas have been spatially established to retain or restore the ecological attributes associated with old forest, and to maintain areas that are subject to natural forest succession. They may also contribute to the preservation of other features important for biodiversity or other values.

The forested area associated with OGMAs is excluded from the LHLB. Depending on the order land is excluded from harvesting, it may overlap with land removed earlier in the netdown process. The IP should indicate both the total area in that landbase category as well as the net area removed at that stage in the netdown process. In this example, OGMAs overlap with protected areas and miscellaneous reserves. The total area of OGMAs is 4864 hectares and the net area that will be removed from the LHLB to account for OGMAs is 977 hectares. Maps showing the location of OGMAs (and other landbase categories) will be helpful to reviewers of the IP.

2.6.2.3 Wildlife habitat reserves

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

In the example shown in Table 8, a net area of 3037 hectares is excluded from the LHLB to account for ungulate winter range where harvesting is not allowed. The example also includes a comment stating the reason for the exclusion. This reduces the number of questions asked by reviewers.

Table 8. Example of a wildlife habitat exclusion from LHLB

Category	Criteria	Reduction (%)	Total Area (ha)	Net Area (ha)
Mountain Goat Ungulate Winter Range	No harvest	100	6010	3 037

Comments:

On February 1, 2018, a Government Action Regulation Order to establish Ungulate Winter Range (UWR) U-6-017 for mountain goat was established. This UWR includes a General Wildlife Measure (GWM) that prohibits timber harvesting over a total area of 5166 hectares.

2.6.2.4 Other categories of land where timber harvesting is prohibited

This will vary depending on the forest values being managed in the tenure. In this example, timber harvesting is prohibited in the red- and blue-listed ecological communities and hydro-riparian ecosystems located within the tenure. Therefore, these areas will not contribute to the LHLB. In total, 1200 hectares of land will be removed from the LHLB to account for rare and endangered ecological communities and hydro-riparian ecosystems.

Table 9. Red- and blue-listed ecological communities and hydro-riparian ecosystem exclusions

Category	Criteria	Reduction (%)	Total Area (ha)	Net Area (ha)
Red- and blue-listed ecological communities	Details related to how to identify these areas	100%	1 500	500
Hydro-riparian ecosystems	Details related to how to identify these areas	100%	2 000	700

2.6.3 Identifying the timber harvesting land base (THLB)

The THLB is the portion of the LHLB where timber harvesting is likely to occur because it is **economical based on current practice and capabilities** of the tenure holder. It is particularly important to **provide unbiased data to justify including land in the THLB**. The following sections describe land that typically should be netted out to arrive at the THLB. As with the FMLB and the LHLB, it would be very useful to prepare a map showing the THLB.

2.6.3.1 Inoperable Areas

Physical barriers sometimes limit harvesting or the merchantability of stands. Sources of information for inoperable areas include opening classification information, as reported in RESULTS; slope class information, as derived from digital elevation models; or economic operability studies.

For example, the current practice for a tenure holder may be that stands located on slopes steeper than 40 percent are not harvested because they are considered unsafe for conventional ground-based systems and uneconomical to harvest with other methods. This would be supported by recent harvest and slope data that show for example, that 97 percent of slopes steeper than 40 percent are not harvested. Therefore, stands located on slopes steeper than 40 percent will be excluded from the THLB.

The IP might include a statement such as: “There is a total area of 2886 hectares on slopes greater than 40 percent. After accounting for overlap with other factors – such as parks and OGMAs – the net area removed from the THLB is 855 hectares.”

2.6.3.2 Sites with Low Timber Growing Potential

Sites may have low productivity because of inherent site factors such as nutrient availability, exposure, or excessive moisture. These stands are unlikely to grow a merchantable crop of trees in a reasonable amount of time. As such, these stands are identified and do not contribute to the THLB.

This factor is related to the minimum merchantability criteria which will be discussed later. If, for example, current practice is not to harvest stands that have less than 150 cubic metres/hectare of timber, then there should be no future harvesting on those areas that are not capable of producing stands with greater than 150 m^3/ha within a reasonable time. These areas should not contribute to the THLB. In the example below, “reasonable time” depends on the leading species and the BEC zone.

For the base case a minimum site index criterion was established to identify stands that are removed from the THLB due to low timber growing potential. **Note**: If sensitivity analyses are conducted on the minimum harvestable volume criterion, these cutoffs may need to be revised because of the linkage between site productivity and volume growth.

The example in Table 10 shows the net area removed from the THLB to account for sites with low timber growing potential is 693 hectares.

Table 10. Example of a description of sites with low timber growing potential

Characteristics								
Logging History	Leading Species	BEC Zone	Age (years)	Minimum Volume (m^3/ha)	Minimum Site Index	Reduction (%)	Total Area (hectares)	Net Area (hectares)
No	PL, PLI	ESSF	≤140	150	9.7	100%	327	120
		SBS	≤140	150	10.1	100%	288	106
No	S, SB, SE, SW, SX	ESSF	≤250	150	7.5	100%	350	126
		SBS	≤140	150	6.9	100%	925	341

2.6.3.3 Problem Forest Types

Problem forest types are stands that are physically operable and exceed low site criteria yet are not currently used or have marginal merchantability due to species, quality, size or volume. These stand types are excluded from the THLB.

Table 11 shows examples of three problem forest types that are not included in the THLB. In this example, deciduous-leading stands are not currently being harvested in the tenure. Note that it is very important for the IP to specify how deciduous-leading stands are managed. In many areas of British Columbia, deciduous-leading stand are excluded from the THLB.

In the ESSF and SBS stands are excluded that do not contain 150 cubic metres per hectare by the time that they reach ‘old growth’ status (i.e., 140 years for the SBS and 250 years for the ESSF).

The net area removed from the THLB to account for problem forest types is 2700 hectares.

Table 11. Example of problem forest types criteria

Description	**Logging History**	**BEC Zone**	**Age (years)**	**Minimum Volume (m^3/ha)**	**Reduction per cent (%)**	**Total Area (hectare)**	**Net Area (hectare)**
Deciduous	No	All	All	All	100	6 089	1 500
Old stands - ESSF	No	ESSF	> 250	150	100	1 504	500
Old stands - SBS	No	SBS	> 140	150	100	1 408	700

2.6.3.4 Riparian Areas

Riparian areas occur next to the banks or edges of streams, lakes, and wetlands. Riparian areas frequently contain the highest number of plant and animal species found in forests, and provide critical habitats, home ranges, and travel corridors for wildlife. Biologically diverse, these areas maintain ecological linkages throughout the forest landscape, connecting hillsides to streams and upper headwaters to lower valley bottoms.

The Forest Practices Planning Regulations defines the riparian reserve zone (RRZ) and the riparian management zone (RMZ) widths for streams, lakes, and wetlands; these widths correspond to the older Forest Practices Code Riparian Management Area Guidebook. Table 12 below lists these minimum requirements that must be observed. Since the actual retention practice may be greater than these minimum requirements due to physical constraints or forest stewardship considerations, **please provide the data documenting the actual practices and model those practices**.

There is often overlap between riparian areas and wildlife tree retention areas. This overlap is addressed in the section below. In this example, riparian areas occupy a total of 3763 hectares; 2356 hectares were removed from the THLB at this stage of the netdown process.

Table 12. Riparian reserve zones and riparian management zones

Riparian Class	**RRZ width (m)**	**RMZ width (m)**	**RRZ percent (%) retention**	**RMZ basal area (%) retention**	**Total reserve width (m)**
S1-A	0	100	N/A	20	20
S1-B	50	20	100	20	54
S2	30	20	100	20	34
S3	20	20	100	20	24
S4	0	30	N/A	10	3
S5	0	30	N/A	10	3
S6	0	20	N/A	0	0
L1-A	0	0	N/A	10	0
L1-B	10	0	100	10	10
L3	0	30	N/A	10	3
W1	10	40	100	10	14
W3	0	30	N/A	10	3
W5	10	40	100	10	14

Comments:

Minimum widths for riparian reserve zones (RRZ), riparian management zones (RMZ), and riparian management areas (RMA) are specified by the *Forest Planning and Practices Regulation* (FPPR) and these are reflected in approved Forest Stewardship Plans (FSPs).

Total reserve width = reserve zone width + (management zone width × retention %). Buffer is applied to both sides of streams and the outside polygon of lakes and wetlands.

2.6.3.5 Wildlife tree retention / Stand-level biodiversity

Wildlife trees are retained to promote healthy functioning ecosystems that provide wildlife habitat elements at the forest stand level. Wildlife tree retention (WTR) may include the retention of individual wildlife trees in a cutblock or the retention of an area specifically identified as a wildlife tree patch for protecting current or for recruiting suitable wildlife trees. WTR can include living and dead trees standing or down.

Table 13 shows by landscape unit the minimum wildlife tree retention required and the actual retention for some LUs in the tenure. In the example there is currently a total of 7 561 hectares of FMLB spatially identified as WTR reserves. After accounting for overlaps with other area exclusions such as riparian areas, the net area excluded from the THLB to account for WTR is 1200 hectares. Since the area already harvested in this tenure is 25 000 hectares, the net removal for WTR is 1200/25 000 = 4.8%. Assuming a similar reduction will be required for the remaining unharvested areas, this percentage removal will be used to estimate future reductions to the THLB for WTR [((43 634 – 25 000) × 0.048) = 894 hectares].

Table 13. Example of wildlife tree retention targets and area in WTR

Landscape Unit	BEC Zone	Percentage of cutblock required for WTR based on Land Use Objective (%)	Actual percentage cutblock retention for WTR based on RESULTS	FMLB area in WTR (hectares)
LU 1	SBS	>10	16	700
	ESSF			749
LU 2	SBS	>10	15	1 342
	ESSF			654
LU 3	SBS	>12	17	1 109
	ESSF	>9	13	940
LU 4	SBS	>12	19	1 071
	ESSF	>9	10	817

Comments:

The WTR requirements are specified in the LRMP and are reflected in approved FSPs. The current management practice, as evidenced through reporting submissions in the RESULTS database, is to reserve an average of 15 percent of the gross cutblock area to meet WTR requirements. In the timber supply analysis, the current management practice will be modelled.

2.6.3.6 Cultural Heritage Resources

The *Forest Act* defines a cultural heritage resource (CHR) as “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”. CHRs include culturally modified trees (CMTs), cache pits, burial sites, trails, habitation sites, tools, and historic sites and items.

CHRs are usually identified and documented through operational planning and their documentation aids in landscape- and site-level planning as well as providing valuable information on the history of resource use in the tenure.

In the IP, please specify how CHRs are managed for the area and how they will be modelled in the timber supply analysis. Quite often CHRs overlap with areas removed for the management of other values (e.g., wildlife tree retention, riparian areas). Where there is no overlap, these areas should not contribute to the THLB. In this example, identified CHRs covered a total area of 1230 hectares. After accounting for overlaps, the reduction to the THLB was 427 hectares. Of this area, 300 hectares were identified as berry-picking areas or as containing medicinal plants of importance to First Nations, which may require alternate operational management strategies.

Archeological resources (pre-1846) are afforded protection through the Heritage Conservation Act, and although the specific site information is confidential, archaeological assessments often provide relevant details.

2.6.3.7 Terrain stability

Landslide hazard information is useful for planning safe operations and avoiding environmental issues. In the 1970s the Ministry recognized the need for this information and mapped potentially unstable terrain as environmentally sensitive areas (ESA). Terrain stability mapping (TSM) has now replaced ESA mapping in most areas of the province. Reconnaissance terrain stability mapping (RTSM) has three hazard classes (Stable, Potentially unstable and Unstable), and detailed terrain stability mapping (DTSM) has five hazard classes (I, II, III, IV and V).

If any terrain stability mapping (TSM) was completed for the tenure (or parts of the tenure), that data should use the TSM to remove unstable areas from the THLB. Where there is no TSM, the ESA classification should be used. Table 14 provides an example of data provided to remove unstable terrain from a tenure.

Table 14. Description of terrain stability mapping and environmentally sensitive area reduction

Source	Category	Total area (ha)	FMLB area (ha)	Reduction %	Area in THLB (ha)
TSM	Unstable (U or V)	1 100	1 000	100	0
TSM	Potentially unstable (P or IV)	9 000	8 000	50	4 000
ESA	Es1	900	800	100	0

2.6.4 Initial land base classification summary

At this stage of the IP, a table similar to the one below showing the draft THLB should be provided. This section of the IP summarizes the initial land classification based on inventories currently available and legal and economic considerations, as described in the preceding sections. The final land base classification summary will be presented in a revised IP after accounting for feedback from agencies, groups or individuals as required. A map showing the initial THLB would also be helpful for the reviewers.

Table 15. Initial land base classification summary

Land Classification	Total area (hectares)	Forested area (hectares)	Net area (hectares)	% of total area	% of FMLB
Total Area	77 450			100	
Land not managed by the tenure holder	4 643		4 463	6.0	
Non-forested and non-productive	8 285		8 285	10.7	
Roads, trails and landings	1 611		955	1.2	
Total Forest Management Land Base	**63 567**			**82.1**	**100**
Parks and Protected Areas	2 500	2 488	2 488	3.2	3.9
OGMA	4 864	4 788	977	1.3	1.5
Wildlife habitat reserves	6 010	5 166	3 037	3.9	4.8
Red- and blue-listed communities and hydro-riparian ecosystems	3 500	2 604	1 200	1.5	1.9
Total Legally Harvestable Land Base	**55 865**			**72.1**	**87.9**
Inoperable areas	2 886	2 589	855	1.1	1.3
Low productivity sites	1 890	1 430	693	0.9	1.1
Problem forest types	9 000	7 125	2 700	3.5	4.2
Riparian areas	3 763	2 890	2 356	3.0	3.7
Wildlife tree retention areas	7 561	5 551	1 200	1.5	1.9
Cultural heritage resources	1 230	1 000	427	0.6	0.7
Terrain stability	11 000	9 800	4 000	5.2	6.3
Total Current Reductions			**19 933**	**25.7**	**31.4**
Timber Harvesting Land Base	**43 634**			**56.3**	**68.6**
Future Reductions					
Future roads, trails and landings			410	0.5	0.6
Future wildlife tree retention			894	1.2	1.4
Future Timber Harvesting Land Base	**42 330**			**54.7**	**66.6**

2.7 CURRENT FOREST MANAGEMENT ASSUMPTIONS

2.7.1 Harvesting

This section of the information package contains the timber supply analysis assumptions related to timber harvesting practices.

In this section, specify how timber harvesting is done within the tenure. For example, harvesting is done using conventional feller-bunchers and ground skidding. Licensees may describe equipment available for harvesting on steep slopes if that is current practice.

There is no timber supply modelling assumption related to logging method; this is just for general understanding about harvesting operations by the Licensee.

2.7.2 Utilization levels

The utilization levels define the maximum stump height, minimum top diameter (inside bark) and the minimum diameter (outside bark) at stump height; however, for yield table projections, the specifications for minimum stump diameter are converted to a corresponding breast height diameter.

The Ministry's appraisal manual (Coast or Interior) specifies the utilization levels for the billing of harvested timber. Table 16 shows the utilization levels for an Interior management unit.

Table 16. Example of harvest merchantability specifications for major species utilized in an Interior tenure

Leading Species	Minimum DBH (cm)	Minimum Diameter at Stump Height (cm)	Maximum Stump Height (cm)	Minimum Top Diameter (cm)
Lodgepole Pine	12.5	15.0	30.0	10.0
Balsam	17.5	20.0	30.0	10.0
Spruce	17.5	20.0	30.0	10.0

2.7.3 Volume Exclusions for the Deciduous Component of Conifer-leading Stands

In some tenures the deciduous volume (or some other minor species) within conifer-leading stands is not harvested. Therefore, that volume within conifer-leading stands does not contribute to the timber supply. It is very important to ensure that the yield curves for these stands are adjusted to exclude the volume of species not harvested.

In this example, the deciduous component of all conifer-leading analysis units will be excluded from yield tables for the base case. As a modelling simplification, no other modelling adjustments (e.g., overlap with WTR) will be made.

Table 17. Example of volume exclusions for the deciduous component of mixed species types

Mixed Stand Type	Species	Volume Exclusion (%)
All conifer-leading	Deciduous	100

2.7.4 Minimum Harvestable Volume/Age

The minimum harvestable volume or age is **probably the most significant variable** that affects timber supply. It is the volume or age that a stand must attain before it is considered economically harvestable. While harvesting may occur in stands at the minimum volume or age to meet certain modelling objectives (e.g., maintaining overall harvest levels for a short period of time or avoiding large changes in harvest levels), most stands will not be harvested until past the minimum criteria due to management objectives for other resource values.

> **Minimum harvestable criteria**
>
> It is helpful to use cruise information data to derive the minimum harvestable volume or age. Where cruise information is not available, unbiased field samples or analysis results (accompanied by a summary of the procedure) may be used.

This harvestability criterion must not be chosen simply to maximize timber supply. Like all other requirements for the base case, data must be provided to verify current practice. Care must be taken to ensure that the chosen criterion reflects regular practices rather than occasional practices. Sensitivity analyses are usually conducted using various harvestability criteria to test the effect of uncertainty around these values.

Table 18 shows an example for the minimum harvestable volume and age criteria that will be used in the base case. **These criteria were derived based on cruise data from the past 10 years of harvest**.

Table 18. Example of a minimum harvestable criteria in a Coastal unit

Stand Type	Minimum Volume (m^3/ha)	Minimum Age (years)
Existing Natural Stands	500	N/A
Future and Existing Managed Stands	400	80

Comments:

Existing Natural Stands:

A review of cutting permit cruise data shows that from 2010 to 2020, the average net volume of harvested stands was 550 cubic metres per hectare.

The majority – 95 percent – of all cutting permits harvested since 2010 had volumes of at least 525 cubic metres per hectare. The minimum volume of harvested stands declined from 525 cubic metres per hectare in 2010 to 495 cubic metres per hectare in 2020.

Although this data suggests that the minimum harvestable volume is declining, there is considerable uncertainty around this factor. For this analysis, the minimum harvestable volume associated with existing natural stands will be 500 cubic metres per hectare.

Existing and Future Managed Stands: Stands that are regenerated following harvest will not be available for the next harvest until they reach a minimum volume of 400 cubic metres per hectare ***and*** *are at least 80 years of age. This age was selected as it is the age at which the average Douglas fir stand is estimated to reach maximum productivity (culmination of mean annual increment).*

2.7.5 Silviculture systems

Clearcut and clearcut with reserves is the dominant silviculture system in use in the BC. Under this system, a range of patch sizes (one to several hundred hectares) of even-aged forest is produced. A characteristic of this system is the maintenance of older forest remnants within harvest blocks. These remnants are intended to function as wildlife tree patches, riparian management zones and reserves, and island remnants to conserve old growth characteristics. Cutting of adjacent blocks is restricted until the harvested areas is ‘greened-up’.

Commercial thinning, where a certain volume is removed from immature stands, is often considered in BC. Generally, commercial thinning is successful if it was planned when the stand was being regenerated. Practitioners often find that very few existing stands are suitable for commercial thinning. The timber supply analyst should consult with the Ministry’s growth and yield experts at FAIB when preparing volume yield curves for stands eligible for commercial thinning.

When selection harvest systems are used, it is important to specify the modelling assumptions used to reflect current practice. For example, “in the base case, the model will assume 25 percent of the volume will be removed every 30 years from this ecosystem”.

2.7.6 Silviculture

2.7.6.1 Basic Silviculture

Since 1987, major Licensees are legally responsible for basic silviculture. To enable assessment of this responsibility, Licensees conduct surveys of the regeneration on each cutblock and report this information in the Ministry’s database RESULTS. Summary information from RESULTS should be the basis for regeneration assumptions in the base case.

In preparing regeneration assumptions, tenure holders may wish to aggregate regeneration assumptions based on key groups. For example:

1. Pre-1987 era
2. Introduction of seedlings with genetic worth
3. Changes in genetic worth (e.g., from a weighted average of X% to a weighted average of Y%)
4. Changes in planted species

The following is an example of summary information indicating that basic silviculture is being practiced in the tenure:

> *Since 2007, 100 percent of the spruce seedlings planted are from class A seeds with an estimated average genetic gain of 20 percent. The planting of genetically improved pine seedlings began in 2009 and about 64 percent of the pine seedlings currently planted are from genetically improved seed with an estimated weighted average genetic gain of 9 percent.*
>
> *For the base case, current practice represents basic silviculture practices that took place within the last decade. Within the tenure, these include planting (about 5000 hectares) and brushing (about 700 hectares). Information on current practice will be used to project the growth of future harvested stands.*

2.7.6.2 Regeneration activities in managed stands

One of the major areas of uncertainty in timber supply modelling in BC is the volume projection from regenerated stands. Since silviculture practices have evolved over time, it is important to reflect the silviculture treatments applied to those stands. In this context, 'managed' means stands that are/were regenerated after harvesting.

The following is a detailed example of how the IP should describe how managed stands will be modelled in the tenure:

> *The volume of all existing stands that have a history of harvesting or stands harvested in the future will be projected using managed stand yield tables (MSYTs) produced by the TIPSY growth and yield model. Due to differences in regeneration methods, managed stands will be grouped as follows:*
>
> - *Managed stands greater than or equal to 33 years old (regenerated prior to 1987).*
> - *Managed stands 13 to 32 years old (regenerated from 1987 to 2007).*
> - *Managed stands 12 years or younger (regenerated from 2008 to 2020); and*
> - *Future stands.*
>
> *Currently, there are about 6000 hectares of existing managed stands that were regenerated prior to 1987, 9000 hectares that were regenerated between 1987 and 2007, and about 10 000 hectares that have been regenerated since 2007.*
>
> A map showing the location of the first three classes of stands would be useful.

2.7.6.2.1 Managed stands greater than or equal to 33 years of age (regenerated prior to 1987)

> *Regeneration practices prior to 1987 are assumed to be different from post-1987 practices when basic silviculture obligations for Licensees were enacted.*
>
> *The general yield assumptions for managed stands 33 years of age and older are as follows:*
>
> - *Regeneration delay is two years for planted stands and is seven years for natural stands.*
> - *Improved stock was not planted until 2007, so there is no genetic gain applied to any species.*
> - *Standard operational adjustment factors – OAF 1 (15%) and OAF 2 (5%) will be used.*
>
> *Table 19 identifies the five groups of stands that were determined to represent the regeneration assumptions for harvested stands greater than or equal to 33 years old. The information in Table 20 was obtained from RESULTS. There are about 6000 hectares of managed stands greater than or equal to 33 years old.*

Table 19. Example of TIPSY regeneration composition inputs for stands greater than or equal to 33 years old

ID	Species Composition	Area (ha)	Regeneration Delay (yrs)	Regeneration Method Type	%	Initial Density (sph)	Operational Adjustment Factor OAF 1	OAF 2
1	P100	1 000	2	Plant	100	1469	15	5
2	P80S20	1 000	2	Plant	100	1208	15	5
3	S100	1 500	2	Plant	100	1313	15	5
4	S80P20	1 000	2	Plant	100	1389	15	5
5	P90S10	1 500	7	Natural	100	940	15	5

Comments:

The species composition is abbreviated by species (S = Spruce, P = Pine, B = Balsam) and the percent composition. For example, P80S20 is 80% pine and 20% spruce. See Section 2.8.5 for further information on operational adjustment factors.

2.7.6.2.2 Managed stands 13 to 32 years of age (regenerated from 1988 to 2007 for spruce and to 2010 for pine)

The 1987 legislation established basic silviculture obligations for Licensees, including the use of improved stock for planting. In the tenure, improved stock was only available for spruce.

The general yield assumptions for managed stands 11 to 32 years of age are as follows:

- *Regeneration delay for planted stands is two years and for natural stands is seven years.*
- *Genetic gain of 5% is applied to planted spruce; no genetic gain is applied to planted pine; and*
- *Standard operational adjustment factors – OAF 1 (15%) and OAF 2 (5%) will be used.*

Table 20. Example of TIPSY regeneration composition inputs for stands 13 to 32 years old

ID	Species Composition	Area (ha)	Regeneration Delay (yrs)	Regeneration Method Type	%	Initial Density (sph)	Operational Adjustment Factor OAF 1	OAF 2
1	P100	2 000	2	Plant	100	1429	15	5
2	P80S20	1 000	2	Plant	100	1210	15	5
3	S100	2 000	2	Plant	100	1450	15	5
4	S80P20	2 000	2	Plant	100	1370	15	5
5	P90S10	2 000	7	Natural	100	975	15	5

2.7.6.2.3 Managed stands younger than 12 years of age and all future managed stands.

After 2007, improved stock has been commonly used in the tenure, as such specific analysis units were created for these stands. Further, the regeneration assumptions derived for this period will be used as the assumptions for all future managed stands.

The general yield assumptions for managed stands younger than 12 years and for all future managed stands are as follows:

- *Regeneration delay for planted stands is two years and for natural stands is seven years.*
- *Genetic gain of 20% is applied to planted spruce and 9% to planted pine; and*
- *Standard operational adjustment factors – OAF 1 (15%) and OAF 2 (5%) will be used.*

The information for stands younger than 12 years was determined using information from the RESULTS database, specifically the 'Biological Regeneration Delay' report, which provides a consistent method to generate achieved biological date based on either the submission of planting information or forest cover submission for natural regenerated area. At the time of planting, the stock is 1 year old, on average.

Table 21 shows a summary of the regeneration assumptions for stands harvested since 2007. This summary shows 10 different regeneration categories that will be used to generate volume tables for current (post 2007) and future managed stands. There are about 10 000 hectares of managed stands less than 12 years of age within the THLB.

Table 21. Example of TIPSY regeneration composition inputs for stands younger than 12 years of age and all future stands

Original Composition	ID	Regeneration Species Composition	Regeneration delay (years)	Method		Initial Density	Operational Adjustment Factor	
				Type	%		OAF1	OAF2
B	1	P50S50	2	Plant	100	1509	15	5
B	2	S70P30	2	Plant	100	1509	15	5
B	3	S50P40B10	2	Plant	100	1509	15	5
S	1	P50S50	2	Plant	100	1555	15	5
S	2	S100	2	Plant	100	1555	15	5
S	3	P70S30	7	Natural	100	940	15	5
S	4	S70P30	2	Plant	100	1555	15	5
P	1	P50S50	2	Plant	100	1555	15	5
P	2	P100	2	Plant	100	1066	15	5
P	3	P90S10	7	Natural	100	940	15	5

Comments:

Original compositions were derived on classes based on the leading species of the previous stand. Several regeneration species composition types were identified within the three original composition types.

Species and densities were determined by analysis of the preliminary 'Planted Species' reports using the RESULTS database. This report produces a summary of the tree species and seedlot planted based on the parameters specified by the user. These initial reports were broken down by year to establish annual trends. The numbers were further analyzed by prorating densities and species compositions by area. The species percentages and densities reflected in this information package are a direct reflection of reporting in RESULTS.

2.7.6.3 Incremental Silviculture

In some tenures, incremental silviculture programs such as pruning or fertilization are practiced. Where this is the case, specify the nature and extent of the program and how it will be reflected in the base case. For example:

Recently, an intensive program of fertilization was implemented in the tenure. In the past decade, about 1000 hectares of immature stands have been fertilized. Most of these stands (about 900 hectares) were pine-leading older plantations (about 35 years old), although some natural spruce-leading stands aged between 50 and 70 were also fertilized.

In the base case, the yield of stands that have been fertilized will be increased. The yield increase will be provided by the Ministry's Resource Practices Branch based on the findings of fertilization trials conducted in British Columbia.

2.7.7 Forest Health

Insects, diseases, fire, animals and human activities can all affect the health of forests. Both old and young forests are susceptible to damage from forest health factors. Climate change has magnified the impacts to forest health. It is expected that there will be more severe fires, insect and disease outbreaks, and drought affecting the forests in BC.

For factors that kill significant areas of forest (e.g., fires, mountain pine beetle, other bark beetles, root diseases) the effects of these agents on the forest should be reflected in updated forest cover inventories. TFL holders are responsible for ensuring that forest cover inventories are regularly updated to reflect the current condition of the forest in the tenure (including recent harvesting).

There are other factors (e.g., rust, budworms, mistletoe) that affect tree growth and stem form but do not kill extensive areas of forest. In these cases, it is advisable to consult the Ministry's forest health experts and perhaps use TASS (see section 2.8.1.2) to model the effect of the damaging agent. If there is enough data properly collected, the experts may also suggest that OAFs (see section 2.8.5) be adjusted to better represent the effect on stand volume.

2.7.8 Unsalvaged Losses

Unsalvaged losses are those **endemic** losses of timber on the THLB resulting from factors such as fire, wind, insects, and disease that are not captured through decay, waste or breakage in VDYP or operational adjustment factors in TIPSY. Estimates of timber damage, less salvage, are made for the various categories of losses and this volume is subtracted from the volume ‘harvested’ by the timber supply model.

Epidemic or catastrophic losses should not be included in unsalvaged losses estimates. Their inclusion will exaggerate the losses and skew the analysis results. Epidemic losses incurred since the last inventory update should have been reflected in the inventory used for this analysis. Epidemic losses incurred during the period of this MP will be reflected in the updated inventory and in the next TSR. **This highlights the importance of keeping the inventory updated for harvesting as well as for other larger disturbances.**

The table below shows an example of endemic losses subtracted from the harvest projection for a typical Interior tenure:

Table 22. Example of non-recoverable losses

Cause of Loss	Total Loss (m^3 for the 2000–2020 period)	Annual Unsalvaged Loss (m^3/yr)
Blowdown	0	0
Spruce Bark Beetle	14 932	747
Balsam Bark Beetle	6 212	311
Fire	5 072	254

2.7.9 Resource Management Objectives

2.7.9.1 Objectives set by government

The overarching policy direction for the management of resource values within area-based tenures is described in higher level plans such as LRMPs. The operational direction for the implementation of some resource management objectives (such as landscape-level biodiversity) are provided by land use plans, and other important objectives are legally established under the *Land Act*. Resource management objectives for identified forest values are also legally established under the *Forest and Range Practices Act* and the *Government Actions Regulation (GAR Orders)*. Intended results and strategies in relation to objectives established under the Land Act or FRPA are specified in forest stewardship plans prepared by forest tenure holders.

The following sections describe the management objectives that are usually established to manage, protect and conserve the forest values found within the forest management land base of most tenures. Objectives that result in the exclusion of harvesting are addressed in the previous sections of this document, whereas those that require the retention of different forest characteristics across the landscape, but do not fully exclude harvesting, are addressed below.

2.7.9.2 Seral Stage Distribution

The goal of seral stage distribution is to maintain the diversity of seral stages and disturbance regimes found within various ecosystems. This diversity is important because the composition of plant and animal communities change as forest stands develop through time after a disturbance. Various life forms find their habitat requirements from different stages of forest development and most specialist species are associated with either the early herb/shrub stage or the mature to old seral stages.

Management objectives for seral stage distribution apply to biogeoclimatic (BEC) zones within each landscape unit and vary depending on the assigned biodiversity emphasis option. All seral stage requirements apply to the FMLB.

In this Interior example, to ensure stands do not age to infinity and in recognition of natural disturbances, stands located outside of the THLB in the SBS biogeoclimatic zone will have their age reset to 21 years after they reach 250 years old. Stands outside of the THLB in the ESSF biogeoclimatic zone will have their ages set to 21 years after they reach 350 years old. Resetting the age to 21 years, recognizes that these naturally disturbed stands are still considered to contribute to non-timber values, such as visual quality, after they have been disturbed. The maximum ages will vary depending on the BEC and natural disturbance type.

Table 23. Example of seral stage distribution requirements

Landscape Unit (Land base to which requirements applies)	Biodiversity Emphasis Option and BEC Zone	Early Seral		Mature plus Old Seral		Old Seral	
		Maximum Allowable Disturbance Area (%)	Age for Disturbance Allowable Area (years)	Minimum Retention Area (%)	Age for Retention (years)	Minimum Retention Area (%)	Age for Retention (years)
LU1 (FMLB)	SBS – Intermediate	30	<40	23	>100	11	>140
LU2 (FMLB)	SBS – Low	N/A	<40	11	>100	11	>140
	ESSF – Low	N/A	<40	14	>120	9	>250

It is strongly advised to show the current seral stage distribution of the forest in each LU in the IP. This will help tenure holders, reviewers and decision-makers understand where the requirements are binding (where some innovative forest practices may be needed) and will help explain changes in harvest flow when sensitivity analyses are performed in the timber supply analysis.

2.7.9.3 Adjacency, green up and patch size distribution

Cutblock adjacency and patch-size distribution are used to ensure that the structural characteristics left after harvest is consistent with the temporal and spatial distribution of an opening that would result from a natural disturbance. This is an important consideration for values related to hydrology and landscape level biodiversity.

Requirements for harvesting adjacent to an existing cut block are set through the *Forest Planning and Practices Regulation (FPPR)*. The FPPR specifies that timber must not be harvested on a new cut block unless the tallest trees on a minimum of 75 percent of the net area to be reforested on all existing adjacent cut blocks are at least 3 metres in height. There are circumstances when adjacency requirements are not applied, such as for salvage harvest and applying patch size distributions consistent with biodiversity directions. A detailed description of the circumstances must be provided if adjacency is not applied in the base case.

Table 24. Example of cutblock adjacency requirement

Zone or Group	Maximum allowable disturbance (% area)	Green-up height (metres)	Land base to which requirements apply
Cutblock Adjacency	25%	3 m	THLB, by landscape unit

2.7.9.4 Landscape Connectivity: Landscape Corridors

Landscape corridors are established to link distinct patches of older forests and important ecosystems that facilitate the dispersal of plants and animal species from patch to patch. In this example, landscape corridors have been spatially identified and management objectives have been established through the LRMP.

Table 25. Example of forest cover requirements in landscape corridors

BEC Zone	Analysis Units	Minimum Area Retained (%)	Age for Retention (years)	Land base to which requirement applies	Area (hectares)
SBS	Conifer leading	> 70	≥ 70	FMLB, by legal feature	7 844
ESSF	Conifer leading	> 70	≥ 100	FMLB, by legal feature	658

The objective set by government for connectivity is to "maintain, within a managed forest setting, landscape corridors dominated by mature tree cover and containing most of the structure and function associated with old forest by: (1) providing habitat connectivity within the landscape and (b) permitting movement and dispersal of plants and animal species". In approved FSPs and operationally, within the landscape corridors this objective is managed by:

- *restricting cutblock size to an average of 2 hectares with opening size not exceeding 3 hectares.*
- *avoiding new permanent access; and*
- *maintaining over 70 percent of the FMLB in the SBS in stands greater than 70 years old and in the ESSF in stands greater than 100 years old.*

In this analysis, a forest cover requirement will be used to reflect the current management practice objective of maintaining 70 percent of the FMLB in older stands. It is assumed that cut block size and new permanent access are to be met operationally without timber supply implications.

2.7.9.5 Wildlife Habitat

The LRMP identifies areas for the winter survival of moose and deer and the survival of grizzly bear and the *FPPR* requires the conservation of sufficient habitat for these species. Current performance in this example related to wildlife habitat requirements will be modelled according to the criteria in Table 25. These criteria are consistent with the notices issued under section 7 of the *FPPR* for species at risk in the District and established ungulate winter ranges (UWR) in the TSA.

Table 26. Example of forest cover requirements for wildlife habitat

Species	Maximum Allowable Disturbance (% area)	Minimum Green-up Age (years)	Minimum Retained Area (%)	Minimum Age for Retention (years)	Landbase to which requirement apply	Area (hectares)
Deer	≤ 33%	< 17 years			THLB	347
			≥ 50%	> 101 years	FMLB	1 920
Moose	≤ 33%	< 17 years			THLB	1 234
			≥ 30%	> 101 years	FMLB	3 818
Grizzly	≤ 33%	< 28 years			THLB	979
	≤ 50%			< 121 years	FMLB	1 355

2.7.9.6 Visual Quality

The natural beauty of British Columbia is valued by both residents and tourists. The Government of British Columbia is entrusted with ensuring that the scenic quality expectations are met.

In most tenures scenic areas are usually designated for visual quality management. Within these areas, visual quality objectives (VQOs) are established based on physical attributes such as topography and social attributes such as viewer expectations. VQOs ensure that forestry activities are managed so that the size, shape, and location of cut blocks and roads fit with the landscape's natural character.

Within a scenic area one or more visual quality objective may apply. A VQO represents the prescribed extent of forest alteration resulting from the size, shape, and location of cut blocks and roads. Table 26 describes the categories of visually altered landscapes that may apply.

Table 27. Categories of visually altered forest landscape

Categories of visually altered forest landscape	Definition
Preservation	Altered forest landscape in which the alteration is: (i) very small in scale, and (ii) not easily distinguishable from the pre-harvest landscape
Retention	Altered forest landscape in which the alteration, is (i) difficult to see, (ii) small in scale, and (iii) natural in appearance
Partial Retention	Altered forest landscape in which the alteration is (i) easy to see, (ii) small to medium in scale, and (iii) natural and not rectilinear or geometric in shape
Modification	Altered forest landscape in which the alteration (i) is very easy to see, and (ii) is (A) large in scale and natural in its appearance, or (B) small to medium in scale but with some angular characteristics
Maximum Modification	Altered forest landscape in which the alteration (i) is very easy to see, and (ii) is (A) very large in scale, (B) rectilinear and geometric in shape, or (C) both.

Operationally, the management of visual quality objectives for a scenic area is based on meeting requirements from specific viewpoints (i.e., a perspective view); however, for strategic modelling, such as timber supply analysis, these objectives must be translated to a planimetric ("plan") view. To model in a plan view, visual management specialists in the ministry have developed procedures that are described in the *Procedures for Factoring Visual Resources into Timber Supply Analyses*, and the update bulletin, *Modelling Visuals in TSR III*.

The information package should summarize the results of applying the ministry's procedures to the management unit, including the applicable visually effective green-up (VEG) heights, plan-to-perspective (P2P) ratios and the maximum percent planimetric alteration by VQO category as described in the two documents listed above.

2.8 Growth and Yield

Knowledge of the timber volume available from a forest stand over time is a critical input for timber supply modelling. Growth and yield models are used to generate the volume estimates based on the characteristics of the forest stand.

British Columbia has a strong history in growth and yield modelling. The various models have been important to improving strategic decision making and understanding of the management of British Columbia's forest resources.

For most analyses, two of the Ministry's growth and yield models are commonly used. The model variable density yield prediction (VDYP) was specifically developed to project the mature forest inventory. The model TIPSY, on the other hand, is suitable for projection based on known regeneration characteristics.

To enable modelling of the volume available from a forest stand over time, volume tables are created based on common forest stand inputs, growth characteristics, and the most suitable growth and yield model. Volume tables where detailed input information is available may be based on information at a forest polygon or silvicultural opening level; however, where detailed information is not available a volume table may reflect the average characteristics of a group of stands.

2.8.1 Growth and yield models

2.8.1.1 Variable density yield prediction model (VDYP)

The variable density yield prediction (VDYP) model, developed by the Ministry, is an empirical growth model that is based on a large temporary (52 000 plots) and permanent (9300 plots) sample plot database collected from mature natural forests in British Columbia. Decay, waste and breakage estimates are incorporated within VDYP and are based on BEC loss factors using a decay sample tree database, which consists of more than 82 000 trees.

VDYP7 is the latest version of the model used by the Ministry for projecting British Columbia's forest inventory estimates. Input information for VDYP7 is based on VRI attributes, typically at the individual forest polygon level.

Information on VDYP is available at http://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/growth-and-yield-modelling/variable-density-yield-projection-vdyp.

2.8.1.2 Table interpolation program for stand yields (TIPSY)

The table interpolation program for stand yields (TIPSY) model provides yield tables for single-species and even-aged stands based on the interpolation of yield tables generated by the individual tree growth model tree and stand simulator (TASS). Mixed species yield tables generated by TIPSY are weighted averages of single-species yields and do not directly consider inter-species interactions.

Input information for TIPSY is based on stand initiation characteristics including species, initial density, regeneration method (planted or natural), genetic gain, and potential site index. TIPSY also enables consideration for various silviculture treatments, forest health, and general operational adjustment factors. Yield tables developed should indicate the version of the models used to generate those tables.

Information on TIPSY 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.

TASS II, developed by the Ministry, is an individual tree-level model for commercial species of British Columbia. TASS II predicts the potential growth and yield of even-aged and single species stands by modelling individual tree crown dynamics and the crown relationship to bole growth and wood quality. The individual tree and crown focus makes TASS II well suited for predicting the response to many silviculture treatments and the exploration of stand dynamics. TASS III is a recently released version that extends TASS into more complex stand structures including multiple-species and multi-age cohorts; however, the current number of species modelled by TASS III is rather limited.

Information on TASS is available at https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/growth-and-yield-modelling/tree-and-stand-simulator-tass.

2.8.2 Volume table types

Volume tables are an important data input for modelling timber supply forecasts with a forest estate model. Volume tables provide the projection of current forest conditions into the future. These tables may be derived for specific or aggregated forest polygons.

In the example used in this document, a more traditional aggregation of forest polygons into a smaller number of analysis units was described.

Examples of existing natural stand analysis units are described in Table 3. The volume tables for these unharvested analysis units would be a weighted average of individual VDYP-based volume tables generated for each forest polygon based on its existing forest inventory attributes.

Examples of managed stand analysis units are described in Tables 19, 20 and 21 for stands that have been harvested since 1965. These analysis units would use inputs based on an aggregation of RESULTS planting records and associated information to generate TIPSY-based volume tables for the current stands. In some forest estate models such as Woodstock, an analysis unit can be assigned multiple volume tables that have an associated weight. For example, in Table 3 for the analysis unit NSG, 82% of the stands will have the volume table based on species composition P50S50, 7% based on P70S30, 10% based on S70P30, and 1% S100.

Table 3 also identifies the regeneration input to derive the future volume tables for each analysis unit. This input is based on an aggregation of the RESULTS planting records for managed stands regenerated from 2008 to 2017.

Detailed suggestions on how to report regeneration assumptions for the base case are outlined in Section 2.7.6.

2.8.3 Site index

For a particular species, site index is the height of the largest diameter site tree at a breast height age of 50 years. It is the most common measure of forest site productivity used in British Columbia. The growth and yield models TASS and TIPSY require potential site index as a necessary input to develop volume yield tables.

The Ministry has developed formalized standards for deriving site index for the potential productivity of a site. Site indices based on simpler methods (e.g., age and height relationships for forest inventory photo classification) often have biases that result in difference from the potential site index.

It is recommended to use potential site indices based on the FLNRORD provincial layer of site productivity. Describe the method used to estimate the site index such as SIBEC (site index estimates tied to site series from predictive ecosystem mapping or terrestrial ecosystem mapping) or other methods.

2.8.4 Tree improvement

Licensees are obliged to use the best available seed source when regenerating sites with planted stock. As a result, planted stock usually grow faster than natural seedlings that may regenerate on the harvested site. The faster growth may be due to either use of high-quality genetically improved seed (Class A seed) obtained through traditional tree breeding within seed orchards or use of seed harvested from superior wild trees (Class B+).

Information on the availability and characteristics of select seed and the associated genetic gains are available from the Seed Planning and Registry (SPAR) application of the Forest Improvement and Research Management Branch (see https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/tree-seed/seed-planning-use/spar). RESULTS information provides the source of seed used for individual plantations and thus enables a linkage to the genetic gain database.

This part of the IP may be used to provide a summary of the history of improved seed planted in the tenure, such as: since 2007, 100 percent of the spruce seedlings planted are from class A seeds with an estimated average gain of 20 percent. The planting of genetically improved pine seedlings began in 2009 and about 64 percent of the pine seedlings currently planted are from genetically improved seed with an estimated weighted average gain of 9 percent. The average gain for spruce and pine applied to future managed stands will be determined by extrapolating orders from planting years 2007 to 2020.

2.8.5 Operational adjustment factors

Yield projections in TIPSY are based on potential yields of a healthy stand where the site is fully occupied. Because a stand may not fully occupy a site or be able to reach its potential growth (e.g., due to forest health issues), it is necessary to adjust the potential yields of TIPSY to reflect an operational yield.

In TIPSY, there are two operational adjustment factors (OAFs) that are used to modify the potential yields. These OAFs differ in their application. OAF 1 is a static reduction across all time periods and, for example, may reflect non-productive openings within a forest. OAF 2 is dynamic reduction that increases over time and, for example, may reflect a forest health issue that increases as a stand grows older. Standard OAF values of 15% for OAF 1 and 5% for OAF 2 should be used unless localized OAFs have been developed and approved by Forest Analysis and Inventory Branch.

2.9 Forest Estate Modelling

2.9.1 Forest Estate Model

State which forest model will be used for this analysis. A short description of the model will also be useful for the reader and reviewer.

See Appendix 4 for a discussion on timber supply modelling at FAIB.

> **Base case harvest flow**
>
> The base case is chosen to avoid both excessive changes from decade to decade and significant timber shortages in the future, while ensuring the long-term productivity of forest lands.
>
> The base case projection provides a baseline harvest flow from which the AAC decision maker can understand the dynamics of timber supply in the management unit **given current forest management assumptions**.
>
> Marginal or intended practices **must not** be reflected in a base case.

2.9.2 Base Case

Several harvest flows based on different procedures to generate the harvest flow are possible. FAIB recommends to first find the highest flat line (even flow) possible and then increase the short term only if it can be done without lowering the highest even flow. In most cases this will allow for a range of possible short-term harvest flows. Analysts may also be able to find a number of possibilities for increasing the long-term harvest level. From this range of possible projections, one is chosen that attempts to avoid both excessive changes from decade to decade and significant timber shortages in the future, while ensuring the long-term productivity of forest lands. This is known as the base case projection and it provides a baseline harvest flow from which the AAC decision maker can understand the dynamics of timber supply in the management unit given current forest management assumptions.

There should be no expectation that the current AAC level will be maintained. Even though the base case is a reference point, it needs to be recognized that the AAC determination is an informed decision by the designated decision maker that considers multiple sources of information.

2.9.3 Sensitivity Analysis

> **Sensitivity Analysis**
>
> The effect of marginal or intended practices on timber supply may only be examined in sensitivity analysis.

Sensitivity analysis can help to understand the implications of uncertainty around data and management assumptions and can be used to determine which variables have the greatest effect on harvest forecasts. Specific issues can also be investigated to enhance understanding of possible impacts on timber supply. Table 27 lists some sensitivity analyses that are usually performed in a timber supply analysis. Further sensitivity analyses may be completed as needs are identified.

Table 28. Proposed sensitivity analyses

Issue to be tested	*Sensitivity Levels*
Marginally economic stands	*Some portions of the legally harvestable land base might be considered for harvesting if lumber prices are high enough*
Managed Stand Volumes	*±10% of the managed stand volume tables or some other value where the magnitude of the uncertainty can be estimated*
Natural Regeneration	*Increase percentage of future analysis units regenerated naturally by 10% or some other value where the magnitude of the uncertainty can be estimated*
Minimum harvestable criteria	*Decrease or increase minimum harvestable volume/age requirement to reflect uncertainty in the practice*

3 TIMBER SUPPLY ANALYSIS

The timber supply analysis report is a part of the management plan. It explores the short- and long-term availability of merchantable timber within the tenure and considers how management practices affect the availability of timber.

It is assumed that the IP was reviewed by all relevant parties and that the IP was updated to reflect those comments. The data and assumptions in the updated IP will form the basis for the timber supply analysis.

3.1 INTRODUCTION

Government agencies and some expert reviewers will have access to the updated IP, but most other reviewers will not; therefore, repeating some of the information contained in the IP in the analysis report (AR) enables those reviewers to more easily understand the analysis and to offer informed comments.

Here is an example of a typical introduction in an analysis report:

> *The tenure holder is in the process of preparing Management Plan xx, which is due for approval by June 21, 2021. The tenure is administered through the 100 Mile House Natural Resource District Office within the Cariboo Region. As part of the MP process, a timber supply analysis was conducted to examine the short- and long-term effects of current forest management practices on timber available for harvest.*
>
> *The timber supply analysis provides projections of future harvest levels given the ecological, social and economic factors in the tenure area. The analysis accounts for both timber and non-timber values and attempts to ensure that timber harvest rates are balanced against social and ecological values such as wildlife, biodiversity, watershed health, and recreational opportunities.*
>
> *An Information Package providing detailed technical information and assumptions regarding current forest data, management practices, policy and legislation for use in this analysis was published on September 15, 2020. An updated Information Package that reflects changes made in response to the public review is included in this submission. The information package provides details on the data inputs and assumptions used in this analysis.*
>
> *This Analysis Report summarizes the results of the timber supply analysis for the base case that reflects current management practices and the best available data. A detailed description of the data and management practices modelled in the base case is contained in the updated IP. The AR also includes alternative harvest flows as well as several sensitivity analyses to provide insight into how timber supply may be affected by changes in data or management practices.*

3.2 DESCRIPTION OF THE TENURE

Here it is appropriate to provide a description of the tenure similar to the one in the IP. This could be quite brief because the updated IP is included as Appendix 1 to the AR. This is an example of a short description for a tenure:

The tenure, located in north-central British Columbia, encompasses approximately 77 450 hectares of land (see Figure XX). The tenure contains tributaries of the Nechako River as well as five lakes used for recreation.

The terrain of the tenure is typical of the Nechako plateau portion of the central interior of British Columbia. The climate is characterized by seasonal extremes of temperature, including severe and snowy winters, and relatively short and warm summers. The ecosystems support forests dominated by lodgepole pine, hybrid spruce and subalpine fir (balsam).

The tenure is located to the north of the community of Vanderhoof, a municipality of approximately 8,000 people. Approximately 80% of the tenure is Crown land (Schedule B) and the remaining 20% is municipal land (Schedule A).

3.3 First Nations

This section should contain information regarding First Nations with asserted traditional territory and any associated interests or treaty rights within the the area of the tenure. The IP should describe the engagement with those Nations and include a description of any specific commitments in the management plan intended to address concerns raised by First Nations.

3.4 Current state of the Forest

This section of the analysis report contains a comprehensive description of the current state of the forest. Maps, tables and graphs are very helpful for describing the current conditions. A detailed description of the current state also helps in understanding the harvest flow projections and sensitivity analyses. As most of the graphs will be about the forest management land base (FMLB) and timber harvesting land base (THLB), it will be useful to start by providing the netdown table found in the updated IP.

The following description of the forest is an example:

The total area within the tenure's geographic boundary covers 77 450 hectares; however, some of this land base is not considered to be available for timber supply purposes. This includes areas such as non-forest and non-productive areas. The remaining forested area, commonly called the FMLB, is 63 567 hectares. Further, about 69 percent of the FMLB is identified as suitable for timber harvesting. This area of 43 634 hectares is referred to as the THLB. Table 29 shows the updated netdown table for the base case.

The FMLB of the tenure has relatively large areas of young forest resulting from harvesting activities and fires during the past several decades. Figure 3 shows the current age class distribution of the forests in the FMLB by THLB and non-THLB. The graph shows an uneven age-class distribution with the lowest amount of forest in the 60- to 100-year age category. Because there is not anything that can be done to increase the amount of forest in this age category, it will likely lead to a 'pinch point' in timber supply in 30 to 60 years from now. The large amount of non-THLB in older age classes contributes to meeting many of the non-timber objectives.

The forests on the THLB are primarily composed of lodgepole pine- and spruce-leading stands. There are also smaller amounts of balsam-leading stands and deciduous-leading stands (i.e., aspen and cottonwood). Figure 4 shows the current area and volume distribution of forests in the THLB. The total THLB volume is 4.2 million cubic metres with 3.7 million cubic metres being from coniferous-leading stands.

Table 29. Example of the updated land base classification summary

Land Classification	**Total area (hectares)**	**Forested area (hectares)**	**Net area (hectares)**	**% of total area**	**% of FMLB**
Total Area	**77 450**			**100**	
Land not managed by the tenure holder	4 643		4 463	6.0	
Non-forested and non-productive	8 285		8 285	10.7	
Roads, trails and landings	1 611		955	1.2	
Total Forest Management Land Base	**63 567**			**82.1**	**100**
Parks and Protected Areas	2 500	2 488	2 488	3.2	3.9
OGMA	4 864	4 788	977	1.3	1.5
Wildlife habitat reserves	6 010	5 166	3 037	3.9	4.8
Red- and blue-listed communities and hydro-riparian ecosystems	3 500	2 604	1 200	1.5	1.9
Total Legally Harvestable Land Base	**55 865**			**72.1**	**87.9**
Inoperable areas	2 886	2 589	855	1.1	1.3
Low productivity sites	1 890	1 430	693	0.9	1.1
Problem forest types	9 000	7 125	2 700	3.5	4.2
Riparian areas	3 763	2 890	2 356	3.0	3.7
Wildlife tree retention areas	7 561	5 551	1 200	1.5	1.9
Cultural heritage resources	1 230	1 000	427	0.6	0.7
Terrain stability	11 000	9 800	4 000	5.2	6.3
Total Current Reductions			**19 933**	**25.7**	**31.4**
Timber Harvesting Land Base	**43 634**			**56.3**	**68.6**
Future Reductions					
Future roads, trails and landings			410	0.5	0.6
Future wildlife tree retention			894	1.2	1.4
Future Timber Harvesting Land Base	**42 330**			**54.7**	**66.6**

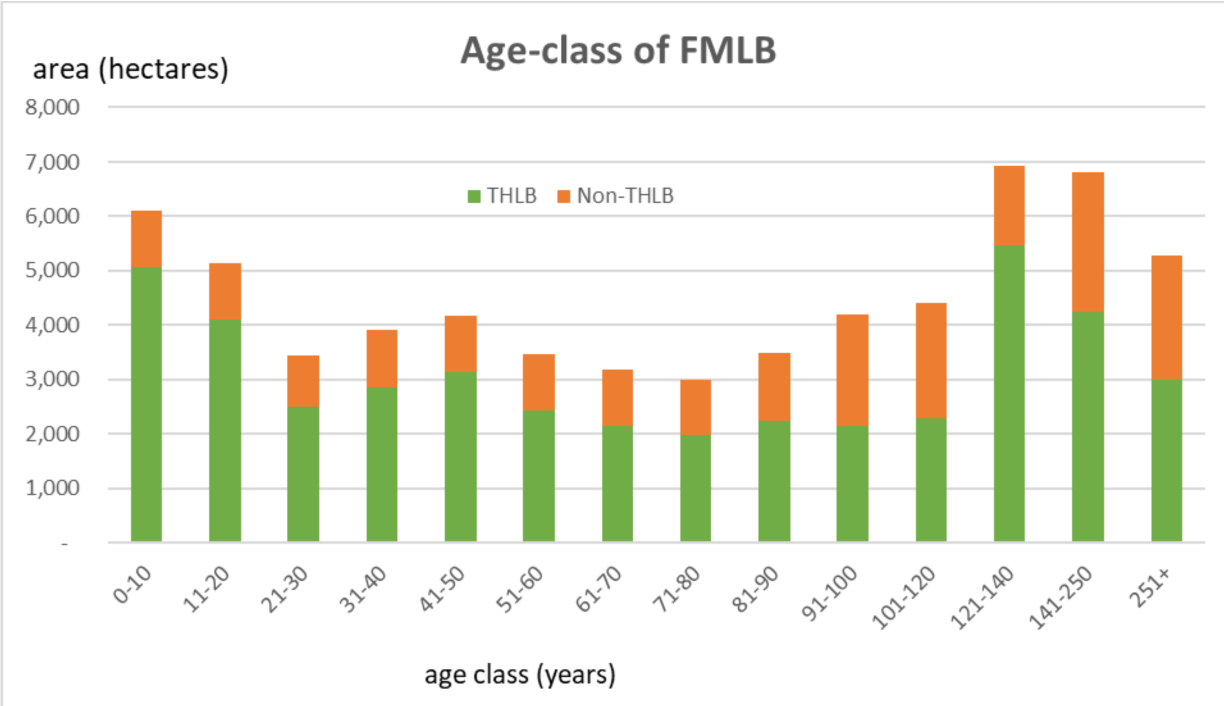


Figure 3. Example of an age-class distribution of the forest management land base in a tenure.

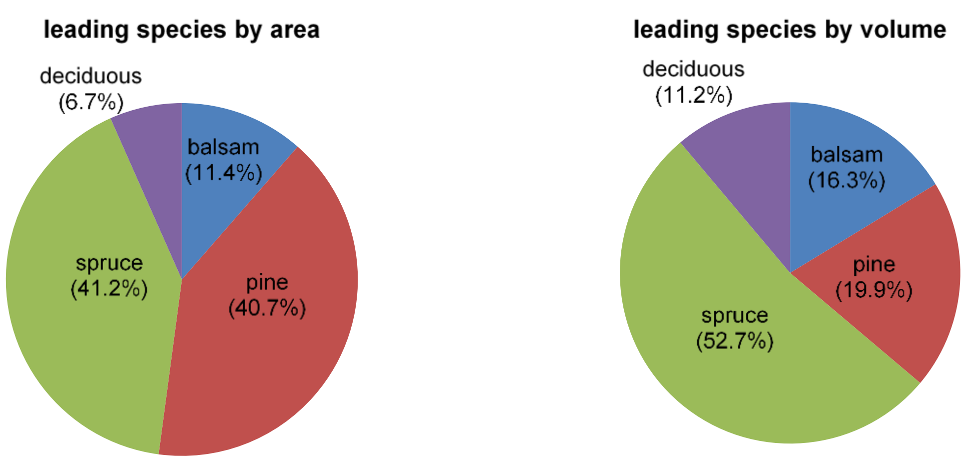


Figure 4. Example of the area and the volume by leading species for the FMLB in a tenure.

Figure 5 shows an example of a description of the current forest conditions in a Coastal unit:

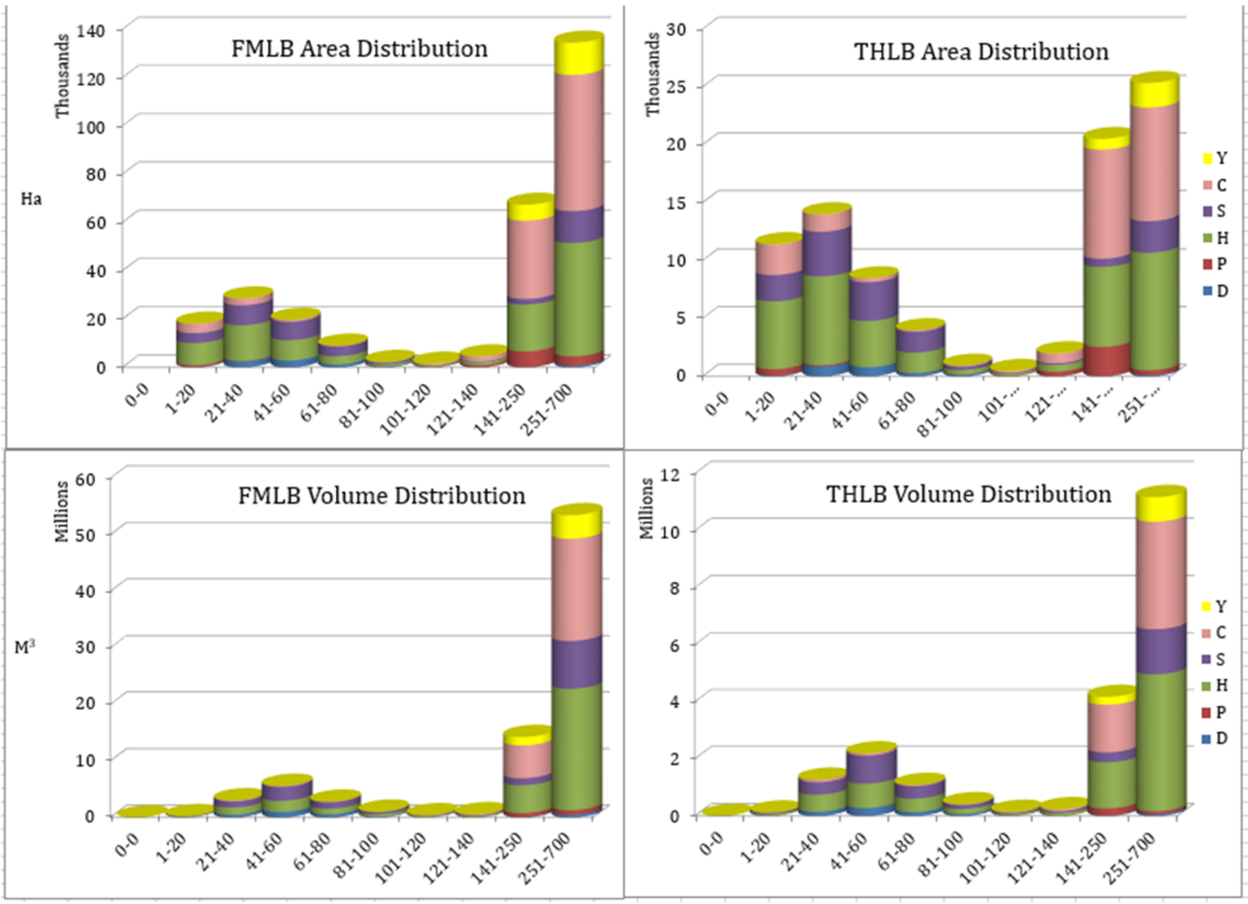


Figure 5. Example of area, volume and species composition by age class for the FMLB and THLB

The example in Figure 5 combined the species distribution along with the volume and area by age class for the FMLB and the THLB. Closer examination of the Y axis in the upper part of the graph scale indicates that the THLB is a rather small part of the FMLB. Looking at the THLB area and volume graphs, it can be seen that harvesting will have to be from the older age classes for about 60 years until the younger forest reaches maturity.

One can also see that the mature volume contains cedar and hemlock in roughly equal proportions, so one would expect the harvest to reflect this species composition.

Further, the Ministry has been monitoring actual harvest practices of Licensees to see whether they substantiate what was assumed in the TSR. For every TSA and TFL, the Ministry produces a *"Timber Management Goals, Objectives & Targets"* report, which compares key assumptions in the TSR to actual practice. If, for example, the base case projects that balsam on steep slopes accounts for 15 percent of the volume harvested, then this should be reflected in the harvest monitoring report.

Failure to adhere to the base case assumptions generally leads to a reduction in timber supply and to the AAC. **The base case must reflect current practice.**

3.5 History of the AAC and harvest performance

This section of the report gives the reader some context about what occurred in the recent past. It also gives the reader a benchmark for evaluating the base case and proposed AAC. A table or graph with a general description or explanation of the information presented is usually sufficient. Table 29 shows an example of this information for a typical small tenure that experienced significant pine mortality from the recent mountain pine beetle epidemic.

Table 30. AAC and harvest history for the tenure.

Year	*AAC (m^3)*	*Harvest*	*Live Volume*	*Dead Volume*
2012	*30 000*	*29 500*	*10 300*	*19 200*
2013	*30 000*	*30 000*	*14 500*	*15 500*
2014	*30 000*	*28 200*	*15 000*	*13 200*
2015	*27 000*	*27 000*	*17 800*	*9 200*
2016	*27 000*	*26 480*	*18 000*	*8 480*
2017	*27 000*	*26 900*	*18 200*	*8 700*
2018	*27 000*	*26 000*	*20 100*	*5 900*
2019	*27 000*	*24 750*	*24 750*	*0*
2020	*27 000*	*25 500*	*25 500*	*0*

In 2010, the AAC was set at 30 000 cubic metres and it limited the harvest of live volume to no more than 15 000 cubic metres. A new AAC of 27 000 cubic metres was set in 2015. This AAC removed the limit on live volume harvested because most of the dead pine stands were already salvaged or had become un-useable.

3.6 Major changes since the last AAC determination

This component of the IP should indicate whether there were any major changes to the tenure that could affect timber supply since the last AAC determination. Generally, this involves any significant land additions or deletions from the tenure and may include any newly established GAR Orders or other management objectives. Acquisition of more accurate forest inventory or better estimates of site productivity could also affect timber supply.

3.7 Base Case

Several harvest flows are usually developed and among them one is chosen that best reflects the latest information available and current management practices employed within the tenure. This harvest flow is known as the base case. The process of establishing the base case varies among analysts and the timber supply model used.

Most analysts start by running the model without applying the forest cover requirements for non-timber values just to see whether the model is working as expected. Then, by turning the requirements on separately, one can have a good idea where the 'pinch points' in timber supply may be.

Analysts also usually calculate the long run sustained yield (LRSY) to have an idea of how much timber may be available for harvesting in the long term and thus set the level of the harvest target for the timber supply model. For timber supply to be sustainable, the rate of harvest must be less than or equal to the rate of growth of the forest. The LRSY is obtained by multiplying the rate of growth or culmination mean annual increment (CMAI), expressed as the volume per hectare per year, by the size of the future THLB. The LRSY is a theoretical number because it assumes that each stand is harvested at the age it reaches the maximum or culmination MAI. In actual practice as well as in the model, some stands are harvested well after the culmination age because they were needed to satisfy forest cover requirements. Also, some stands are harvested before culmination age because they meet the merchantable criteria and are needed to meet the harvest request.

Timber supply sustainability

For timber supply to be sustainable, the rate of harvest must be less than or equal to the rate of growth of the forest. Sustainability implies that over time, timber supply can be maintained or enhanced while conserving and managing all other forest values.

The harvest flow procedure recommended by FAIB is to first find the highest flat line (maximum even flow), and then increase the short-term harvest only if it does not result in a harvest level that is below the maximum even flow. Similarly, the analyst may increase the long-term harvest if it does not lower the maximum even flow.

Increasing the short-term by 'borrowing' from the mid-term will lead to the harvest falling below the maximum even flow in the near future. **This practice is not recommended because it can be interpreted that the harvest is not sustainable. The AAC decision is a stewardship decision; it is not about maximizing net present value.**

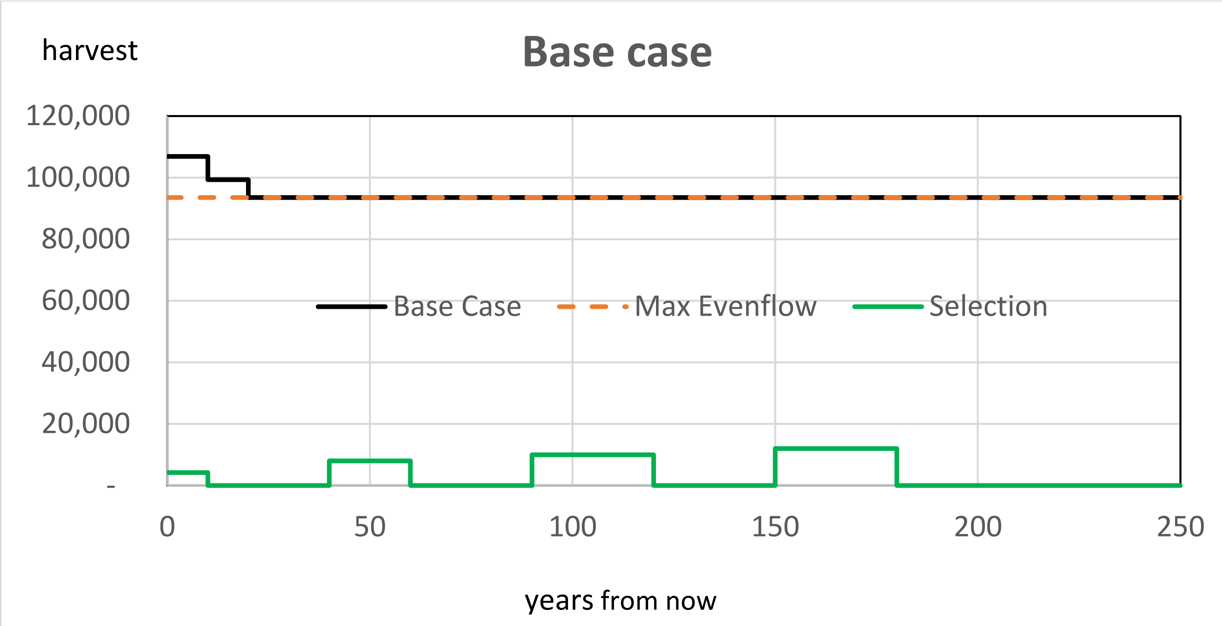


Figure 6. Base case showing maximum even flow projection and contribution from selection harvesting

In the above example, it was possible to increase the short-term harvest for twenty years without lowering the maximum even flow projection; however, it was not possible to increase the long-term harvest because there were not sufficient existing managed stands to allow some of them to grow much beyond their culmination age and increase the volume harvestable in the long term. Figure 6 shows a harvest forecast horizon of 250 years. Although no one can predict what will happen in the future and forest practices may change, this harvest projection is saying that this will be the timber supply if all the assumptions in the base case remain true in the future. This is about demonstrating sustainability of timber supply to all interested parties. Note that year 0 in Figure 6 is the year to which the forest inventory was updated (volumes projected and all depletions such as harvesting and fires included).

Also shown in Figure 6 is the contribution from selection harvesting to both the base case and the maximum even flow harvest projections. The management practice in these stands is to remove 25 percent of the volume every 30 years.

3.8 Base case diagnostics

After the base case is introduced, there should be several diagnostics presented to help the reader understand why the base case looks the way it does. The following key diagnostics are usually presented, which may help the decision maker to accept the base case as a reasonable starting point for making an AAC decision for the tenure. The analyst is encouraged to present additional diagnostics to illustrate characteristics specific to the tenure.

3.8.1 Growing stock

As mentioned earlier, the AAC decision is a stewardship decision. The decision maker needs evidence that there is sufficient growing stock in the tenure to adequately maintain the forest in perpetuity. Ideally, the total growing stock should stabilize at a reasonable level in the mid to long term. A stable growing stock indicates that the rate of harvest is equal to the rate of growth. A decreasing growing stock means that the harvest rate is greater than the rate of growth and is therefore unsustainable. Figure 7 shows the total and merchantable growing stock on the portion of the THLB being managed for clearcut harvesting. Merchantable growing stock is that portion of the total growing stock that meets or exceeds the minimum merchantability requirements specified in the IP.

Figure 7. Example of total and merchantable growing stock for the THLB managed for clearcut harvesting.

3.8.2 Stand type composition of the base case harvest

It is also useful to show the types of stands that will be harvested over the forecast horizon. This gives the reader an idea of how and when the harvest transitions from older stands to younger stands.

The example in Figure 8 shows that the harvest will be mainly from existing old forest for the next two decades. Existing managed stands are already harvestable because of the relatively long harvest history in this tenure and this allows the initial harvest level to be increased to 106 884 cubic metres per year. Future managed stands will comprise the bulk of the harvest by decade seven. Older stands will continue to be harvested because of the selection harvesting and the effect of requirements delaying the harvest beyond the minimum harvest age.

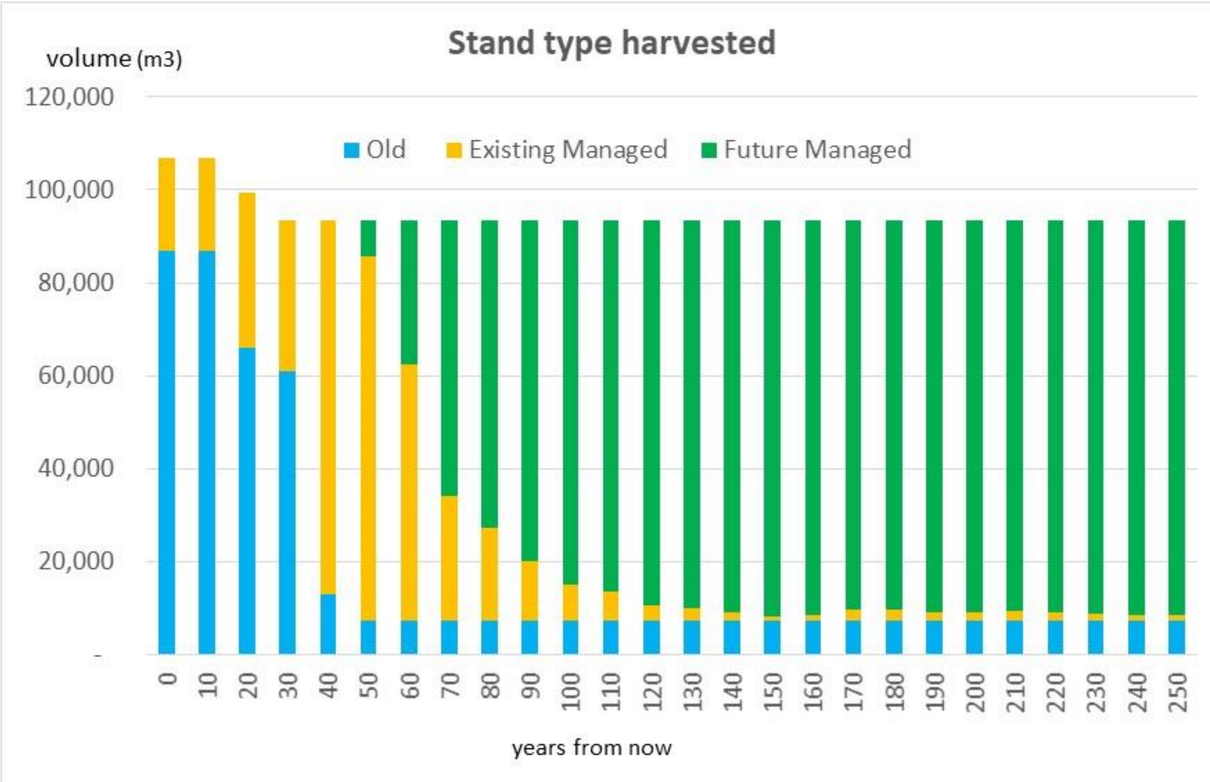


Figure 8. Example of volume composition by stand type harvested for base case

3.8.3 Average age and volume harvested

These diagnostics should complement what was shown in Figure 8. The older stands should have higher volume and as the harvest moves to younger stands the average volume should decrease. In analyses that provide data to show that the site productivity of the forest is greater than shown in the forest cover inventory, and where the genetic gain of regenerated stands is significant, the average volume per hectare of future managed stands may be higher than existing old stands. Figure 9 shows a typical age and volume composition of the stands being harvested in a tenure that did not plant stock with significant genetic gains on more productive sites.

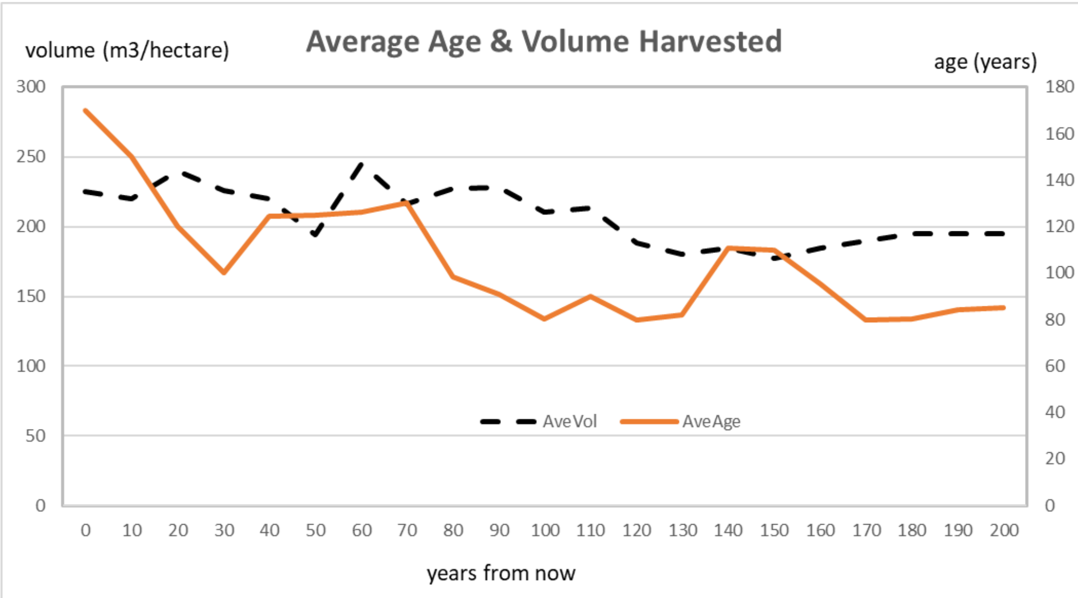


Figure 9. Example of average age and volume of stands harvested in the base case.

3.8.4 Average area harvested

Average area harvested should also complement the age and volume harvested. For a given volume harvested, older, higher-volume stands would require less area harvested than younger, lower-volume stands. Figure 10 confirms the story being told by Figures 8 and 9. As mentioned in the previous section, there may be cases where the average volume per hectare of future managed stands is greater than the average volume from existing older stands.

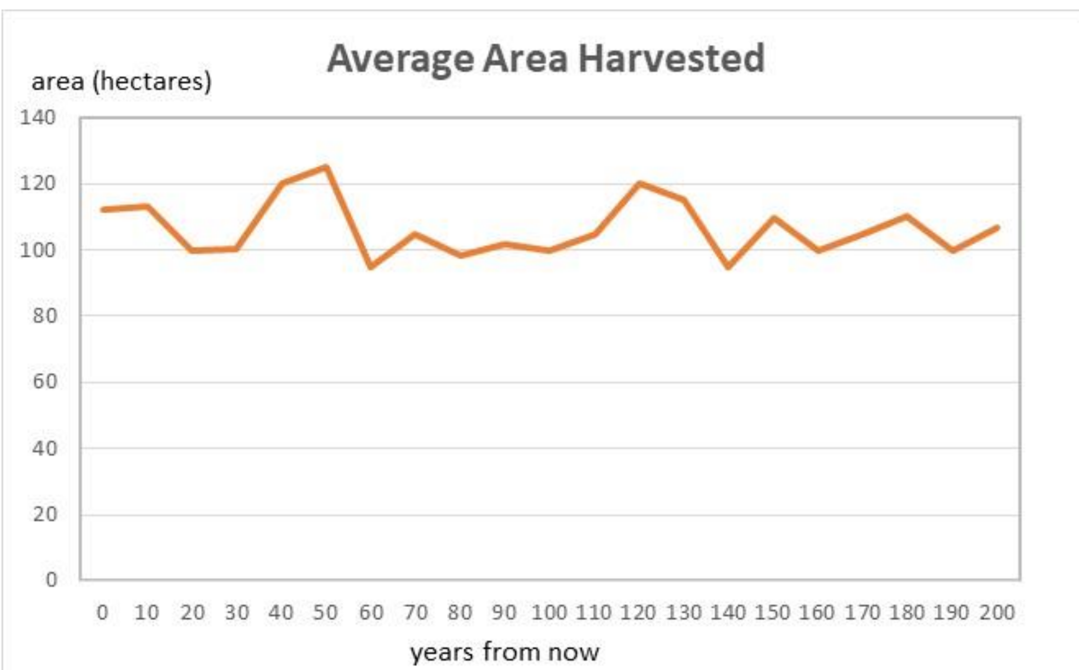


Figure 10. Example of average area harvested by clearcut harvesting.

3.8.5 Seral stage composition of the forest over time

Figure 11 shows the current and future seral stage distribution of forest on the THLB assuming the base case harvest forecast is followed. The current proportion of young forest (age 0 to 20 years) decreases as the tenure is steadily harvested and regenerated. After about 100 years, young forest accounts for about 10 percent of the area of the THLB.

The proportion of old (81 to 140 years) and very old (greater than 140 years) forest gradually decreases because harvesting is mainly from these areas during the first 50 years. By year 80, the proportion of old forest increases and remains stable for the remainder of the harvest forecast.

Some analysts present this information by showing the age class distribution of the THLB at selected intervals over time. The presentation in Figure 11 is probably more effective in conveying this information.

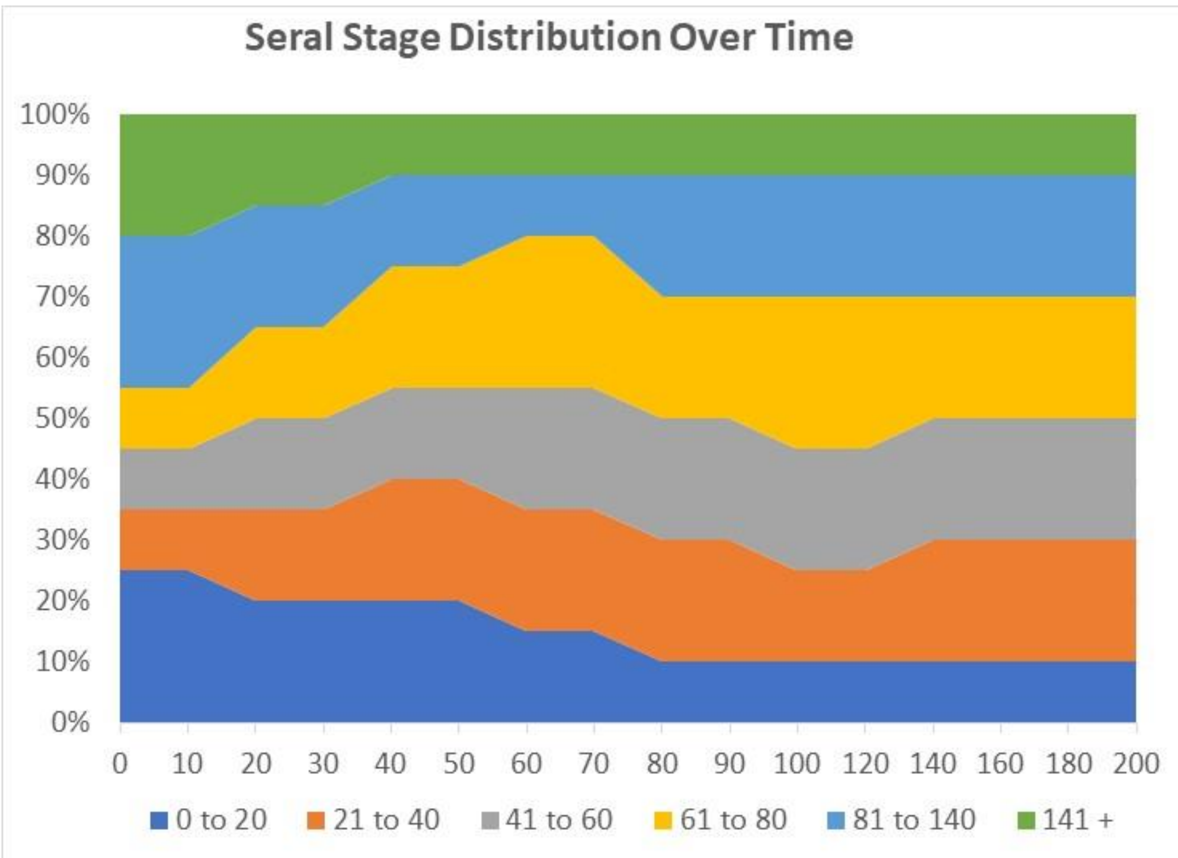


Figure 11. Example of seral stage distribution over time on the THLB

3.8.6 Other diagnostics of the base case harvest forecast

If there are other concerns specific to the tenure about the composition of the harvest, such as species harvested, terrain logged or haul distance, then this part of the report should include graphs similar to Figure 11 showing their contribution to the base case forecast. This allows the Licensee to compare actual performance to the base case assumptions to demonstrate whether the analysis assumptions are being followed.

This part of the report can also be used to show the condition of some non-timber values. Figure 12 shows an example of a scenic area where the current amount of disturbance exceeded the maximum allowed and how its condition changed during the harvest forecast period. Similar graphs could show the condition of other values such as wildlife habitat or domestic watersheds.

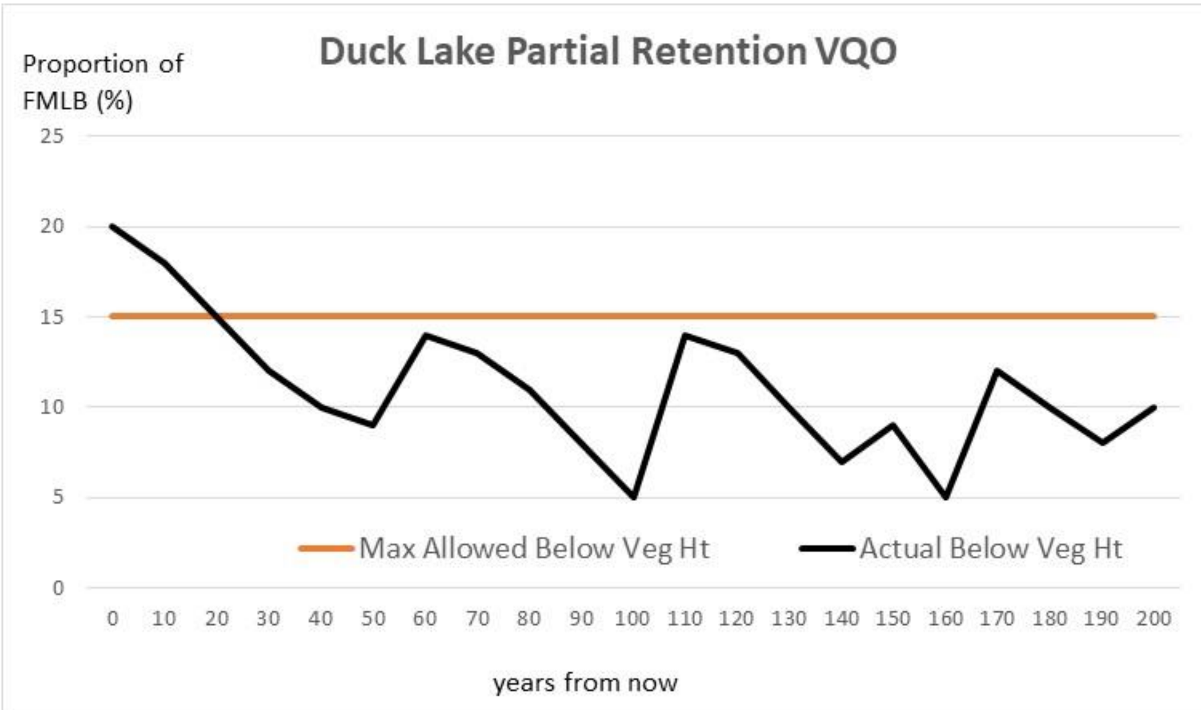


Figure 12. Forest cover condition of Duck Lake scenic area – example provided for illustration purposes

3.9 Alternative harvest flows

Several harvest flows are usually developed before one is chosen as the base case. In the example shown in Figure 13, there was an attempt to maintain the current AAC of 116 000 cubic metres for 20 years; however, this was only possible if it was followed by harvesting less than the maximum even flow. Since this violates the recommended harvest flow procedure, it was decided to lower the initial harvest to the midpoint between the current AAC and the maximum even flow. Further, it was found that maintaining the current AAC for 10 years caused the future harvest to fall slightly below the maximum even flow projection.

An alternative harvest flow does not change any assumptions in the base case. It just shows different rates of harvest of the timber available for harvest under the base case assumptions.

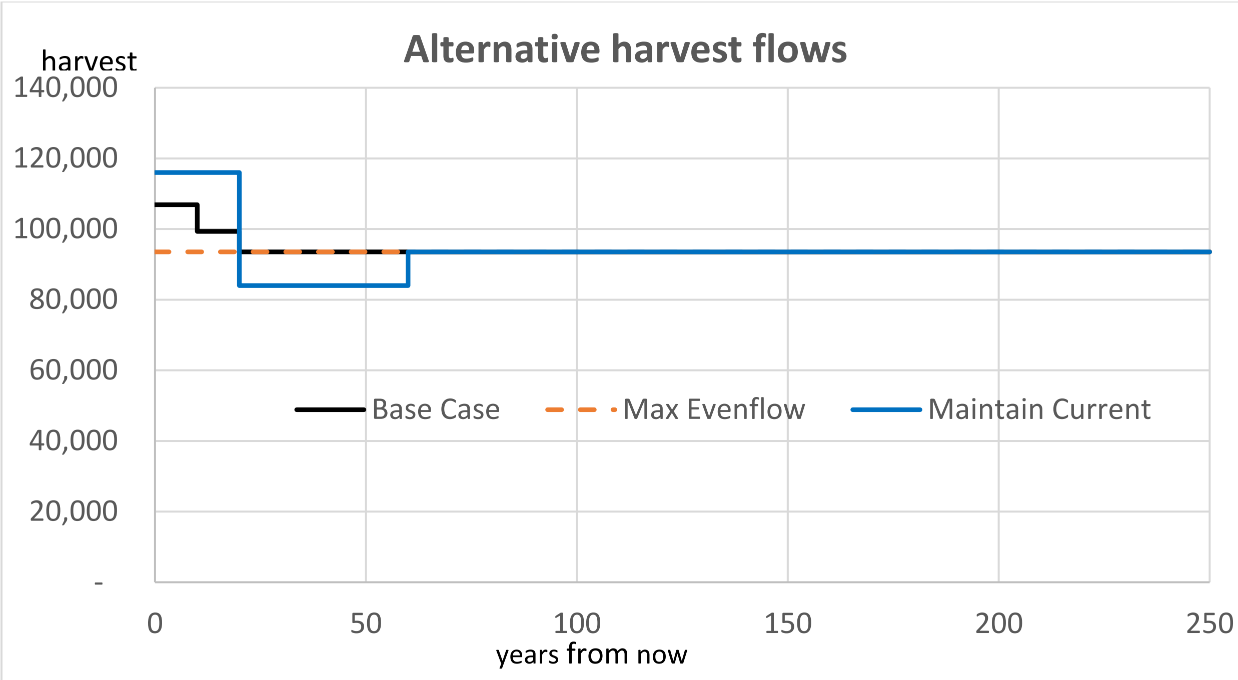


Figure 13. Alternative harvest flow – maintain current AAC for 20 years

3.10 Sensitivity Analyses

Sensitivity analyses are intended to explore the effect of uncertainty in data and management practices on timber supply.

When conducting a sensitivity analysis **only one change** must be made to the base case assumptions, and **the same harvest flow objectives used in the base case must be followed.** If the harvest flow objective is changed this will confound the results and the explanation for the difference in timber supply will not be logical. As a result, the 'sensitivity analysis' will not explain anything.

Note: Sometimes making one change requires changes to other inputs. For example, lowering the minimum harvestable volume could also lead to an increase to the THLB because some areas previously removed now meet the minimum volume criterion. This involves recalculating the netdown and ensuring the additional area is from the LHLB.

Harvest flow for sensitivity analyses

Sensitivity analysis must be based on the same harvest flow objectives as the base case. That is, first find the maximum even flow and then increase the short-term harvest only if it does not reduce the maximum even flow level.

In the example below the analyst explored the effect on timber supply of harvesting deciduous-leading stands. This is a sensitivity analysis because only one assumption was changed from the base case and the harvest flow method was not changed. This was done because the Licensee indicated in the MP that there was a strong possibility that it could market deciduous volume to certain specialty manufacturers and to the local wood pellet plant. Figure 14 shows the timber supply contribution from 1500 hectares of deciduous-leading stands that were removed from the THLB.

Figure 14. Example of the effect of including deciduous-leading stands.

If more than one change is made to the base case it results in a new scenario; it does not explain anything regarding the base case. Since the base case represents current practice, this means that the scenario does not. It shows what timber supply could be if those changes are made (new scenario) and adopted in the future.

For example, given the recent and ongoing incidence of fires and insect damage of the forest, the analyst may provide sensitivity analyses exploring the effect of different assumptions of sawlog ‘shelf life’ on timber supply in the tenure; however, if a sensitivity analysis has different assumptions from the base case about regenerating the harvested sites then it becomes a new scenario. This must be clearly identified as a different scenario, not as sensitivity analysis. The scenarios should highlight the data and assumptions where they differ from the base case. Scenarios may require as much work as was required to develop the base case.

3.11 PARTITIONS

3.11.1 Partitions for Tree Farm Licences

Section 8(5) of the *Forest Act* grants authority to the chief forester to partition the AAC of a TFL if required. In partitioning an AAC, the chief forester specifies that certain portions of the AAC must be from a certain type of timber, terrain or geographic area within the tenure.

If, for example, there is a track record of some limited harvesting of deciduous-leading stands (or if the Licensee committed in the management plan to harvest these stands) then it would have been appropriate to include these stands **in a sensitivity analysis**, show their contribution to the harvest forecast, and ask the decision maker to partition this additional volume. If the decision maker agreed with the request, then the AAC decision would likely say something like "the new AAC is X+Y and of this volume, and no more than X must be from coniferous-leading stands". This would ensure that the Licensee cannot use the larger AAC, which included deciduous volume (Y), to over-harvest coniferous-leading stands.

3.11.2 Partitions for other Area-based Tenures

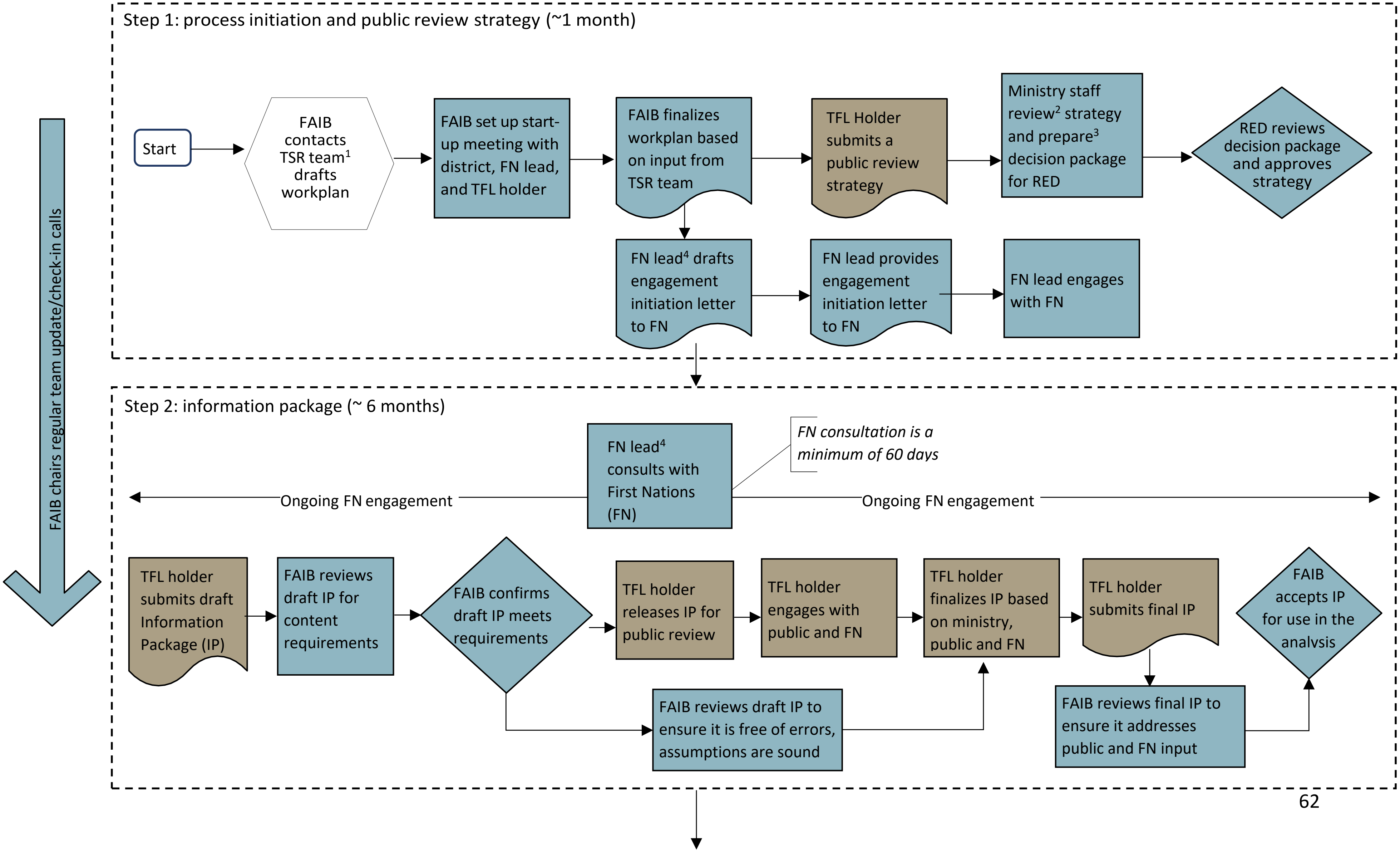
There is no provision in the *Forest Act* or the licence document to partition the AAC for WLs, CFAs or FNWLs; however, the tenure holder may request a partition in the AAC proposal. When that is the case, the information should be provided in a manner similar to the one described above for TFLs.

Examples of where this may be appropriate is when there is a private land component on a management unit, the Management Plan and AAC proposal should specify the portion of AAC to be attributed to private land and Crown land. Another example would be inclusion of deciduous-leading stands. Generally, they should only be included in the AAC when there is market for, and demonstrated utilization of, deciduous species.

The delegated decision-maker may specify approval conditions that are similar to partitions.

APPENDIX 1: AAC Determination Process for TFLs

Forest Analysis and Inventory Branch Management Plan (MP) Review and Allowable Annual Cut (AAC) Determination Process for Tree Farm Licence (TFL)



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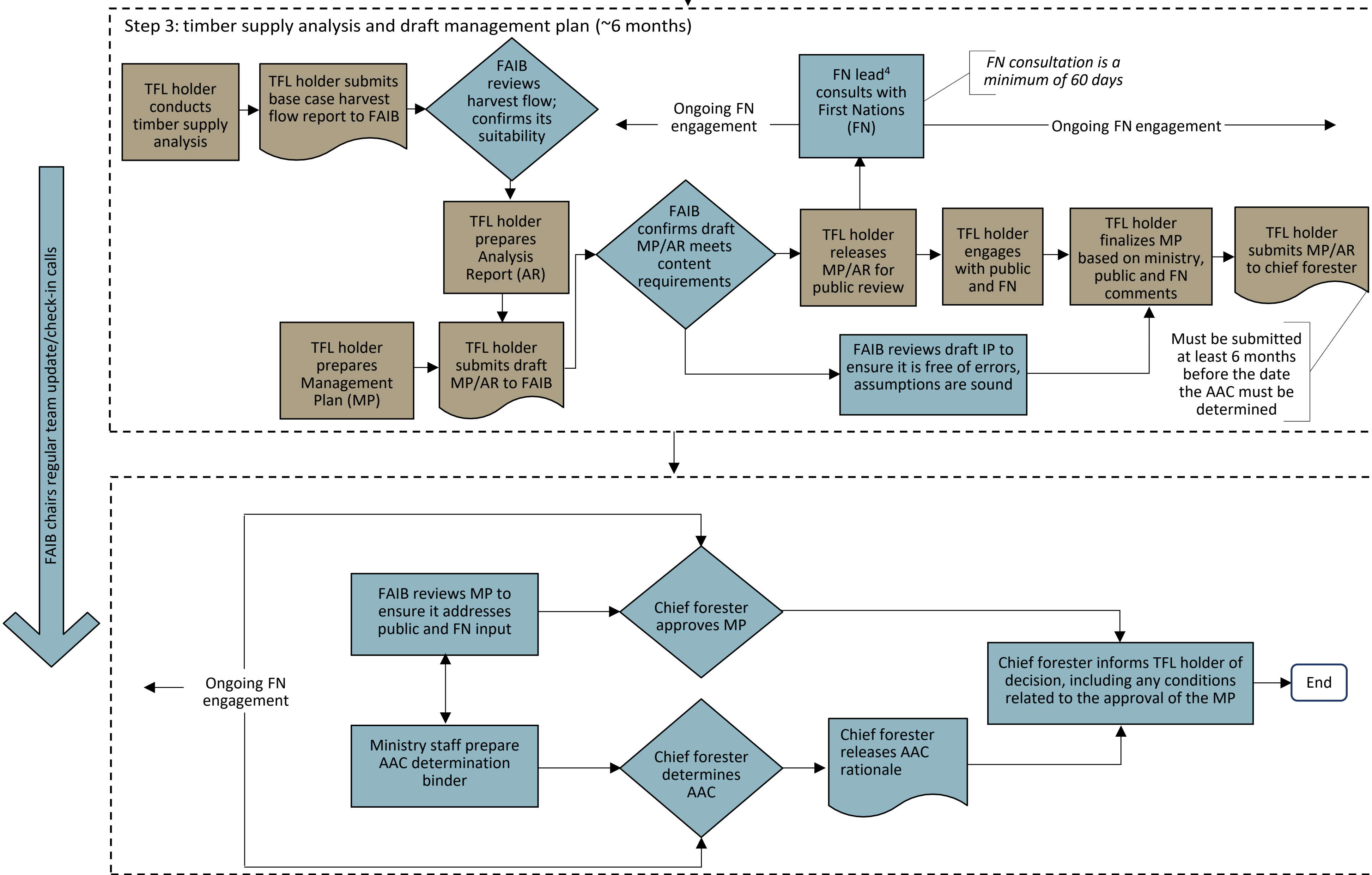
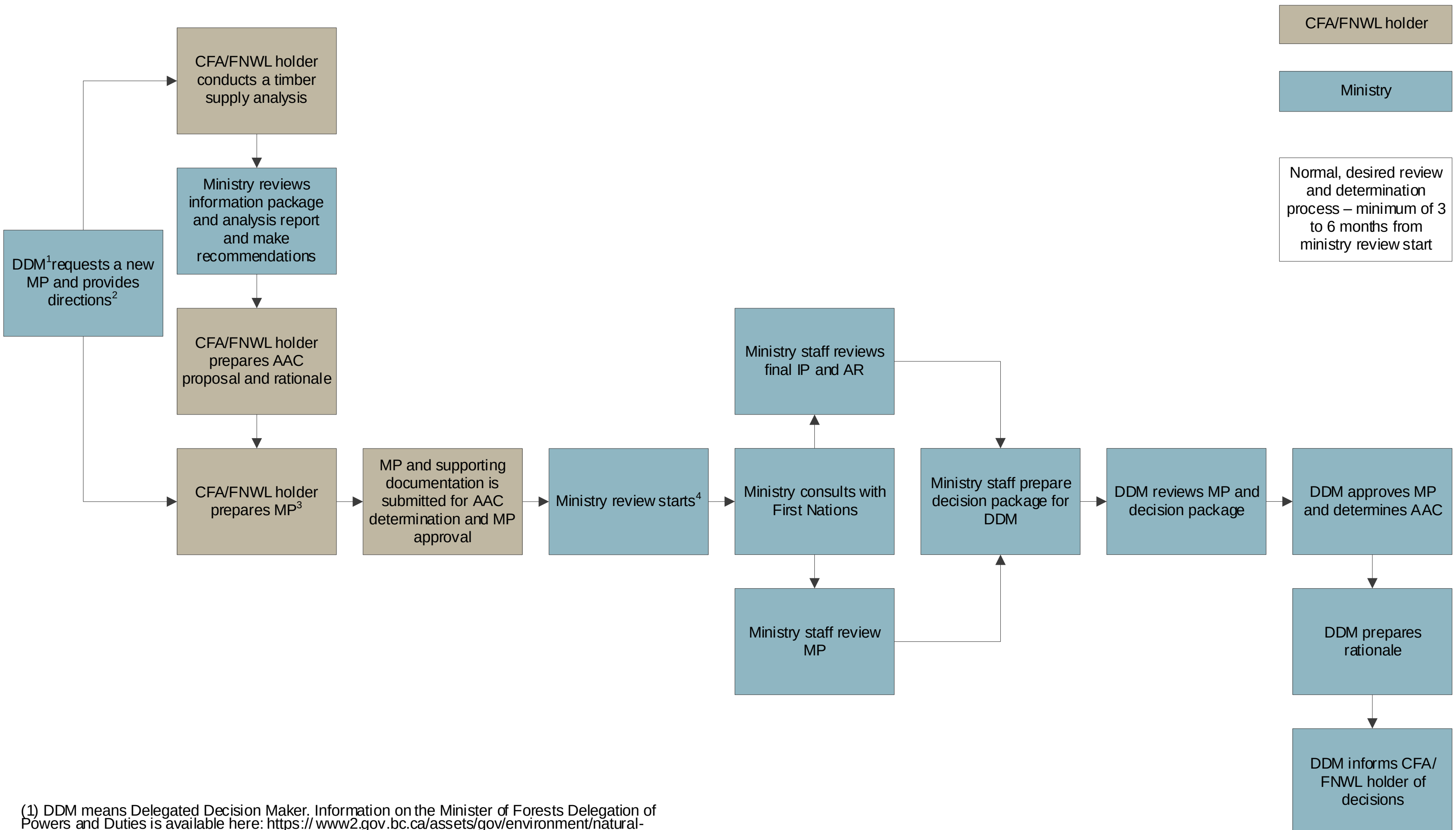


TFL holder | Ministry

(1) FAIB, district, TFL holder. May include regional staff and consultant
(2) District (local stakeholders, FN contacts and newspaper) and FAIB (overall content review)
(3) Typically district staff
(4) Typically district FN advisor

APPENDIX 2: AAC Determination Process for Existing CFAs and FNWLs

Note: This process applies to signed agreements



(1) DDM means Delegated Decision Maker. Information on the Minister of Forests Delegation of Powers and Duties is available here: https:// www2.gov.bc.ca/assets/gov/environment/natural-resource-policy-legislation/ transfer-of-authority-matrices/fa_delegation_matrix.pdf.

(2) Directions may be provided for the preparation of the MP, the inclusion of inventories and information required to determine the AAC and the preparation of a AAC rationale for the proposed AAC.

(3) Licensees are encouraged to engage with FN on an ongoing basis and prior to initiating work on the MP to ensure interests can be managed, to the extent possible.

(4) Ministry review team may include district, regional or FAIB staff.

APPENDIX 3: Timber supply modelling and choice of models

The choice of a model relates directly to what type of problem is being examined. No one model is better than any of the others. Some are better suited to different types of problems. Some are easier to set up than others. Some are more efficient at handling large problems. Some are faster for a given type of problem. Some are easier to conduct sensitivity analyses. There is no ‘perfect’ model.

Regardless of the model selected, it is important to think of the model as being only a part of the process. The model is used to come to an understanding of the issues and interactions. Once there is an understanding, then a story can be told. It is the story that is important, not the model. In this context, models are better at explanation than prediction. Part of this explanation are the appropriate sensitivity analyses to explore the decision space.

Linear programming, metaheuristics and simulation models are all important components of the modelling systems that FAIB and consultants use. Each has strengths and weaknesses that should be considered before undertaking an analysis. Understanding how to undertake sensitivity analyses for each type of model is an important part of model selection. All timber supply modelling requires sensitivity analyses.

Ideally, the selection of a model should be considered before undertaking an analysis. The relative strengths and weaknesses need to be considered in relation to the specifics of the problem. Moreover, if asked: “Is one model better than all the others?”, the answer is “There is no clear winner”. It is much more relevant to consider other things.

How the model is used is very important. Depending on the model selected there can be many options. There are also many alternative methods, including massaging the data. In addition, different users tend to do things differently. These factors affect solutions much more than the selection of a particular model. Given the same data, same formulation and same pattern of usage, the expected outcomes should be the same regardless of the model.

Processing time of the actual model to do one run is irrelevant. The time required, using a particular model, to undertake all the analyses required to come to a complete understanding of a problem is what is relevant. In essence, it is the time required to build a ‘story’. To understand a problem (or a natural system), one must be able to explore alternative scenarios and interactions. With a complex problem, more than one scenario must be examined.

Simulation requires multiple runs to home in on an acceptable solution. Optimization does it in ‘one’ run. Metaheuristics require sensitivity around goals/penalties; however, there are trade-offs between a fast simulator versus a slow optimizer. As the time it takes for a model run becomes longer, the ability to examine and come to an understanding of a problem starts to become limited. If the solution time is extremely long, there is the danger of accepting just one solution and understanding of the problem is thus limited. But no matter what, a complete picture of the issues is required to tell a ‘good’ story.

Unexpected outcomes should always be questioned and explained. It is unacceptable to say, “that is what the model said”.

Characteristics of some models used by FAIB and consultants

	Woodstock	Patchworks	SELES	W4W
Optimization	✓	✓		
Simulation	✓		✓	✓
Multiple Objective	✓	✓		
Choice between mgmt actions	✓	✓		
Vector	✓	✓		✓
Raster			✓	
GIS overlay required	✓	✓		
Open Format	✓	✓	✓	
Explicit Spatial		✓	✓	
Flexible Reporting	✓	✓	✓	
Cutblocks		✓	✓	
Explicit Roading		✓		
Neighbours		✓	✓	
Age requirements	✓	✓	✓	✓
Height requirements	✓	✓	✓	✓
Strategic	✓	✓	✓	✓
Operational		✓		
Commercial	✓*	✓		
Maintenance Cost	✓	✓		
Single Programmer		✓	✓	✓

*Requires additional LP solver software

Model	*Strength*	*Weakness*
Woodstock		
	Optimization model	Size limits (due to solve times)
	Post optimal analysis	Not explicitly spatial
		Requires commercial LP solver ($$)
		Requires additional sensitivity analyses to tune penalties (if used)

Model	*Strength*	*Weakness*
Patchworks		
	Pseudo-optimization model	Size limits; solve time
	Output links to report producers	Takes time to build a model
	Strategic or operational	Requires sensitivity analyses re: penalties
	GIS-like visualization	Cannot adjust model control parameters
		Proprietary solve technique

Model	*Strength*	*Weakness*
SELES		
	Pseudo-open code	Support (single contractor)
	Raster data format	Uses older raster formats
	No GIS overlays (easy to add)	Counterintuitive error messages
	Very flexible modelling environment	Lack of documentation

Model	*Strength*	*Weakness*
Woodlot for Windows (W4W)		
	Pseudo-open code	Support (single contractor)
		Rigid structure
		Size limits

APPENDIX 4: Information Checklist

Information Package Content	
Introduction	☐
Overview description of the area	☐
Data sources	☐
Vegetation inventory	☐
Management zones	☐
Analysis units	☐
Land Base Classification	☐
Gross Land Base	☐
Tenure area	☐
Non-tenure area	☐
Forest Management Land Base Definition	☐
Non-forested area	☐
Non-productive area	☐
Roads – existing and future	☐
Legally Harvestable Land Base Definition	☐
Protected areas	☐
Reserves	☐
Old growth management areas	☐
Ungulate winter range no-harvest area	☐
Wildlife habitat area no-harvest area	☐
Other areas prohibiting timber harvesting	☐
Wildlife reserves	☐
Timber Harvesting Land Base Definition	☐
Physically inoperable areas	☐
Economically inoperable areas	☐
Potentially unstable or unstable terrain or environmentally sensitive areas	☐
Sites with low timber growing potential	☐
Problem forest types	☐
Cultural heritage resources	☐
Riparian areas	☐
Existing and future wildlife tree retention	☐
Current Forest Management Assumptions	☐
Harvesting system	☐
Utilization level	☐
Decay, waste and breakage	☐
Volume exclusions for deciduous and other species	☐

Minimum harvestable volume/age	☐
Silviculture system	☐
Managed stands	☐
Silviculture management regimes	☐
Regeneration assumptions	☐
Genetic worth	☐
Regeneration delay	☐
Non-satisfactorily restocked areas	☐
Incremental silviculture	☐
Non-recoverable losses	☐
Resource Management	☐
Landscape-level biodiversity	☐
Stand-level biodiversity	☐
Old growth	☐
Ungulate winter range harvest conditions	☐
Wildlife habitat area harvest conditions	☐
Cutblock adjacency/patch size	☐
Visual quality	☐
Growth and yield	☐
Unmanaged stand growth and yield curves	☐
Managed stand growth and yield curves	☐
Site index	☐
Tree improvement	☐
Operational adjustment factors	☐
Modelling	☐
Forest estate model	☐
Initial harvest rate	☐
Initial year of the forecast	☐
Harvest rules	☐
Harvest flow objectives	☐
Sensitivity analysis	☐
Other	☐
Maps	☐
Tables	☐
Graphs	☐
Changes since the last timber supply analysis	☐
Date of the original inventory and of updates/re-inventories	☐
Date the inventory has been updated for depletion	☐
Date the inventory has been updated for growth	☐

Indicate which year time zero represents in the timber supply model	☐
Description of process for FLNRORD to review and accept the inventory	☐
Description of results of inventory audit or other sampling procedures	☐
If the base case incorporates a draw down of old seral objectives, a sensitivity analysis is included to show the impact on timber supply of applying the full old-seral objectives	☐
Community watershed objectives	☐
Minimum harvestable criteria and age are described and compared to the age of culmination	☐
Assumptions incorporated are supported by evidence of recent harvest performance	☐
The flow of timber supply over time objectives for the alternative harvest flows have been described	☐
All other information not covered above that impacts on timber supply have been described and incorporated appropriately	☐

NOTES: