DATA PACKAGE

TIMBER SUPPLY REVIEW
2003/2004

Arrow Timber Supply Area

Prepared for:
The Arrow Forest Licence Group

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3	Final Draft	March 4, 2004	Gordon Nienaber

EXECUTIVE SUMMARY

A timber supply review process has been initiated for the Arrow Timber Supply Area (TSA). Timberline Forest Inventory Consultants Ltd., on behalf of the Arrow Forest Licence Group, is preparing timber supply information for the analysis. These reviews are conducted every five years and assist the B.C. Forest Service's Chief Forester in re-determining allowable annual cuts (AAC). For the Arrow Timber Supply Area, the Chief Forester will determine a new AAC by September 2004.

Prior to this process, the licencee group has been working under an innovative forest practices agreement with the Province of British Columbia toward submitting an allowable cut uplift application under Section 59.1 of the B.C. Forest Act. This data package documents analysis inputs and assumptions for both of these initiatives.

The allowable annual cut for the Arrow TSA was set in 1983 at 619,000 m^3 per year and was maintained at that level in the 1995 Timber Supply Review No. 1 (TSR 1) AAC determination. Following TSR 1 the Forest Practices Code was implemented and the *Kootenay-Boundary Land Use Plan* was completed. The *Arrow TSA Rationale for AAC Determination* was published in April of 2001. At that time the AAC was reduced by 11% to 550,000 m^3 per year.

This data package was provided to the public and First Nations for review prior to initiation of the analysis to support allowable cut determination for TSR 3. Although it is a technical document for a technical audience, every effort has been made to ensure that it is self-explanatory.

The data package allows the reader to consider the inputs and assumptions to be used in the timber supply analysis. This includes:

- The documentation of inventory data and sources;
- Classification of the land base according to each hectare's contribution to management (harvest, resource management for wildlife, *etc.;*
- Land productivity estimates and prediction of stand growth and timber yield;
- Silviculture and harvesting regimes;
- Action taken to model multi-resource requirements;
- Modelling structures to address the *Kootenay Boundary Land Use Plan*; and
- Timber supply scenarios to be investigated.

This document will evolve and be finalized when published as an appendix to the analysis report. There will be another public review at that time.

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1.0 INTRODUCTION

Timberline Forest Inventory Consultants Ltd., on behalf of the Arrow Forest Licence Group (AFLG), is preparing timber supply information for the Provincial timber supply review (TSR). These reviews are conducted every five years and assist the B.C. Forest Service's Chief Forester in re-determining allowable annual cuts (AAC). For the Arrow Timber Supply Area (TSA), the Chief Forester will determine a new AAC by September 2004.

Under proposed defined forest area management (DFAM) legislation, the responsibility to conduct timber supply analysis within a TSA will be transferred to the licencees operating within the TSA. The DFAM legislation requires, to carry out this process, the formation of a DFAM group that includes the holders of replaceable forest licences, BC Timber Sales (BCTS), and other holders of agreements that meet the prescribed requirements.

The DFAM group will complete the steps leading up to, and including the delivery of, timber supply analyses as follows:

- Collecting data and preparation of an data package which summarizes the data assumptions - land base, growth and yield, forest management practices, statement of management strategies, and analysis methods - that will be used, and the critical issues that will be examined in the timber supply analysis;
- Completing the timber supply analysis and report, and
- Providing for public and First Nations reviews.

After the completion of these steps, the analysis report is submitted to the Chief Forester. The AAC is then set by the Chief Forester using the analysis report as one of the many factors required as part of the determination process.

In the Arrow Timber Supply Area the DFAM group is represented by the five forest companies operating in the former Arrow TSA portion of the Arrow Boundary Forest District of southern British Columbia, known collectively as the Arrow Forest Licence Group (AFLG). The AFLG was formed in 1998 when it entered into Innovative Forestry Practices Agreements (IFPA) with the Ministry of Forests under Section 59.1 of the British Columbia Forest Act. IFPAs are designed to test and pilot alternative and new approaches to forest resource management.

The third Timber Supply Review (TSR 3) process has been initiated for the Arrow TSA. Prior to this process, the AFLG had been working under the IFPA toward submitting an AAC uplift application under Section 59.1 of the Forest Act. This data package documents analysis inputs and assumptions for both initiatives under the title 2003/2004 analyses.

1.1 PURPOSE

The purpose of the data package under DFAM is defined in the document *DFAM Interim Standards for Data Package Preparation and Timber Supply Analysis* (B.C. MoF, 2003a). It states that the data package must provide a clear description of information sources, assumptions, issues, and any relevant data processing or adjustments related to the land base, growth and yield, and management objectives and practices.

The interim standards guide states that the following principles apply to the data sources and data package:

- The data package must describe, and where appropriate summarize, all data and information to be used in the timber supply analysis;
- The data package must contain descriptions of how current forest management, or reasonable extrapolations of current management, will be modelled;
- The most current and best available data must be used;
- More detailed discussion should be provided in the package for data for which there is a high degree of uncertainty;
- The data package must contain a summary of plans for examining the potential impacts of important uncertainties in information (*e.g.*, planned sensitivity analysis);
- The evidentiary basis for information used in analyses must be available on request, and to the extent possible be included in the data package. Evidence could include the following:
    - A description of data sources;
    - The source data itself;
    - A description of sampling and data analysis methods or standards;
    - Digital or analog maps of the land base (*e.g.*, forest cover, ownership, habitat areas);
    - Results of any reviews or audits of source information or inventories; and
    - Any acceptances by appropriate professionals (*e.g.*, terrain stability mapping).
- When collecting or analyzing data to include in the data package, existing standards should be followed, unless justification is provided for diverging from standards. Such justification should demonstrate that although standards were not followed, the information is the best available that could be obtained for the timber supply review;
- Where possible, the implications to the timber supply analysis (*e.g.*, increased uncertainty) of diverging from the standards should be examined and reported; and
- The choice of a particular timber supply model is left to the discretion of the DFAM group.

1.2 BACKGROUND

This section provides background information to the 2003/2004 analyses and describes the various processes which have shaped the analyses and within which the analyses fit.

The allowable annual cut (AAC) for the Arrow TSA was set in 1983 at 619,000 m^3 per year and was maintained at that level in the 1995 (TSR 1) AAC determination. Following TSR 1 the Forest Practices Code was implemented and the *Kootenay-Boundary Land Use Plan* was completed. The *Arrow TSA Rationale for AAC Determination* was published in April of 2001 (Pedersen, 2001). At that time the AAC was reduced by 11% to 550,000 m^3 per year. A number of factors had changed between TSR 1 and 2 including removal of woodlot licences from the TSA, management for stand and landscape level biodiversity, riparian protection, and identified wildlife.

Timberline Forest Inventory Consultants Ltd. (Timberline) completed an IFPA base case timber supply analysis in March of 1999. That analysis was used to provide direction for the program of activities outlined in the *IFPA Forestry Plan*. An additional *Options Analysis* (Timberline, 2000a) was completed in June of 2000 to reflect changes made in the *Timber Supply Review Analysis Report* (B.C. MoF, 2000a). Subsequent to the release of the Arrow AAC rationale report and the *Kootenay-Boundary Higher Level Plan Order* (Government of B.C., 2002), further changes to the Arrow IFPA base case were required to maintain concurrence with these documents. The impacts of meeting the new requirements were explored in the *Updated Arrow IFPA Base Case and Spatial Analysis* (Timberline, 2002b).

The IFPA has been working toward submitting an AAC uplift application under Section 59.1 of the Forest Act for the following reasons: the IFPA objective to mitigate downward pressure on the AAC; the AAC reduction in April 2001; and the subsequent completion of a number of key IFPA projects. The most significant of these projects are: a new vegetation resources inventory (VRI) for the TSA, and predictive ecosystem mapping (PEM) for use in productivity estimation.

In order to apply for the uplift, an analysis demonstrating that the increased harvest level does not jeopardize resource sustainability was required. An uplift analysis was performed for the IFPA by Timberline during 2002/2003. This analysis included the new VRI but it did not include the PEM because it had not yet achieved approval for use in timber supply analysis. The results of the uplift analysis are reported in the document titled *Support and Analysis for Uplift Application 2002/2003 Timber Supply Analysis Report* (Timberline, 2003a). The analysis found that when the land base was modelled using the new VRI the current maximum sustainable harvest level could not be sustained (609,300 m^3/yr). The main evidence in support of uplift was anticipated to come from the use of ecologically based productivity estimates. Unfortunately, these estimates are calculated using PEM data so they could not be included in the analysis.

The third Timber Supply Review (TSR 3) process for the TSA is now underway, using a set of project specifications developed by the Forest Analysis Branch of the MoF. Timberline was retained to conduct the timber supply analysis in support of TSR 3. This analysis was conducted in conjunction with the continuation of the AAC uplift application project. Prior to this analysis, the PEM was approved for use in timber supply analysis allowing the ecologically based productivity estimates to be implemented in the analysis. It was anticipated that the review of the modelling assumptions and the addition of new data would allow for an analysis supporting the uplift application while providing the information required for the TSR process.

This data package documents the inventory and forest management issues incorporated in the TSR 3 and uplift analyses, as well as the sources of information used to model the timber supply.

1.3 PROCESSES

This data package fits within a long continuum of processes all working towards ensuring the sustainability of management practices in the Arrow TSA.

1.3.1 AFLG Processes

Under the IFPA, the AFLG completed a *Forestry Plan* (Arrow IFPA, 1999), which was approved in June of 1999. The *Forestry Plan* focused on addressing a balance between mitigating downward pressure on the allowable annual cut (AAC) while maintaining or enhancing environmental and other values. Over the course of the IFPA this has evolved into two main streams, timber supply related projects, and the development of a sustainable forest management (SFM) framework. The major timber supply related themes of the IFPA included:

- Investigating ecologically appropriate ways of rationalizing management constraints;
- Improving or validating measurements of site productivity;
- Improving the definition of the timber harvesting land base; and
- Increasing the size of the timber harvesting land base.

The SFM stream is focused on an alternative conceptual framework for forest management, one where desired future conditions (thresholds) are specified and criteria and indicators are developed and monitored to measure progress in moving towards the defined desired future conditions. This framework remains a work in progress and has not expressed itself in terms of management regimes that might be modelled in this timber supply analysis.

A work plan was developed prior to initiating the 2003/2004 analyses. The work plan is documented in the report titled *Work Plan – Forest Level Analyses 2003/2004 – Arrow TSA* (Timberline, 2003b). The work plan outlines the processes to be followed from collection of existing information through to completion of the timber supply analysis reports. These processes are detailed in Figure 1.1.

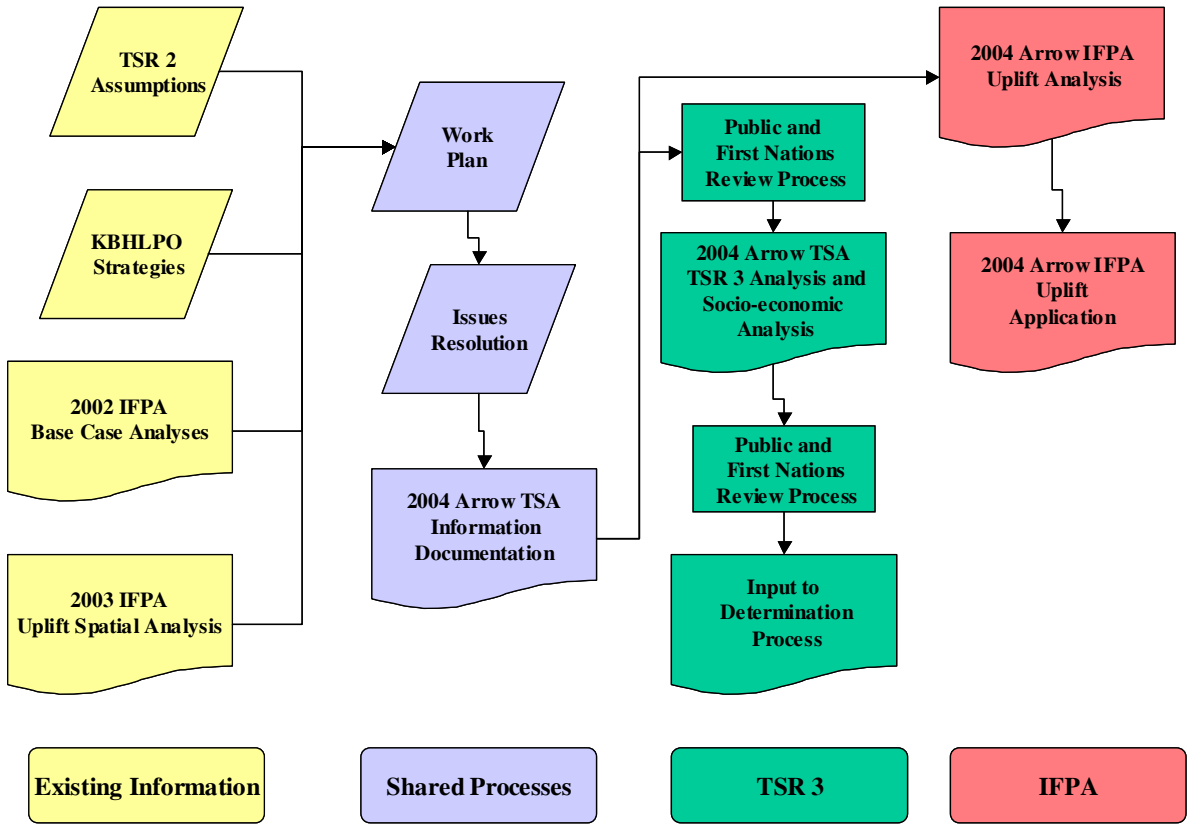


Figure 1.1. Analysis project flow

1.3.2 DFAM TSR Processes

The preparation of the data package is the first step in the TSR process. The data package and subsequent analysis must go through a two step revision processes before it is accepted. The first draft of the data package must be submitted to the MoF and it also must be made available for a public and First Nations review. Feedback from this review process must be documented along with records of how comments were incorporated into the analysis. After the analysis, the analysis report (including the data package) is then submitted for a second review by the public and First Nations.

After the data package has achieved approval for use, the timber supply analyses can be performed following all of the criteria outlined in the data package. The results of these analyses are documented in the analysis report. This report is then submitted to the Chief Forester for consideration as part of the TSR process.

To facilitate the data package review process, an Internet web site dedicated to the 2003/2004 analyses was established at www.timberline.ca/arrowtsa . The draft data package, background documents, and maps were placed on this site. From this site they could be freely downloaded by individuals for review.

1.4 SLOCAN VALLEY PROCESS

Inclusion of the Slocan Valley in the timber harvesting land base is a contentious issue when considering timber supply in the Arrow TSA. Licensees have had limited ability to access timber in the Slocan Valley. This can lead to more intense harvest in the remaining TSA, or under achievement of quota by operators in the Slocan Valley.

At an executive level, the forest licencees of the Arrow TSA are working toward an approach to this issue that will be acceptable to as many parties as possible. The outcome of this process can not be known. This analysis is limited to determining the impact of differing approaches to harvesting and silviculture within the Arrow TSA. The analysis does not address issues of tenure or administration within the Arrow TSA. Therefore, it does not contribute to the issue resolution process for the Slocan Valley nor will it limit any possible solutions.

2.0 INVENTORY AND MODEL FILES

This section documents inventory and thematic information used in the 2003/2004 analyses.

2.1 THEMATIC DATA SOURCES

Many sources of data were compiled to provide input to the timber supply analyses for the Arrow TSA 2003/2004 analyses. These are documented in Table 2.1. Several of the spatial data sets have been mapped (maps can be viewed at the website www.timberline.ca/arrowtsa). The maps are available for viewing in digital format (Acrobat PDF) with this data package. The final column in Table 2.1 indicates the map number in which the layer is incorporated.

Table 2.1. Data sources

Issue or Data	Description, Source	Coverage Name	Version or Date Stamp	Map
Administrative and Land Base Issues				
TSA and TFL boundaries	Boundary for TSA/TFL, Ministry of Forests	ttsa_ar	2002 Update	All
Forest inventory zones	Timberline calculated FIZ within VRI, MSRM	vri	2002 Update	
Ownership	Ownership, Ministry of Forests	town_ar	2002 Update	All
Public sustained yield units	Timberline calculated PSYU within VRI, MSRM	vri	Aug 2003	
Slocan Valley boundary	Linework defining Slocan Valley contentious area	svca	Feb 2004	
Woodlots	Included in ownership coverage, Ministry of Forests	Included in town_ar	2002 Update	
Protected Area Strategy goal 1	Included in ownership coverage, Ministry of Forests	Included in town_ar	2002 Update	
Protected Area Strategy goal 2	PAS Goal 2, Ministry of Forests	tpas2_ar	2002 Update	01
Landscape units	Ministry of Forests	tbecb_ar	2002 Update	07
Base Inventories				
Forest cover data	VRI (including disturbance update) and associated attribute tables, MSRM	vri	Aug 2003	09,10
Ecosystem inventory	IFPA Predictive Ecosystem Mapping (PEM) Project, JMJ Holdings	pem	Aug 2003	02
Operability and Harvest Planning				
TSR 2 operability	Original operability line used for TSR 2	ts_ter	1999 Technical	
Updated operability	Updated through IFPA to reflect issues discussed in the AAC Rationale – AFLG revisions, removal of total chance blocking, Ministry of Forests	topr_ar	2002 Update	
Seed zones and elevation	Union of seed zones and elevation bands	t_seedelev	2002 Update	
Environmentally sensitive areas	(ESAs) from previous Forest Cover, Ministry of Forests	fc	2001	06
Terrain classification mapping from TSR 2	Terrain classification data used to assign ESA in TSR 2	ts_ter	1999 Technical	

Issue or Data	Description, Source	Coverage Name	Version or Date Stamp	Map
Extended terrain stability mapping coverage	Expanded mapping used to define environmentally sensitive areas, Timberland	t_terrain	2002 Update	06
Existing roads	Forest cover roads coverage and buffered by Timberline	tot_roadbuf	2002 Update	
Forest development plan	Development plan information from MoF including wildlife tree patch information	tfdp_ar	2002 Update	
Treatment unit (blocking) layer	Derived from the overlay of various inputs	tums	Oct 2003	
Integrated Resource Management Issues				
Enhanced resource development zones	KBHLP required data set (ERDZ), Ministry of Forests	erdz_dar_r	2002 Update	01
Regional connectivity	KBHLP required data set, Ministry of Forests	qcnt_ar	2002 Update	07
Old growth management areas	KBLUP required data set (OGMA) from MoF (2003). Timberline updated with revisions made by Slocan	ogma_new	Aug 2003	07
Resource management zones	KBLUP required data set (RMZ), Ministry of Forests	qrmz_ar	2002 Update	01
Biodiversity emphasis	KBHLP required data set	tbecb_ar	2002 Update	01
Caribou management zones	KBHLP required data set, updated after TSR 2, Ministry of Forests	qcari_ar	2002 Update	03
Ungulate Winter Range	KBLUP required data set, refined in 2002	luwr_ar	Nov 2002	03
West Kootenay ungulate winter range zones	Mowat	tfl_uwr	March 2004	
Forage	Mowat	uwr_forage	March 2004	03
Wildlife tree patches	Timberline extracted from tfdp_ar	t_wtp	2002 Update	
Identified wildlife	Known wildlife stick nests	ts_stik	1999 Technical	
Scenic areas	KBLUP required data set, Ministry of Forests	tsce_ar	2002 Update	04
Visual landscape inventory	Timberline update, Ministry of Forests	vli_sep03	Sept 2003	13
Dewdney trail buffer	Ministry of Forests	tcul_ar	2002 Update	
Riparian and Water Issues				
Community watersheds	KBLUP required data set, Ministry of Forests	tcws_ar	2002 Update	05
Domestic watersheds	KBLUP required data set, Ministry of Forests	tdws_ar	2002 Update	05
Consumptive use streams	Inside community and domestic watersheds, in addition to FPC riparian buffers, S5, S6 streams have a 30m buffer applied, Timberline processed	arw_rma	2002 Update	
Riparian management areas	Riparian buffers and lake classification, Ministry of Forests	arw_rma	2002 Update	11

Note:

- "2002 Update" refers to data that can only be tracked back to first being received and utilized in the *Updated Arrow IFPA Base Case and Spatial Analysis* (Timberline, 2002).
- "1999 Technical" refers to data that can be tracked back to being used in the *Technical Report, Arrow IFPA Base Case Analysis* (Timberline, 1999)

The four major new or updated sources of data not included in the previous analyses are the recently approved PEM, the VRI, updated visual landscape inventory mapping, and newly refined old growth management areas. These data sources are described in detail in the following sections.

2.2 PREDICTIVE ECOSYSTEM MAPPING

A predictive ecosystem mapping (PEM) process was used to inventory ecosystems within the Arrow TSA. The *Arrow TSA Predictive Ecosystem Mapping (PEM) 2003 Re-Iteration* (Ketcheson, 2003) is an important base inventory for management of the Arrow TSA. As will be discussed below, the Ministry of Forests has accepted this revised 2003 version for use in base case analysis for TSR 3 (Meidinger, 2003). The ecosystem inventory will be used as a foundation for organization of the land base for administration of management and prediction of stand yields.

The 2003 PEM is significantly improved over the original version, which did not meet accuracy standards, as set by the MoF. Originally a raster-based resultant of a GIS overlay process, the PEM has been converted to a polygon base, and now addresses multiple site series in a polygon. General improvements and characteristics of the PEM include:

- Increased input layer testing, quality assurance, and improvement;
- GIS processing of 12 input layers;
- 1:50,000 scale input BEC subzones;
- 1:50,000 scale input bioterrain;
- First run predictions based on overlay GIS data in raster format;
- A second run implements polygon and decile based bioterrain and forest cover information;
- A mix of predicted site series and groups (combination units) of site series;
- An allocation of proportional area to individual site series within the combination units; and
- Revised BEC lines.

The revised BEC lines were compared with those from the original version. The changes did not appear to be significant. More information about the PEM can be found in Section 5.1.

2.3 VEGETATION RESOURCES INVENTORY

The phase 1 VRI for the Arrow TSA was conducted by ARC Alpine Resource Consultants Ltd. and completed in 2002 (ARC Alpine, 2002). No phase 2 sampling program has been undertaken. An audit to evaluate the quality of the VRI was conducted concurrently with the 2003/2004 analyses (Jahraus, 2003). The audit attempted to verify the accuracy of the inventory through a comparison of the VRI attributes to a set of inventory audit ground samples from a 1995 audit. The audit found that volume estimates are underestimated in the VRI and it is especially apparent in younger stands. This underestimation was found to be linked to inventory attributes such as height which was found to be significantly underestimated.

The VRI data was first implemented in the 2002/2003 uplift analysis. The land base classification was conducted using the VRI data set. A comparison between the VRI data and the previously used forest cover inventory was provided in the 2002/2003 uplift analysis information package (Timberline, 2003a). The VRI has since been updated for disturbance to 2003. In preparation for this analysis process, the VRI was projected to 2003 and volumes were populated using the MoF program Variable Density Yield Predictor (VDYP) version 6.6..

The switch to VRI data from traditional forest cover information introduced many fundamental differences in implementation. The VRI takes a more objective and non-cultural approach to inventory. This expresses itself in the altogether different approach to identifying non-forest, non-productive forest, and non-commercial brush. A VRI describes vegetation using the BC Land Classification System (BCLCS). This system no longer relies on subjective descriptors such as non-productive forest. Instead information about the percentage of vegetation cover is provided. For example, large areas of high elevation parkland forest previously described as non-productive forest are now simply described as forested. However, the land base classification system used to determine the net harvesting land base was robust enough to deal with this. Most of the high elevation parkland forest was above the operability line and reclassified at the operability step. The assumptions used to make the transition to VRI in the classification process were well documented throughout Section 3.0.

2.3.1 Merging the PEM and VRI Inventories

For preparation of the analysis data set, the VRI and PEM data were merged. Due to the large size of the PEM and VRI inventories for the TSA, adding both inventories as separate databases would have created an unwieldy and sometimes unmanageable resultant. Instead, the PEM attributes were merged into the VRI without adding the PEM linework. This created one small inventory capable of addressing forest inventory and ecological (biodiversity) constraints. In addition, this method of combining the inventories maintains VRI linework and associated attributes while simultaneously maintaining the integrity of the PEM. This was achieved by representing each ecological unit (site series) as a percentage of a specified area. When the size, shape or area of a polygon changes the ecological composition remains the same.

2.4 VISUAL LANDSCAPE INVENTORY

The visual landscape inventory (VLI) was updated by Timberline to make the line work conform to current standards. The VLI was used to define visual quality objectives (VQO) within the scenic areas defined by the KBLUP (KBLUP Map No. 9.1 - Arrow RMZ). As part of this project the VLI was compared to a visibility analysis done as a KBLUP project.

For analysis purposes it is important to apply forest cover requirements to units that are as similar to what is used at the operational level as possible. Many of the VQO polygons were mapped as separate polygons based on differences in other VLI attributes. To address this issue, some small polygons with identical VQOs were grouped on the basis of what could be seen from accepted viewpoints for the purposes of applying forest cover requirements.

2.5 OLD GROWTH MANAGEMENT AREAS

The use of old growth management areas (OGMA) in the base case is a new analysis approach for the 2003/2004 analyses. In previous analyses the landscape level biodiversity retention objectives were used to maintain old growth areas instead (see Section 3.2.10).

Individual members within the AFLG have been working to refine the OGMA coverage within their operating areas. The revised linework from all Licencees except for Slocan Forest Products was amalgamated by the MSRM current to 2003. The revised data from Slocan was submitted to Timberline in early 2004 and was amalgamated into the OGMA coverage for use in this analysis. The revised Slocan coverage was scheduled for review and approval by MSRM before the 2003/2004 analyses but this has not yet occurred. The revised data has been tentatively accepted for use in these analyses (B.C. MoF, 2003h).

A sensitivity analysis was conducted to investigate the impact of using the landscape level biodiversity retention objectives in place of OGMAs. The methods used in this approach are documented in Section 10.2.

3.0 LAND BASE

This section provides a numerical description of the land base assumptions reflected in the 2003/2004 analyses.

3.1 LAND BASE CLASSIFICATION

The classification of land base for contribution to analysis described in this section is based on the procedure outline in the *Supplemental Guide for Preparing Timber Supply Analysis Data Packages* (B.C. MoF, 2003d). The order of classification is depicted in Table 3.1. Detailed descriptions of each classification step are included in subsequent sections.

In order to facilitate comparisons with previous analyses, extra data have been included in Table 3.1 under the heading eligible area. These values represent the total area of the land base that meets the criteria for the removal at each step regardless of area removed previously. By studying the eligible area totals, it will be easier to evaluate how the forest inventory has changed under the new VRI.

All of the land base classification steps performed during TSR 2 remain in the current classification. However, problem forest types are now divided into the categories low timber growing potential sites and unmerchantable forest types. Goshawk nests are now classified under the identified wildlife step. Many additions have been made since TSR 2. Non-productive stands are now specifically identified and classifications are made for old growth management areas. Areas not satisfactorily restocked was added to the classification process in analyses since TSR 2 but was removed for the 2003/2004 analyses to match TSR protocol.

The final classification indicates a long-term net harvesting land base of 198,705 ha, a 1.7% decrease over the TSR 2 base case (202,201 ha) and an 8.6% decrease from the 2002/2003 uplift analysis (217,306 ha).

Table 3.1. Timber harvesting land base determination

Land Classification	Reference Section	Total Land Base		Eligible Area
		Area (ha)	Volume (m^3)	Area (ha)
Total Area		826,847		
Not administered by MoF	3.2.1	221,207		
Total TSA		605,640		
Non-forest	3.2.2	62,042		
Non-productive forest	3.2.2	50,331		
Productive Forest		493,267	82,252,056	493,267
Inoperable	3.2.3	204,000	28,500,686	204,000
Operable Forest		289,267	53,751,371	289,267
Low productivity	3.2.4	4,144	347,933	110,227
Unmerchantable	3.2.5	8,885	4,500	51,764
Deciduous	3.2.5	7,676	757,055	17,813
Environmentally sensitive – outside watersheds	3.2.6	19,838	5,100,217	85,186
Environmentally sensitive – inside watersheds	3.2.6	5,927	193,670	16,985
Riparian	3.2.7	10,803	3,411,799	20,495
Identified wildlife	3.2.8	48	7,557	52
Protected areas strategy (Goal 2)	3.2.9	299	101,390	493,267
OGMA	3.2.10	13,416	4,846,146	54,080
Wildlife tree patches	3.2.11	792	185,708	1,082
Dewdney trail	3.2.12	93	16,410	251
Existing roads	3.2.13	4,706	645,386	6,276
Landings	3.2.13	1,192	731	1,703
Timber licences	3.2.1	1,171	285,927	1,747
Total Reductions		78,992	16,634,699	
Current Timber Harvesting Land Base		210,275	37,116,672	
Plus timber licences	3.2.1	1,171		
Less future roads	3.2.14	12,742		
Future Timber Harvesting Land Base		198,705		

3.2 EXCLUSIONS FROM THE TIMBER HARVESTING LAND BASE

3.2.1 Land Not Administered by the Ministry of Forests

All land ownerships not contributing to timber supply area harvests were reclassified as non-contributing. This is achieved by excluding all areas except for those coded ownership 62C or 69C in the MoF ownership layer. Timber licences (ownership 70N) were included in the future timber harvesting land base according to the schedule for which they are anticipated to revert to the TSA. Reversions take place over 25 years. This schedule is summarized in Table 3.2.

Table 3.2. Timber licence area reversion

Area Initially Removed (ha)	Cumulative Timber Licence Area Returned to the THLB (ha) by Decade			
	Start	Decade 1	Decade 2	Decade 3
1,171	293	585	878	1,171

3.2.2 Non-forest and Non-productive Forest

The BCLCS included in the VRI was used to identify non-forest areas. Under this land classification system any areas with less than 5% of the total surface area covered by trees, shrubs, herbs or bryoids are classified as Non-vegetated. Areas identified under the BCLCS at Level 1 as Non-Vegetated (N) were considered as non-forest and were removed from the productive land base. Unreported (U) areas were also removed from the productive land base at this stage. An exception was made for non-forested areas with a logging history which were assumed to have a regenerating forest cover and were therefore retained in the productive land base.

Non-productive areas were identified using the VRI attribute "Non-productive Description". Areas identified as non-productive or as non-productive brush under this attribute were removed from the productive land base. Again, an exception was made for non-productive areas with a logging history as it was assumed that areas that had previously supported harvestable stands and should be considered productive. The non-forest and non-productive areas are listed in Table 3.3.

Table 3.3. Non-forest area

Description	Area Removed (ha)
Non-forest	62,042
Non-productive forest	50,331
Total	**112,373**

3.2.3 Areas Considered Inoperable

Operability mapping for the Arrow TSA has been revised since TSR 2 and has been accepted by the MoF for use in timber supply analysis. Operable areas were identified during the classification using this mapping. The inoperable area removed is summarized in Table 3.4.

Table 3.4. Operable areas

Operability Attribute	Productive (ha)	Area Removed (ha)
Accessible	289,267	0
Inoperable	204,000	204,000
Total	**493,267**	**204,000**

3.2.4 Low Timber Growing Potential

The issues surrounding low growth potential sites and unmerchantable forest types within the Arrow TSA were explored in the report *Harvesting Performance in Problem Forest Types and Low Sites* (Rowe, 2002). The report states that one hundred and fifty cubic metres per hectare is considered a minimum harvestable volume per hectare. Although, the report does state there is some uncertainty with the Douglas-fir and larch limits.

Stands greater than age 140 with current volumes less than 150 m^3/ha were classified as not contributing to harvest. In addition, stands with age less than or equal to 140 years of age and not capable of producing 150 m^3/ha were reclassified. These stands were identified using a site index threshold. The site index limits were updated from TSR 2 values through a modelling exercise that found the site index value at which a stand is no longer able to produce 150 m^3/ha by 140 years in age. Stands with a logging history were not reclassified. The criteria are presented in Table 3.5.

Table 3.5. Low productivity criteria

Leading Species	Inventory Type Group	Age (yrs)	SI 50	Volume (m^3/ha)	Reduction	Area Removed (ha)
Douglas-fir/larch	1-8	≤ 140	< 13		100%	1,484
Douglas-fir/larch	1-8	> 140		< 150	100%	275
Western redcedar	9-11	≤ 140	< 10		100%	1
Western redcedar	9-11	> 140		< 150	100%	0
Hemlock/balsam	12-20	≤ 140	< 7.5		100%	226
Hemlock/balsam	12-20	> 140		< 150	100%	1,596
Spruce	21-26	≤ 140	< 8.5		100%	36
Spruce	21-26	> 140		< 150	100%	228
Lodgepole pine	27-31	≤ 140	< 9		100%	210
Lodgepole pine	27-31	> 140		< 150	100%	0
Total						**4,144**

3.2.5 Unmerchantable Forest Types

Unmerchantable forest types are forest types currently not utilized in the Arrow Boundary Forest District. The report *Harvesting Performance in Problem Forest Types and Low Sites* (Rowe, 2002) provided guidance on defining these forest types. As directed by the Chief Forester in the TSR 2 AAC rationale document, TSR 1 reductions were considered more appropriate than those used for TSR 2. The TSR 1 reductions were used for this analysis with some adjustments recommended in the Rowe report. The merchantability limits for pure hemlock stands changed from 30% to 40% and the limits for balsam leading stands changed from 10% to 30%. The removals are listed in Table 3.6.

Table 3.6. Unmerchantable type criteria

Leading Species	Inventory Type Group	Age (years)	TSR 1 Reduction	2003/2004 Analyses	Area Removed (ha)
Western redcedar	11	> 140	50%*	50%*	71
Pure hemlock	12	> 140	80%	80%	1,049
Hemlock leading	13-17	> 140	30%	40%	5,823
Balsam	18-19	141-250	10%	30%	328
Balsam	18-19	> 250	100%	100%	17
Balsam/spruce	20	> 140	20%	20%	1,569
Pine	28**	> 100	90%	90%	28
Deciduous	35-42	all	100%	100%	7,676
Total					**16,561**

* (Edgewood PSYU only)
** Height class = 2, stocking class >= 2, site class = "Poor"

3.2.6 ESAs and Unstable Terrain

A number of terrain stability mapping projects were completed by the AFLG during the period from 1995 through 2000. Pre-1995 mapping was updated by the MoF to meet current standards. In the 2002/2003 Uplift Analysis a new approach to classifying ESAs and unstable terrain was implemented. The approach combined two sources of information to identify environmentally sensitive areas (including soils):

- ESA1 and ESA2 designations in the MoF forest cover inventory; and
- Terrain stability mapping (TSM) data.

The TSM classifications are considered to be the best available information and were used for all areas where TSM data were available. Approximately 66% of the operable land base has been classified using the TSM (41% with TSIL B/C and 25% with TSIL D). The remaining area was classified using the original ESA designations. Areas were reclassified as non-contributing as shown in Table 3.7 and Table 3.8. Different criteria were applied depending if the identified areas were within a community watershed or a domestic watershed. For each polygon, only one reclassification was made.

Table 3.7 and Table 3.8 document how the deductions have evolved since TSR 2. The Chief Forester, in the Arrow TSA AAC rationale report (Pedersen, 2001), acknowledged that the TSR 2 methodology for soils and unstable terrain was overly restrictive. The Arrow Forest Association put forward in the report *Technical Report, Arrow TSA Timber Supply Option Analysis* (Timberline, 2000a) an alternate approach.

Based on the Chief Forester's review of the report the Arrow Base Case compromise solution was designed that has been accepted for use by the Chief Forester.

The terrain stability deductions were introduced in the 2002/2003 uplift analyses and were maintained for the 2003/2004 analyses. These deductions are based primarily on applying the previously used deduction percentages to the increased areas with TSM. The percentage deduction for Class "U" terrain outside of community watersheds has been increased from 60% to 80% to make it compatible with Class "V" terrain and to recognize that it is now used alone and not as an additional deduction to the inventory ESAs.

The ESA deductions for values other than soils remain unchanged from TSR 2.

Table 3.7. ESA and unstable terrain outside community watersheds

Environmentally Sensitive Area	TSR 2	IFPA Base Case Analysis	2003/2004 Analyses
Class V	80%	80%	80%
ESA1 Soils and/or Avalanche*	90%	90%	90%
Class U	60%	60%	80%
ESA1 Regeneration and/or Recreation	50%	50%	50%
ESA2 Avalanche and/or Recreation	50%	50%	50%
ESA2 Soils*	20%	20%	20%
Class IV	25%	13%	13%
Class P	20%	0%	13%

* Except where level A, B or C TSM mapping exists.

Table 3.8. ESA and unstable terrain inside community watersheds

Environmentally Sensitive Area	TSR 2	IFPA Base Case Analysis	2003/2004 Analyses
Class V	90%	90%	90%
ESA1 Soils and/or Avalanche*	100%	100%	100%
Class U	90%	90%	90%
ESA1 Regeneration and/or Recreation	100%	100%	100%
ESA2 Avalanche and/or Recreation	50%	50%	50%
ESA2 Soils and/or Regeneration*	50%	50%	50%
Class IV	35%	18%	18%
Class P	35%	0%	18%

* Except where level A, B or C TSM mapping exists.

Table 3.9 provides a summary of area reclassified as not contributing to harvest based on ESA and terrain surveys.

Table 3.9. Definition of unstable soils

Category	Area Removed (ha)
Outside Community Watersheds	19,838
Inside Community Watersheds	5,927
Total	**25,765**

3.2.7 Riparian Zones

Riparian zones along waterways are required by the Forest Practices Code to protect aquatic and terrestrial habitat. Streams, wetlands, and lakes defined in the MoF stream atlas have been classified by the Arrow Boundary Forest District on the basis of slope and width. Riparian management areas were generated as buffer polygons around these features based on their classifications. The criteria are listed in Table 3.10. Areas represented by the total riparian width were reclassified as unavailable for harvest.

Table 3.10. Riparian areas

Class	Reserve Zone Width (m)	Management Zone Width (m)	Retention in Management Zone	Total Riparian Width (m) (1)	Area Removed (ha)
S1	50	20	50%	60	107
S2	30	20	50%	40	5,687
S3	20	20	50%	30	3,544
S4	0	30	25%	8	0
S5	0	30	25%	8	599
S6	0	0	0%	0	0
W1	10	40	25%	20	82
W3	0	30	25%	8	4
W5	10	40	25%	20	678
L1	10	0	0%	10	102
Total					10,803

(1) Reserve zone width + (management zone width * retention % / 100)

The absence of S4 class streams was an outcome that caused some concern. Investigations revealed that it is the result of the automated stream classification model used to create the stream data for TSR2. It is likely to be inaccurate, but according to Arrow Boundary District MoF staff, it still represents the best available data at the time of the 2003/2004 analyses.

3.2.8 Identified Wildlife

No-harvest zones were established around known bird nesting sites (stick nests) which are protected under federal and provincial legislations. The criteria and areas reclassified for other species are listed in Table 3.11.

Table 3.11. Nesting site allowances

Species	Buffer	Area Removed (ha)
Goshawk	200	45
Great blue heron	100	3
Total		**48**

Stick nests represent only one element in a full program of management for identified wildlife. MoF policy sets a 1% maximum timber supply impact associated with identified wildlife. The Chief Forester stated a preference to see the 1% reduction implemented as a reduction in harvest yields instead of a reduction in THLB. Therefore, all existing stand yields were reduced by 1%.

3.2.9 Protected Areas Strategy - Goal 2

Protected Areas Strategy (PAS) Goal 1 areas are addressed in the ownership classification step documented above. These areas were removed with the established parks.

Work towards protecting areas identified in PAS Goal 2 has not progressed in recent years. Areas identified under PAS Goal 2 were still removed from the contributing land base. However, under the recommendation of MoF (B.C. MoF, 2003h) the following areas previously removed under PAS Goal 2 were no longer considered necessary to remove: Grassy Mountain, Kid Creek Cedars, and Sandon. The remaining areas removed are summarized in Table 3.12.

Table 3.12. Definition of PAS Goal 2

Goal 2 Protected Area	Area Removed (ha)
Bremner Delta Old Growth	235
Bulldog Tunnel Switchback	0
Hutchison - Sunshine	0
Idaho Peak	0
Summit Lake Park	41
Trout Lake / Northwest	0
Waldie Lake	0
Wragge Beach	22
Waneta	0
Total	**298**

3.2.10 Old Growth Management Areas

Old growth management areas (OGMA) were defined the Licencees and approved by the MoF for use within the Arrow TSA with revisions current to 2003. Additional revisions were provided by Slocan Forest Products for their chart area. The Slocan coverage was combined with the MoF coverage. The areas identified as OGMAs were removed from the harvestable land base during the land base classification in order to meet landscape level biodiversity objectives. These objectives are documented in Section 8.5.1.

3.2.11 Wildlife Tree Patches

In addition to accounting for landscape-level biodiversity, there is a requirement to maintain mature stand structural elements over time, in the form of wildlife tree patches (WTP). To allow for the retention of these patches, TSR 2 applied an area reduction of 2.5% to the net timber harvesting land base.

For these analyses, a forest development plan data layer (B.C. MoF, 2002) was used to explicitly identify currently mapped wildlife tree patches. These areas were removed from the timber harvesting land base.

In addition, a GIS buffer exercise was completed to identify other potential areas requiring additional representation for wild life tree patches (see Section 8.5.2). The results of this analysis defined additional volume reductions required to address the WTP issue.

3.2.12 Dewdney Heritage Trail

A 100-metre reserve on either side of this designated heritage trail was classified as not contributing to harvest.

3.2.13 Existing Roads, Trails, and Landings

Road lengths were determined by the MoF based on road lines captured in the forest inventory files, including Forest Service, road permit, and non-status roads. These line features were then buffered according to the widths summarized in Table 3.13, and the buffered areas were removed from the harvestable land base. In addition, a 3% reduction was made to all stands age 40 and less to account for existing landings.

Table 3.13. Existing road allowances

Class	Estimated Total Width (m)	Buffer Distance (m)	Reduction (%)	Area Removed (ha)	
				< age 41	> age 40
Highway/secondary	16	8.0	n/a	17	155
Roads	15[(1)]	7.5	n/a	2,013	2,288
Trails	4[(1)]	2	n/a	79	154
Landings	n/a	n/a	3 [(1)]	1,192	-
Total				**3,301**	**2,597**

[(1)]Estimated by Arrow Boundary Forest District staff

3.2.14 Future roads, Trails, and Landings

It is assumed that all stands older than age 40 will be roaded in the future at time of harvest. In these cases, area reductions were made in the timber supply analysis *after the volume is credited to the harvest*. These road allowances are summarized in Table 3.14.

Although the AFLG expressed the opinion that the future trails deduction of 2% is aggressive, the Chief Forester supported the numbers in the TSR 2 AAC rationale document.

Table 3.14. Future road allowances

Class	Reduction (%) [(1)]	Area (ha)
Roads	3.0	5,166
Trails	2.0	3,444
Landings	2.4	4,133
Total	**7.4** [(2)]	**12,742**

[(1)]Estimated by Arrow Boundary Forest District staff
[(2)]Net of 2,609 ha already removed as polygonal features in Section 3.2.13.

4.0 MANAGEMENT ZONES AND ANALYSIS UNITS

The Arrow TSA supports a very complex set of competing resource demands which are expressed in analysis as forest cover objectives. These objectives are applied to subsets of the land base and are very often overlapping. The objectives are described in this section.

4.1 MANAGEMENT ZONES, GROUPS, AND OBJECTIVES

The Arrow TSA falls within the Arrow Resource Management Zone established through the *Kootenay-Boundary Higher Level Plan Order* (KBHLPO). The KBHLPO was implemented on January 31, 2000 and was revised on October 26, 2002. It establishes many of the resource management zone objectives for the TSA. These are over and above Forest Practices Code requirements.

Forest cover objectives are applied to specific areas within the Arrow TSA. Zones to which the objectives are applied were defined by the plan. These resource emphasis zones are then used by the forest level model to ensure that the objectives are met over the modelled time horizon. The resource emphasis zones used in the 2003/2004 analysis are listed in Table 4.1. All of the zones are overlapping and are therefore not additive in area.

Table 4.1. Resource emphasis zones

Zone	Area (ha)
Integrated resource management	210,275
Connectivity corridors	66,928
Caribou habitat	13,669
Ungulate winter range	21,443
Visual quality objectives	86,793
Watersheds	102,392
Biodiversity mature seral reserve	39,621

4.1.1 Slocan Valley

The special management consideration given to the Slocan Valley required a clear definition of the extent of the valley. Originally the Slocan Valley was defined as the area within the following five landscape units: Hills, Idaho, Lemon, Pedro, and Perry. This definition was considered to be too broad and a mapping exercise was undertaken to more specifically define the contentious area within the Slocan Valley. This exercise refined the socially contentious area down to the slope face areas within the five landscape units. The new contentious area line work was refined once more in February 2004 (Ozan, 2003). This refined area line work is used by default in these analyses but the five landscape unit definition is also used in the sensitivity analyses. A comparison of the THLB within each definition is provided in Table 4.2.

Table 4.2. Slocan Valley area definitions

Landscape Unit	THLB within Contentious Area Line (ha)	Total THLB (ha)
Hills	982	8,244
Idaho	1,420	7,235
Lemon	154	11,549
Pedro	3,795	5,995
Perry	3,187	3,260
Total	9,537	36,284

4.2 ANALYSIS UNIT DEFINITION

Stands are grouped into analysis units in order to group stands of similar composition and growth pattern. In previous analyses, analysis units were formed based on similar species mix, productivity, and age group. For the 2003/2004 analyses, an ecologically based system for grouping stands into analysis units was implemented. This approach was selected because it integrates more closely with ecologically based productivity estimates. Additionally, many management and silviculture treatment decisions are determined based on the ecological classification of the stand being treated.

Stands were grouped using the biogeoclimatic ecosystem classification (BEC) system at the site series level. A cut off was determined for site series that only represent a small proportion of the land base. Stands within site series that only composed less than 100 ha (less than 0.1% of the land base) were grouped with the next closest site series in the BEC zone. A small component of stands was found to be within the IDF zone. All of the IDF stands were grouped in their own analysis unit regardless of differences in subzone and leading species. Three additional analysis units were added to account for the small portion of the land base managed under a partial harvest system (see Section 9.2).

This ecological approach to assigning analysis units resulted in a total of 96 analysis units which are summarized in Table 4.3. The analysis units are ordered in descending proportion of the land base.

Table 4.3. Analysis unit definitions

Analysis Unit	BEC		
	Zone	Site Series	Leading Species
1	ICHdw	01a	Douglas-fir
2	ICHmw2	04	Douglas-fir
3	ICHmw2	01	Douglas-fir
4	ICHmw2	01	Larch
5	ICHmw2	03	Douglas-fir
6	ICHmw2	04	Hemlock
7	ICHmw2	01	Hemlock
8	ICHmw2	01	Lodgepole pine
9	ICHdw	01b	Douglas-fir
10	ICHdw	01b	Larch
11	ESSFwc4	02	Balsam
12	ICHmw2	04	Larch
13	ESSFwc4	01	Balsam
14	ESSFwc1	01	Balsam
15	ESSFwc1	01	Spruce
16	ICHdw	01a	Larch
17	ICHmw2	01	Balsam
18	ICHmw2	04	Lodgepole pine
19	ICHmw2	03	Lodgepole pine
20	ICHdw	01a	Lodgepole pine
21	ESSFwc4	01	Spruce
22	ICHmw2	01	Balsam
23	ESSFwc1	02	Lodgepole pine
24	ESSFwc1	01	Lodgepole pine
25	ICHdw	01b	Lodgepole pine
26	ICHmw2	03	Larch
27	ESSFwc1	02	Balsam
28	ICHmw2	03	Hemlock
29	ESSFwc4	02	Spruce
30	ICHmw2	02	Lodgepole pine
31	ESSFwc4	02	Lodgepole pine
32	ESSFwc1	01	Hemlock
33	ESSFwc4	04	Balsam
34	ICHwk1	04	Hemlock
35	ESSFwc1	02	Spruce
36	ICHmw2	01	Western redcedar
37	ICHmw2	04	Spruce
38	ESSFwc4	01	Lodgepole pine
39	ICHmw2	05	Hemlock
40	ICHmw2	02	Douglas-fir
41	ICHmw2	05	Douglas-fir
42	ICHdw	01b	Hemlock

Analysis Unit	BEC		
	Zone	**Site Series**	**Leading Species**
43	ICHdw	02	Douglas-fir
44	ICHmw2	04	Western redcedar
45	ICHmw2	03	Spruce
46	ICHmw2	02	Larch
47	ICHmw2	04	Balsam
48	ESSFwc1	01	Larch
49	ESSFwc1	01	Douglas-fir
50	ICHmw2	03	Western redcedar
51	ICHmw2	05	Larch
52	ESSFwc4	04	Spruce
53	ICHdw	01b	Western redcedar
54	ICHmw2	05	Lodgepole pine
55	ICHmw2	03	Balsam
56	ICHdw	01a	Hemlock
57	ICHmw2	05	Spruce
58	ESSFwc4	04	Lodgepole pine
59	ESSFwc1	02	Larch
60	ESSFwc1	03	Balsam
61	ICHdw	01b	Balsam
62	ICHwk1	04	Douglas-fir
63	ESSFwc1	02	Douglas-fir
64	ICHdw	01a	Balsam
65	ESSFwc1	02	Hemlock
66	ESSFwc1	03	Spruce
67	ICHmw2	02	Spruce
68	ICHwk1	01	Spruce
69	ESSFdc1	01	Lodgepole pine
70	ESSFwc1	01	Western redcedar
71	ICHdw	01a	Western redcedar
72	ICHmw2	02	Balsam
73	ICHwk1	01	Hemlock
74	ICHmw2	05	Western redcedar
75	ICHwk1	04	Western redcedar
76	ICHdw	02	Lodgepole pine
77	ICHxw	01	Douglas-fir
78	ICHwk1	04	Spruce
79	ICHmw2	05	Balsam
80	ICHxw	03	Douglas-fir
81	ICHmw2	02	Hemlock
82	ESSFdc1	01	Balsam
83	ICHdw	02	Larch
84	ESSFdc1	01	Spruce
85	ICHdw	01b	Spruce

Analysis Unit	BEC		
	Zone	**Site Series**	**Leading Species**
86	ESSFwc4	02	Larch
87	ESSFwc1	03	Lodgepole pine
88	ESSFwc1	02	Western redcedar
89	ICHxw	02	Douglas-fir
90	ICHmw2	09	Hemlock
91	ICHmw2	09	Douglas-fir
92	ESSFwc4	02	Douglas-fir
93	IDF (all)	(all)	(All)
94	ICHmw2	01	Partial Harvest Lodgepole pine
95	ICHmw2	04	Partial Harvest Lodgepole pine
96	ICHmw2	03	Partial Harvest Lodgepole pine

A parallel series of analysis units running from 101 to 196 was also created to represent the existing managed stands (see Section 6.4). An additional parallel series running from 301 to 396 was created to identify stands pending harvest under the current forest development plan.

5.0 GROWTH AND YIELD

Forest stand growth and yield modelling for the 2003/2004 analyses will follow standard MoF methodologies, using well established tools and processes.

Managed stands were modelled with genetic gains from tree improvement programs calculated in the report *Impact of the Current and Planned Seed Orchard Program on Timber Flow in the Arrow Timber Supply Area* (Timberline, 2000c). The Forest Practices Code requires the use of improved seed where it is available.

As was discussed in Section 3.2.11, and calculated in Section 8.5.2, all yield estimates were reduced by a further 2.5% to reflect the anticipated impact of wildlife tree patches.

5.1 PREDICTIVE ECOSYSTEM MAPPING

A PEM process was used to inventory ecosystems within the Arrow TSA. The ecosystem inventory will be used as a foundation for the prediction of stand yields and therefore requires further discussion in this section. Uncertainty associated with the approval for use process is discussed below.

The PEM, as reprocessed January 2003, has been approved for use in Timber Supply Review.

> *The accuracy statistics are somewhat inconsistent, but overall indicate that the PEM is reasonably accurate and, in my opinion, can be used in TSR modelling with some qualification.* (Del Meidinger, May 9, 2003).

This report section summarizes qualifications associated with this approval which have bearing on implementation in forest level analysis.

There is no test data set available which meets the full range of requirements for independent quality assessment of the PEM. Plot data assigned to polygons (composed of amalgamated pixels) is limited to few plots per polygon, and plots were not distributed across the entire land base profile.

Predominant site series or combination of units is correct 67% (above the 65% requirement) of the time. Significant aggregation of site series was required to achieve this.

The percent overlap score is 50% (well below the 65% requirement). Uncertainty associated with this score is due to the nature of the accuracy assessment data set. The MoF summarized the risk as "*less abundant site series in polygons may not be as well predicted as dominant ones*".

The chi-squared tests evaluating map-unit proportions are not significantly different. This result is related to the level of site-series aggregation and only meaningful with regard to the site index issue if site index is assigned at this same level of aggregation. Sub-unit chi-squared tests indicate significant difference in the units ESSFwc4 and ICHdw (collectively 44% of the land base), which lowers confidence with respect to these particular areas.

The site series groupings were used for the chi-squared test of ecosystem unit proportions, an element of the accuracy assessment protocol defined by the Ministry of Forests (Ketcheson, 2003). The level of

groupings is of concern, especially where there are more than three units. Groupings seem to be designed to meet map accuracy requirements and are not necessarily justifiable ecologically. These groupings were considered for use in applying site index productivity values. However, loss of site index resolution associated with implementation of groupings, and loss of spatial resolution in relating site index to the landscape to some degree may jeopardize the spatial forest level analysis. Therefore, these groupings were not used to assign site index values.

5.2 SITE INDEX

The growth potential of modelled stands is quantified using site index. Site index is defined as the potential height of a site tree at age 50 grown on the site. All site index values are based on the standard set of site index curves used in the MoF software *Batch Site Tools 3.2i*. The site index values in this analysis came from two different sources:

- Derived from VRI age and height estimates; and
- Site index correlated to biogeoclimatic ecological classification (SIBEC).

5.2.1 VRI Site Index

Site index estimates were recalculated as part of the new VRI. The VRI site index values will be used to predict the yield of all natural stands. A comparison with the previously used forest cover inventory site index values found that many stands with low productivity or zero site index values were assigned higher values under the VRI. However, the VRI site index values had a smaller range than the forest cover values resulting in less area found in the higher site index classes.

The inventory audit found that VRI tree heights were significantly underestimated. Since tree height is the basis through which site index is calculated, it can also be assumed that the VRI site index will also be underestimated.

Concern was expressed by the AFLG that regenerating stand VRI site index estimates were underestimated when compared to the actual observed growth rates (Ozan, 2003). This will not be a concern in this analysis since managed stands will be modelled using SIBEC site index values.

5.2.2 SIBEC Productivity Estimates

Site index estimates produced using the MoF SIBEC system (including local data from the IFPA SIBEC sampling project) will be used to model the growth of the managed stands. SIBEC site index estimates are assigned to a stand based on the BEC site series classification. For this analysis, the BEC site series information required to use SIBEC was derived from the recently completed PEM project (JMJ Holdings Inc., 2003) for the Arrow TSA.

SIBEC values are particularly useful in stands where it is impossible to determine site productivity through analysis of past growth patterns. This occurs in very old stands where suppression prevents any tree from demonstrating the full growth potential of the site. It is also difficult to assess past growth patterns in very young stands due to their short growth history. SIBEC site index estimates were therefore assigned to the young existing managed stands. SIBEC productivity estimates can not be assigned to the very old stands because the model used to project natural stand yields is based on traditional site index values.

The productivity estimates to be used to model the future managed growth of stands currently between 25/15 and 141 years old (also known as “thrifty” stands) was controversial. The growth patterns of trees

in this age range make it possible to derive acceptable productivity estimates from the VRI data. An investigation comparing the VRI site index values and SIBEC values to ground sample data from the inventory audit was performed. This investigation revealed that the SIBEC values most closely represent the true ground measured sample data. Therefore, SIBEC productivity estimates were used to model the growth of all future managed stands. The site index values utilized are summarized in Table 5.1.

Table 5.1. Site index estimate application

Age Range (Years)		Douglas-fir and Spruce 0 - 25, All Others 0 - 15	Douglas-fir and Spruce > 25, All Others > 15
Existing	Model Site Index	Managed (TIPSY) SIBEC	Natural (VDYP) VRI Site Index
Future	Model Site Index	Managed (TIPSY) SIBEC	Managed (TIPSY) SIBEC

The AFLG completed a program of localized SIBEC sampling to improve the accuracy of the SIBEC estimates with localized data. The results of this project are documented in *Biogeoclimatic Ecosystem Classification Site Index Correlation Project Correlation Results* (Timberline, 2002a). An investigation was carried out that studied the impact of applying only the localized SIBEC values for zones where a sufficient number of local samples had been collected. This investigation revealed that the impact would be insignificant. This is due to the fact that the sample data collected by the AFLG was submitted to MoF for use in the SIBEC database. Therefore, the IFPA data now constitutes the majority of the data used to derive the current provincial SIBEC values for the same zones.

5.3 UTILIZATION LEVELS

The utilization levels modelled are listed in Table 5.2. They reflect current standards and performance.

Table 5.2. Utilization levels

Leading Species	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Pine	12.5	30.0	10.0
All others	17.5	30.0	10.0

Note: dbh = diameter breast height, dib = diameter inside bark

5.4 DECAY WASTE AND BREAKAGE – NATURAL STANDS

Decay, waste and breakage (DWB) factors associated with Forest Inventory Zone (FIZ) and the public sustained yield unit (PSYU) for each stand were used to model the natural stand yields. A summary of the break down of the land base into each FIZ and PSYU is provided in Table 5.3.

Table 5.3. FIZ and PSYU in THLB

FIZ	PSYU	THLB (ha)
E	126	25,785
E	129	132
E	170	202
E	180	86,633
E	303	34
E	323	536
E	356	13
E	511	180
E	575	68
E	707	48
E	2400	77
E	2402	10
E	2408	1
E	9999	344
G	125	2,560
G	126	3,501
G	128	30,837
G	129	46,593
G	160	571
G	170	217
G	180	9,854
G	303	446
G	323	2,260
G	535	23
G	614	2
G	761	105
G	831	2
G	1057	16
G	1917	152
G	2401	15
G	2405	68
G	2407	15
G	2496	25
G	2498	4

5.5 OPERATIONAL ADJUSTMENT FACTORS – MANAGED STANDS

Operational Adjustment Factors (OAF) are used to adjust managed stand yields to account for gaps in the stands (OAF1) and losses due to endemic factors such as pests or pathogens (OAF2). Standard OAF values were used to model managed stands. OAF1 was set to 0.85 (15% reduction) and OAF2 was set to 0.95 (5% reduction).

5.5.1 Root Rot

Concern was expressed by the MoF that the default OAF2 values do not reflect the extent of the endemic root rot in the Arrow TSA. However, the data on the extent and impact of the root rot is still inconclusive and has not been accepted for use in the base case (B.C. MoF, 2003h). In order to investigate the uncertainty in this issue, a root rot sensitivity analysis was included in this analysis.

The sensitivity was performed in conjunction with research conducted by Stearns-Smith & Associates Forestry Consultants. This research investigated the timber supply impact of *Armillaria* root rot on Douglas-fir leading stands in the ICH biogeoclimatic zone. Estimated OAF2 values reflecting various levels of infection severity were provided by Stearns-Smith & Associates for use in the sensitivity analysis.

5.6 NATURAL YIELD TABLE DEVELOPMENT

The MoF Variable Density Yield Prediction (VDYP) model (Version 6.6d) was used to develop natural stand yields at the analysis unit level. A yield curve was first generated for each stand using the species composition, crown closure and VRI site index of the stand. These yield curves were then area-weight averaged to produce one yield curve for each analysis unit. Volumes were calculated net of secondary deciduous species volume contributions. The average inputs to VDYP are presented in Table 5.4 but do not represent the actual inputs used as it was the yield curves that were averaged, not the inputs.

Table 5.4. VDYP analysis unit inputs

Analysis Unit	Description	Net Area (ha)	Average SI50	Average CC	Species Composition							
1	ICHdw 01a Fd	13,021	17.5	49	Fd	72	Lw	13	Pl	12	At	3
2	ICHmw2 04 Fd	8,661	17.6	59	Fd	65	Lw	14	Hw	13	Pl	8
3	ICHmw2 01 Fd	16,537	17.2	50	Fd	46	Se	28	Lw	15	Pl	11
4	ICHmw2 01 Lw	12,072	18.1	56	Lw	66	Pl	15	Fd	12	Se	7
5	ICHmw2 03 Fd	11,926	17.4	51	Fd	72	Lw	11	Pl	10	Hw	7
6	ICHmw2 04 Hw	5,550	15.7	57	Hw	64	Cw	16	Fd	15	Bl	5
7	ICHmw2 01 Hw	6,034	16.2	53	Hw	64	Cw	19	Fd	11	Se	6
8	ICHmw2 01 Pl	10,878	17.3	55	Pl	74	Lw	13	Fd	9	Se	4
9	ICHdw 01b Fd	6,950	18.1	52	Fd	69	Lw	16	Pl	11	Cw	4
10	ICHdw 01b Lw	5,842	19.3	57	Lw	64	Fd	18	Pl	14	At	4
11	ESSFwc4 02 Bl	1,242	12.0	49	Bl	68	Se	23	Pl	4	Hw	5
12	ICHmw2 04 Lw	3,944	17.9	61	Lw	62	Fd	21	Pl	11	Hw	6
13	ESSFwc4 01 Bl	8,449	13.1	41	Bl	65	Se	27	Pl	6	Fd	2
14	ESSFwc1 01 Bl	3,806	13.5	43	Bl	66	Se	25	Pl	5	Hw	4
15	ESSFwc1 01 Sx	2,960	13.3	51	Se	60	Bl	27	Pl	9	Hw	4
16	ICHdw 01a Lw	4,400	19.8	57	Lw	64	Fd	17	Pl	14	At	5
18	ICHmw2 04 Pl	2,353	16.5	62	Pl	71	Fd	13	Lw	13	Bl	3
19	ICHmw2 03 Pl	3,668	16.4	52	Pl	74	Fd	16	Lw	8	Bl	2
20	ICHdw 01a Pl	3,628	17.9	56	Pl	71	Fd	15	Lw	12	At	2
21	ESSFwc4 01 Sx	4,297	12.0	49	Se	64	Bl	32	Pl	3	Hw	1
22	ICHmw2 01 Bl	2,478	13.6	37	Bl	69	Se	20	Pl	7	Hw	4
23	ESSFwc1 02 Pl	1,611	16.3	55	Pl	78	Lw	8	Bl	8	Se	6
24	ESSFwc1 01 Pl	3,894	16.1	53	Pl	77	Bl	8	Fd	8	Lw	7

Analysis Unit	Description	Net Area (ha)	Average SI50	Average CC	Species Composition							
25	ICHdw 01b Pl	2,808	17.6	56	Pl	68	Lw	16	Fd	13	At	3
26	ICHmw2 03 Lw	2,365	17.8	55	Lw	61	Fd	20	Pl	14	Se	5
27	ESSFwc1 02 Bl	2,424	13.8	37	Bl	66	Se	26	Pl	4	Hw	4
28	ICHmw2 03 Hw	1,921	15.0	53	Hw	59	Cw	21	Fd	14	Se	6
29	ESSFwc4 02 Sx	308	11.8	49	Se	55	Bl	34	Pl	6	Hw	5
31	ESSFwc4 02 Pl	773	15.1	59	Pl	74	Bl	15	Se	7	Fd	4
32	ESSFwc1 01 Hw	821	13.5	57	Hw	60	Bl	15	Se	14	Cw	11
33	ESSFwc4 04 Bl	1,323	12.8	43	Bl	70	Se	26	Pl	3	Hw	1
34	ICHwk1 04 Hw	128	12.6	56	Hw	62	Cw	17	Fd	13	Bl	8
35	ESSFwc1 02 Sx	2,643	13.8	48	Se	65	Bl	27	Hw	5	Pl	3
36	ICHmw2 01 Cw	1,920	17.4	46	Cw	60	Hw	22	Fd	12	Se	6
37	ICHmw2 04 Sx	720	14.1	52	Se	61	Bl	22	Hw	10	Fd	7
38	ESSFwc4 01 Pl	2,476	15.5	54	Pl	74	Bl	12	Se	9	Fd	5
39	ICHmw2 05 Hw	18	14.7	53	Hw	74	Fd	13	Cw	12	PW	1
41	ICHmw2 05 Fd	4	16.6	55	Fd	70	Se	15	Lw	8	Pl	7
42	ICHdw 01b Hw	651	16.5	57	Hw	65	Cw	18	Fd	10	Lw	7
43	ICHdw 02 Fd	959	17.0	45	Fd	82	Pl	7	At	6	Ep	5
44	ICHmw2 04 Cw	571	17.0	47	Cw	55	Hw	27	Fd	12	Se	6
45	ICHmw2 03 Sx	527	15.9	48	Se	56	Bl	20	Hw	15	Fd	9
47	ICHmw2 04 Bl	683	15.1	56	Bl	61	Se	16	Hw	15	Fd	8
48	ESSFwc1 01 Lw	1,039	18.0	46	Lw	68	Pl	14	Fd	10	Se	8
49	ESSFwc1 01 Fd	1,460	16.6	49	Fd	64	Pl	16	Lw	12	Se	8
50	ICHmw2 03 Cw	1,065	16.9	44	Cw	54	Hw	25	Fd	17	Se	4
51	ICHmw2 05 Lw	8	22.5	69	Lw	62	Hw	29	Se	5	Pl	4
52	ESSFwc4 04 Sx	1,022	12.1	51	Se	60	Bl	32	Pl	5	Hw	3
53	ICHdw 01b Cw	510	17.4	43	Cw	64	Fd	14	Hw	14	Bl	8
54	ICHmw2 05 Pl	0	13.3	57	Pl	62	Bl	19	Se	10	Lw	9
55	ICHmw2 03 Bl	311	15.5	35	Bl	58	Se	19	Pl	12	Fd	11
56	ICHdw 01a Hw	236	15.5	59	Hw	64	Fd	16	Cw	13	Lw	7
57	ICHmw2 05 Sx	4	13.8	41	Se	62	Bl	35	Pl	2	Hw	1
58	ESSFwc4 04 Pl	429	16.0	59	Pl	70	Bl	18	Se	9	Lw	3
59	ESSFwc1 02 Lw	823	17.8	54	Lw	62	Pl	15	Fd	14	Se	9
60	ESSFwc1 03 Bl	468	14.0	27	Bl	59	Se	30	Hw	6	Pl	5
61	ICHdw 01b Bl	464	19.4	52	Bl	59	Fd	18	Cw	17	Lw	6
62	ICHwk1 04 Fd	55	16.0	61	Fd	66	Hw	23	Cw	10	Se	1
63	ESSFwc1 02 Fd	362	16.4	49	Fd	65	Pl	16	Lw	10	Se	9
64	ICHdw 01a Bl	255	17.6	45	Bl	58	Fd	25	Lw	12	Cw	5
65	ESSFwc1 02 Hw	477	14.6	46	Hw	59	Bl	16	Se	15	Cw	10
66	ESSFwc1 03 Sx	509	14.0	44	Se	71	Bl	24	Pl	3	Hw	2
68	ICHwk1 01 Sx	288	14.2	44	Se	55	Hw	18	Bl	17	Cw	10
69	ESSFdc1 01 Pl	690	17.6	45	Pl	73	Se	15	Bl	9	Lw	3
70	ESSFwc1 01 Cw	111	16.4	35	Cw	47	Hw	23	Bl	16	Se	14
71	ICHdw 01a Cw	322	16.8	26	Cw	65	Fd	22	At	7	Lw	6
73	ICHwk1 01 Hw	2,397	15.4	55	Hw	53	Cw	21	Fd	19	Bl	7
74	ICHmw2 05 Cw	1	17.7	60	Cw	40	Se	29	Fd	20	Hw	11

Analysis Unit	Description	Net Area (ha)	Average SI50	Average CC	Species Composition							
75	ICHwk1 04 Cw	36	14.6	60	Cw	50	Hw	29	Se	13	Bl	8
76	ICHdw 02 Pl	82	14.7	47	Pl	58	Fd	22	PY	15	Lw	5
77	ICHxw 01 Fd	736	19.2	39	Fd	70	Pl	11	Bl	10	Lw	9
78	ICHwk1 04 Sx	7	14.1	52	Se	51	Bl	23	Fd	21	Hw	5
79	ICHmw2 05 Bl	2	12.0	58	Bl	50	Se	35	Pl	14	Fd	1
80	ICHxw 03 Fd	55	17.8	29	Fd	82	At	9	Ep	4	Lw	5
82	ESSFdc1 01 Bl	90	14.4	34	Bl	62	Se	24	Pl	8	Fd	6
83	ICHdw 02 Lw	46	16.7	51	Lw	47	Fd	31	Ep	15	Cw	7
84	ESSFdc1 01 Sx	132	20.0	44	Se	49	Bl	25	Pl	23	Lw	3
85	ICHdw 01b Sx	650	17.8	50	Se	63	Fd	16	Lw	15	Bl	6
86	ESSFwc4 02 Lw	22	18.5	65	Lw	59	Fd	16	Pl	14	Se	11
87	ESSFwc1 03 Pl	69	17.5	44	Pl	76	Se	14	Bl	8	Fd	2
88	ESSFwc1 02 Cw	128	15.7	39	Cw	57	Hw	16	Bl	14	Se	13
90	ICHmw2 09 Hw	10	17.3	30	Hw	50	Cw	30	Ac	15	Ep	5
92	ESSFwc4 02 Fd	151	16.1	52	Fd	53	Bl	19	Pl	15	Se	13
93	IDF	158	17.7	47	Fd	75	Cw	9	Pl	9	Lw	7
94	ICHmw2 01 Pl Partial Harvest	5,946	17.3	55	Pl leading							
95	ICHmw2 04 Pl Partial Harvest	1,006	16.4	62	Pl leading							
96	ICHmw2 03 Pl Partial Harvest	1,193	16.1	53	Pl leading							

Notes:
CC: Crown closure
SI50: Site index base age 50 years

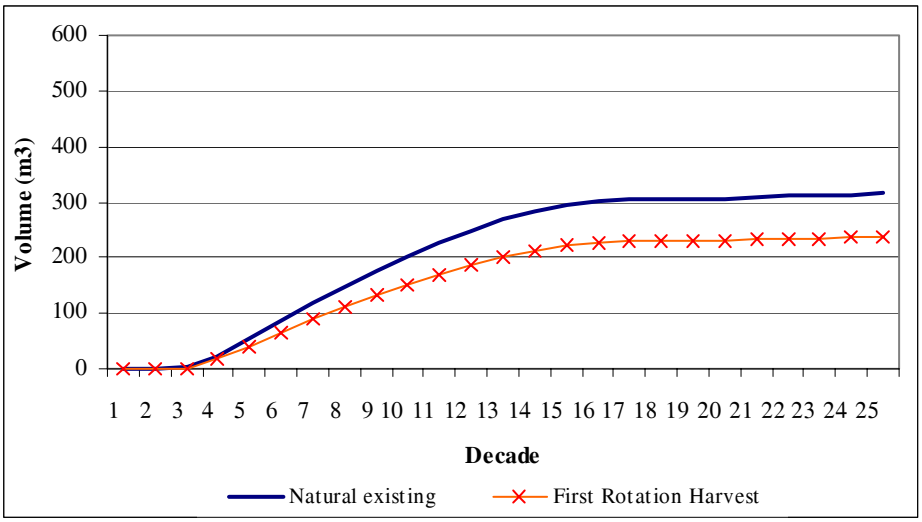
Stands were assigned to analysis units 301 to 390 to identify stands pending harvest under the current forest development plan. These stands are modeled using the same natural yield curve developed for the parallel analysis units listed above.

5.6.1 Partial Harvest Yield Curves

Partial harvesting was applied within the BCTS chart area. In this chart area, all pine leading stands in the ICH mw2 BEC zone are prescribed to be partially harvested (8,145 ha). These areas were assigned to analysis units 94, 95 and 96. To model the volume contribution made by partial harvest systems special yield curves were developed. The methodology used to develop the curves was reviewed and approved for use by MoF (B.C. MoF, 2003h). This approach, developed in conjunction between Timberline and MoF, was selected over the simplified approaches such as flat-line yields because of it has flexibility in re-entry time and it more accurately tracks volume growth if re-entry is delayed.

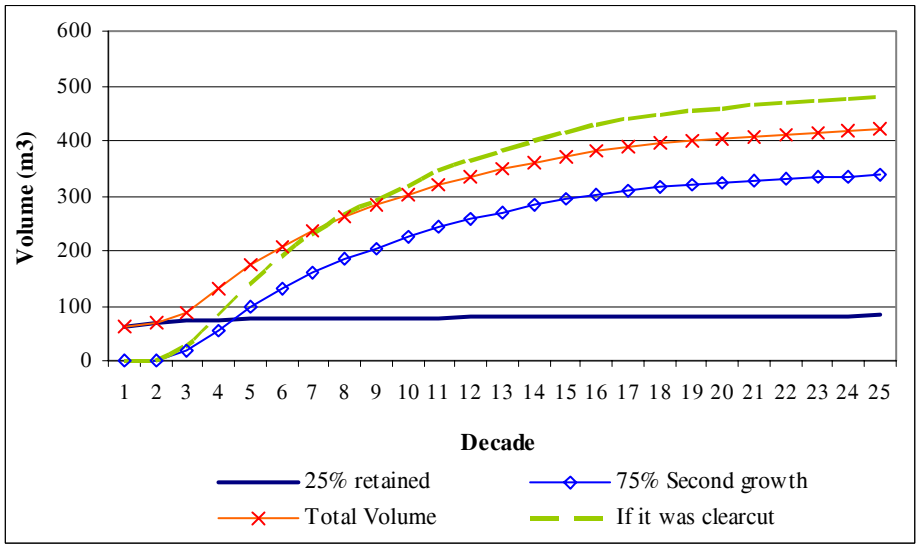
The curves assigned to analysis units 94, 95 and 96 were used to represent the first harvest from a natural stand that is to be managed using a partial harvest system. The yield curves were calculated as 75% of the equivalent clearcut volume from VDYP. An example yield curve is shown compared to the same yield curve for a clearcut stand in Figure 5.1.

Figure 5.1. Yield curve for partial harvest analysis unit 94



Future managed stand yield curves were also created for these analysis units and assigned to analysis units 194, 195 and 196. These curves represent the future entries into the stands for future partial harvests. A re-entry frequency of 50 years was used in the model. These curves were calculated as a combination of 25% of the clearcut volume from VDYP (representing the retained natural portion of the stand) and 75% of the clearcut volume from TIPSY (representing the regeneration in the openings created by the partial harvests). A reduction was made to the TIPSY contribution to represent the shading from the retained portion of the stand. A 0.5% reduction was applied for every 1% of the yield from retained stands. Since 25% was retained this resulted in a 12.5% reduction. The yield curve for analysis unit 195 is shown in Figure 5.2 along with the VDYP and TIPSY curves from which it was calculated.

Figure 5.2. Yield curve for partial harvest analysis units 195



5.7 EXISTING TIMBER VOLUME CHECK

An existing timber volume check was performed in order to ensure that all of the growth and yield inputs were correctly established in the model. The initial volume at time zero calculated by the model was output and compared to the current inventory volume from the VRI. Under the new DFAM standards a difference of less than three percent was considered acceptable. The results are presented in Table 5.5.

Table 5.5. Aggregate volume check

	Polygon Volume Derived Using		**Percent Difference**
	Inventory Volume	Yield Table Volume	
THLB Volume (m^3)	37,116,672	36,410,050	1.90%

6.0 SILVICULTURE

This section describes the assumptions used regarding silviculture treatments applied to the modelled managed stands.

6.1 SILVICULTURE MANAGEMENT REGIMES

Licencees were surveyed to determine the current silviculture practices used in the Arrow TSA. It was found that clearcutting was used almost exclusively across the TSA. A single exception is partial harvesting of pine leading stands in BC Timber Sales operating areas (see Sections 0 and 9.2). The planting species mixtures and densities currently prescribed by the licencees for each ecological zone were used as input for the yield model. A comparison made by the licencees between the observed growth of regenerated stands and the predicted growth generated from the yield model generally showed the model estimates to be conservative (Ozan, 2003).

Existing and future managed stand yields were developed using MoF BatchTIPSY (Version 3.0b). TIPSY incorporates the following inputs to derive a yield curve for each analysis unit:

- Species mix;
- Initial density - based on current stocking objectives (1,400 stems/ha);
- Regeneration method (planting);
- Area-weighted average site index (with SIBEC);
- Area-weighted genetic gains (see Section 6.3.2);
- Operational adjustment factors (OAF1 = 15%, OAF2 = 5%); and
- No regeneration delay (delays are incorporated in forest level modelling).

The planted species compositions used as input for TIPSY are presented in Table 6.1.

Table 6.1. TIPSY regeneration composition inputs

Analysis Unit	Description	Regeneration Species Composition	Average Site Index (m)
Future Managed			
201	ICHdw 01a Fd	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	18.1
202	ICHmw2 04 Fd	Pl 40 Sx 40 Lw 20	18.6
203	ICHmw2 01 Fd	Fd 33 Lw 33 Pl 33	19.3
204	ICHmw2 01 Lw	Fd 33 Lw 33 Pl 33	19.4
205	ICHmw2 03 Fd	Fd 33 Lw 33 Pl 33	18.3
206	ICHmw2 04 Hw	Pl 40 Sx 40 Lw 20	16.7
207	ICHmw2 01 Hw	Fd 33 Lw 33 Pl 33	17.4
208	ICHmw2 01 Pl	Fd 33 Lw 33 Pl 33	18.0
209	ICHdw 01b Fd	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	18.9
210	ICHdw 01b Lw	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	19.8
211	ESSFwc4 02 Bl	Sx 90 Pl 10	14.0
212	ICHmw2 04 Lw	Pl 40 Sx 40 Lw 20	19.2
213	ESSFwc4 01 Bl	Sx 90 Pl 10	13.9
214	ESSFwc1 01 Bl	Sx 100	15.5

Analysis Unit	Description	Regeneration Species Composition	Average Site Index (m)
215	ESSFwc1 01 Sx	Sx 100	18.1
216	ICHdw 01a Lw	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	19.9
218	ICHmw2 04 Pl	Pl 40 Sx 40 Lw 20	17.2
219	ICHmw2 03 Pl	Fd 33 Lw 33 Pl 33	17.1
220	ICHdw 01a Pl	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	18.1
221	ESSFwc4 01 Sx	Sx 90 Pl 10	19.6
222	ICHmw2 01 Bl	Fd 33 Lw 33 Pl 33	14.8
223	ESSFwc1 02 Pl	Sx 60 Pl 40	16.7
224	ESSFwc1 01 Pl	Sx 100	16.6
225	ICHdw 01b Pl	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	18.5
226	ICHmw2 03 Lw	Fd 33 Lw 33 Pl 33	18.5
227	ESSFwc1 02 Bl	Sx 60 Pl 40	15.0
228	ICHmw2 03 Hw	Fd 33 Lw 33 Pl 33	17.5
229	ESSFwc4 02 Sx	Sx 90 Pl 10	14.6
231	ESSFwc4 02 Pl	Sx 90 Pl 10	15.1
232	ESSFwc1 01 Hw	Sx 100	14.9
233	ESSFwc4 04 Bl	Sx 90 Pl 10	14.3
234	ICHwk1 04 Hw	Sx 50 Pl 30 Fd 20	17.2
235	ESSFwc1 02 Sx	Sx 60 Pl 40	16.8
236	ICHmw2 01 Cw	Fd 33 Lw 33 Pl 33	17.7
237	ICHmw2 04 Sx	Pl 40 Sx 40 Lw 20	20.5
238	ESSFwc4 01 Pl	Sx 90 Pl 10	16.4
239	ICHmw2 05 Hw	Pl 70 Lw 30	16.6
241	ICHmw2 05 Fd	Pl 70 Lw 30	16.7
242	ICHdw 01b Hw	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	16.8
243	ICHdw 02 Fd	Py 60 Pl 20 Fd 20	16.6
244	ICHmw2 04 Cw	Pl 40 Sx 40 Lw 20	17.5
245	ICHmw2 03 Sx	Fd 33 Lw 33 Pl 33	18.8
247	ICHmw2 04 Bl	Pl 40 Sx 40 Lw 20	16.5
248	ESSFwc1 01 Lw	Sx 100	18.9
249	ESSFwc1 01 Fd	Sx 100	17.3
250	ICHmw2 03 Cw	Fd 33 Lw 33 Pl 33	16.9
251	ICHmw2 05 Lw	Pl 70 Lw 30	22.9
252	ESSFwc4 04 Sx	Sx 90 Pl 10	19.5
253	ICHdw 01b Cw	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	17.9
254	ICHmw2 05 Pl	Pl 70 Lw 30	13.3
255	ICHmw2 03 Bl	Fd 33 Lw 33 Pl 33	15.6
256	ICHdw 01a Hw	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	15.5
257	ICHmw2 05 Sx	Pl 70 Lw 30	23.6
258	ESSFwc4 04 Pl	Sx 90 Pl 10	15.9
259	ESSFwc1 02 Lw	Sx 60 Pl 40	18.5
260	ESSFwc1 03 Bl	Sx 90 Pl 10	16.1
261	ICHdw 01b Bl	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	20.0
262	ICHwk1 04 Fd	Sx 50 Pl 30 Fd 20	23.4

Analysis Unit	Description	Regeneration Species Composition	Average Site Index (m)
263	ESSFwc1 02 Fd	Sx 60 Pl 40	17.0
264	ICHdw 01a Bl	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	17.7
265	ESSFwc1 02 Hw	Sx 60 Pl 40	14.3
266	ESSFwc1 03 Sx	Sx 90 Pl 10	17.3
268	ICHwk1 01 Sx	Sx 50 Pl 30 Fd 20	18.7
269	ESSFdc1 01 Pl	Sx 90 Pl 10	17.5
270	ESSFwc1 01 Cw	Sx 100	16.7
271	ICHdw 01a Cw	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	16.7
273	ICHwk1 01 Hw	Sx 50 Pl 30 Fd 20	18.3
274	ICHmw2 05 Cw	Pl 70 Lw 30	18.0
275	ICHwk1 04 Cw	Sx 50 Pl 30 Fd 20	18.0
276	ICHdw 02 Pl	Py 60 Pl 20 Fd 20	15.8
277	ICHxw 01 Fd	Fd 50 Lw 30 Py 10 Pl 10	19.3
278	ICHwk1 04 Sx	Sx 50 Pl 30 Fd 20	14.1
279	ICHmw2 05 Bl	Pl 70 Lw 30	12.9
280	ICHxw 03 Fd	Fd 50 Lw 30 Py 10 Pl 10	17.8
282	ESSFdc1 01 Bl	Sx 90 Pl 10	14.8
283	ICHdw 02 Lw	Py 60 Pl 20 Fd 20	17.0
284	ESSFdc1 01 Sx	Sx 90 Pl 10	20.0
285	ICHdw 01b Sx	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	20.1
286	ESSFwc4 02 Lw	Sx 90 Pl 10	18.5
287	ESSFwc1 03 Pl	Sx 90 Pl 10	17.9
288	ESSFwc1 02 Cw	Sx 60 Pl 40	15.5
290	ICHmw2 09 Hw	Cw 90 Sx 10	17.3
292	ESSFwc4 02 Fd	Sx 90 Pl 10	16.1
293	IDF	Fd 100	17.7
Existing Managed			
101	ICHdw 01a Fd	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	23.0
102	ICHmw2 04 Fd	Pl 40 Sx 40 Lw 20	20.5
103	ICHmw2 01 Fd	Fd 33 Lw 33 Pl 33	22.9
104	ICHmw2 01 Lw	Fd 33 Lw 33 Pl 33	24.0
105	ICHmw2 03 Fd	Fd 33 Lw 33 Pl 33	21.1
106	ICHmw2 04 Hw	Pl 40 Sx 40 Lw 20	18.0
107	ICHmw2 01 Hw	Fd 33 Lw 33 Pl 33	19.2
108	ICHmw2 01 Pl	Fd 33 Lw 33 Pl 33	23.9
109	ICHdw 01b Fd	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	24.3
110	ICHdw 01b Lw	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	24.0
111	ESSFwc4 02 Bl	Sx 90 Pl 10	15.7
112	ICHmw2 04 Lw	Pl 40 Sx 40 Lw 20	22.3
113	ESSFwc4 01 Bl	Sx 90 Pl 10	15.0
114	ESSFwc1 01 Bl	Sx 100	19.8
115	ESSFwc1 01 Sx	Sx 100	19.7
116	ICHdw 01a Lw	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	21.0
118	ICHmw2 04 Pl	Pl 40 Sx 40 Lw 20	24.0

Analysis Unit	Description	Regeneration Species Composition	Average Site Index (m)
119	ICHmw2 03 Pl	Fd 33 Lw 33 Pl 33	24.0
120	ICHdw 01a Pl	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	21.0
121	ESSFwc4 01 Sx	Sx 90 Pl 10	20.2
122	ICHmw2 01 Bl	Fd 33 Lw 33 Pl 33	18.3
123	ESSFwc1 02 Pl	Sx 60 Pl 40	17.8
124	ESSFwc1 01 Pl	Sx 100	20.5
125	ICHdw 01b Pl	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	24.0
126	ICHmw2 03 Lw	Fd 33 Lw 33 Pl 33	21.1
127	ESSFwc1 02 Bl	Sx 60 Pl 40	17.3
128	ICHmw2 03 Hw	Fd 33 Lw 33 Pl 33	19.4
129	ESSFwc4 02 Sx	Sx 90 Pl 10	15.8
131	ESSFwc4 02 Pl	Sx 90 Pl 10	15.8
132	ESSFwc1 01 Hw	Sx 100	15.0
133	ESSFwc4 04 Bl	Sx 90 Pl 10	15.0
135	ESSFwc1 02 Sx	Sx 60 Pl 40	17.0
136	ICHmw2 01 Cw	Fd 33 Lw 33 Pl 33	17.9
137	ICHmw2 04 Sx	Pl 40 Sx 40 Lw 20	22.4
138	ESSFwc4 01 Pl	Sx 90 Pl 10	21.0
142	ICHdw 01b Hw	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	18.0
143	ICHdw 02 Fd	Py 60 Pl 20 Fd 20	15.0
144	ICHmw2 04 Cw	Pl 40 Sx 40 Lw 20	18.0
145	ICHmw2 03 Sx	Fd 33 Lw 33 Pl 33	20.1
147	ICHmw2 04 Bl	Pl 40 Sx 40 Lw 20	18.0
148	ESSFwc1 01 Lw	Sx 100	21.6
149	ESSFwc1 01 Fd	Sx 100	19.7
150	ICHmw2 03 Cw	Fd 33 Lw 33 Pl 33	15.0
152	ESSFwc4 04 Sx	Sx 90 Pl 10	20.0
153	ICHdw 01b Cw	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	19.0
155	ICHmw2 03 Bl	Fd 33 Lw 33 Pl 33	15.0
156	ICHdw 01a Hw	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	18.0
157	ICHmw2 05 Sx	Pl 70 Lw 30	24.0
158	ESSFwc4 04 Pl	Sx 90 Pl 10	21.0
160	ESSFwc1 03 Bl	Sx 90 Pl 10	19.7
161	ICHdw 01b Bl	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	24.0
163	ESSFwc1 02 Fd	Sx 60 Pl 40	17.4
166	ESSFwc1 03 Sx	Sx 90 Pl 10	16.9
168	ICHwk1 01 Sx	Sx 50 Pl 30 Fd 20	18.4
169	ESSFdc1 01 Pl	Sx 90 Pl 10	15.0
170	ESSFwc1 01 Cw	Sx 100	15.0
171	ICHdw 01a Cw	Lw 30 Fd 30 Pl 20 Pw 15 Pw 3 Cw 2	15.0
173	ICHwk1 01 Hw	Sx 50 Pl 30 Fd 20	23.5
176	ICHdw 02 Pl	Py 60 Pl 20 Fd 20	21.0
177	ICHxw 01 Fd	Fd 50 Lw 30 Py 10 Pl 10	19.6
183	ICHdw 02 Lw	Py 60 Pl 20 Fd 20	21.0

Analysis Unit	Description	Regeneration Species Composition	Average Site Index (m)
184	ESSFdc1 01 Sx	Sx 90 Pl 10	14.2
185	ICHdw 01b Sx	Lw 40 Fd 35 Pl 10 Py 8 Pw 4 Cw 3	24.6
187	ESSFwc1 03 Pl	Sx 90 Pl 10	18.0
188	ESSFwc1 02 Cw	Sx 60 Pl 40	15.0
192	ESSFwc4 02 Fd	Sx 90 Pl 10	15.5
193	IDF	Fd 100	20.0

Stands were assigned to analysis units 301 to 390 to identify stands pending harvest under the current forest development plan. These stands were regenerated analysis units 401 to 490 with managed stand yield curves. For these managed stand curves, all TIPSY inputs were the same as the parallel two hundred series analysis units listed above except for differing genetic gains values (see Section 6.3.2).

6.2 REGENERATION DELAY

Regeneration delays are deployed separately from yield prediction in the forest level analysis. A 2-year delay was applied in all cases.

6.3 GENE RESOURCES

The Forest Practices Code requires use of best genetic material seed from tree improvement programs where available. Use of improved seed was modelled in the 2003/2004 analyses. The analyses utilized growth and yield estimates from the document *Final Report, Impact of the Current and Planned Seed Orchard Program on Timber Flow in the Arrow Timber Supply Area* (Timberline, 2000c), employing genetic gain information from the MoF Tree Improvement Branch and the Forest Genetics Council. A key input was a geo-reference of the genetic gain estimates by planning zone and elevation bands.

6.3.1 Seed Planning Zones

Seed planning zones have been established within the Arrow TSA for spruce, Douglas-fir, lodgepole pine, and larch. In each case, the genetic volume gain expectations vary according to elevation. In order to geo-reference these gain expectations, 100 metre elevation bands were generated across the TSA, using 1:250,000 TRIM digital elevation data. These bands were used to define six separate elevation zones (A-F). These are summarized in Table 6.2. Low *vs.* high distinctions were made to correspond to Seed Planning Units (*i.e.* portions of Seed Planning Zones defined by species and elevation band) whereby current and forecast seed production and genetic gain estimates may differ by elevation band.

Table 6.2. Seed planning zones

Planted Species	Zone A < 1000 m	Zone B 1000-1300 m	Zone C 1300-1400 m	Zone D 1400-1500 m	Zone E 1500-1700 m	Zone F > 1700 m
Spruce	Low	Low	High	High	High	None
Douglas-fir	Low	High	High	High	None	None
Larch	Low	Low	Low	None	None	None
Lodgepole pine	Low	Low	Low	None	None	None
Cedar	None	None	None	None	None	None

6.3.2 Genetic Gain

Genetic gain estimates current to 1999 were obtained for the Timberline seed orchard impacts analysis (2000c) for each planted species from the species plans of the Forest Genetics Council. These factors were based on current genetic gain expectations by elevation band within each seed planning zone, and take into account seed production expectations within each zone. To reflect expanding seed orchard programs, for each species and elevation band genetic gain estimates were provided for years 1-5, 6-10, and 11+.

After year 10, further changes in genetic gain were relatively minor. To simplify modelling, the gain figures for years 6-10 and 11+ were combined for a long-term value. The genetic gain estimate for years 1-5 was kept as a short-term value. The application of the short-term genetic gains proved to be problematic because the timber supply model works in ten year time increments. To solve this problem, the short-term genetic gains were applied to the regenerated stands resulting from the harvest of blocks identified for harvest under the forest development plan. These stands were initially assigned to analysis units 301 to 390 and are queued for harvest in the first period of the model scenario. These stands provide the total harvest volume required for approximately the first four years. After harvest, they were regenerated to analysis units 401 to 490 which are modeled with managed yield curves using the short-term genetic gains. This was accepted as a reasonable approach by MoF (2003h).

In addition, in TIPSY, larch is modelled as Douglas-fir. Therefore, the Douglas-fir and larch genetic gain expectations were blended based on the expected ratio of larch and Douglas-fir in the planting program. The simplified genetic gain values used are presented in Table 6.3.

Table 6.3. Genetic gain (simplified for modelling purposes)

	Zone A < 1000 m		**Zone B 1000-1300**		**Zone C 1300-1400**		**Zone D 1400-1500**		**Zone E 1500-1700**		**Zone F > 1700 m**	
Planted Species	**≤5**	**6+**	**≤5**	**6+**	**≤5**	**6+**	**≤5**	**6+**	**≤5**	**6+**	**≤5**	**6+**
Spruce	6	12	6	12	7	18	7	18	7	18	None	
Fir/Larch	11	15	3	16	4	13	None		None		None	
Lodgepole pine	7	10	7	10	7	10	None		None		None	
Cedar	None		None		None		None		None		None	

6.3.3 Implementation

Genetic gains factors are applied to each of the planted species when creating a managed stand yield table for an analysis unit. Since each analysis unit covers a range of elevation zones, the genetic gains for each zone were area weight averaged by the proportion of the analysis unit area in each zone. An example is given for a hypothetical analysis unit in Table 6.4.

Table 6.4. Example implementation of genetic gains factor

Planted Species	Zone A		Zone B		Zone C		Total Genetic Gain
	Genetic Gain	Area (ha)	Genetic Gain	Area (ha)	Genetic Gain	Area (ha)	
Pine (40%)	10	500	10	250	10	250	10
Spruce (40%)	12	500	12	250	18	250	13.5
Fir/Larch (20%)	15	500	16	250	13	250	14.8

In the above example, the genetics gain factors for each species would be applied as an input to TIPSY. TIPSY applies the gain factor to the yield curve for each species and then averages all three curves based on the planting ratios (Pl 40%, Sx 40%, Fd 20%) to produce one yield curve for the analysis unit. Since the genetic gains are averaged with many other factors within TIPSY, it is not possible to estimate an overall genetic gains factor for each analysis unit.

6.4 SILVICULTURE HISTORY

For growth and yield application, stands are classified into two categories based on their silviculture regime: natural stands and managed stands. Natural stands have no prior silviculture treatments and were regenerated naturally. Managed stands have had previous silviculture treatments and are assumed to be artificially regenerated. For simplicity, all Douglas-fir and spruce leading stands less than 26 years old are assumed to be managed. All other stands less than 16 years old are assumed to be managed. These values have been increase by five years from the TSR 2 values to represent the five years that have passed since TSR 2. The area considered managed and natural is summarized in Table 6.5.

Table 6.5. Managed and natural area

Silviculture Regime	Definition	Area (ha)
Natural	Fd and Sx > 25 yrs, All others > 15 yrs	182,187
Managed	Fd and Sx 0 - 25 yrs, All others 0 - 15 yrs	28,088
Total		**210,275**

6.5 BACKLOG AND CURRENT NOT SATISFACTORILY RESTOCKED

The not satisfactorily restocked (NSR) area was previously classified in the MoF forest cover database. With the transition to the VRI this information is no longer available. The MoF Integrated Silviculture Information System (ISIS) database was queried to provide information on the backlog NSR (harvested prior to 1987) and current NSR. According to the database there are 2,212 ha of current NSR and 1,603 ha of backlog NSR.

In TSR 2 the current NSR was assumed to regenerate with normal managed stand regeneration delays. In the 2003/2004 analyses it was assumed that the current NSR is represented among the 15,029 ha of THLB currently at age zero and is slowly being regenerated over time. Another difference from TSR 2 is the assumption that the NSR stands are being regenerated to managed stands. According to the MoF, NSR stands are not being managed and have reduced stocking standards when they achieve regenerated status. Therefore, NSR stands were modelled using natural stand yield curves.

The backlog NSR in TSR 2 was calculated to be 2,001 ha. The analysis assumed 70% of the backlog area regenerated over ten years and the remaining 30% would regenerate over the subsequent 60 years. Considering that only five of the initial ten years have passed, it appears that the regeneration of the backlog NSR is behind schedule since the backlog has only decreased by 400 ha. In the 2003/2004 analyses, it was assumed that this rate of regeneration will continue into the future. The remainder of the 70% (1,000 ha) was modelled as regenerated over the first 15 years and the last 30% (600 ha) was modelled as regenerated over the subsequent 45 years.

7.0 UNSALVAGED LOSSES

Expected unsalvaged losses are summarized in Table 7.1. In the 2003/2004 analyses, this volume was added to the annual harvest target to reflect total volume depletion.

Table 7.1. Unsalvaged losses

Cause of loss	Annual Unsalvaged Loss (cubic metres)
Mountain pine bark beetle	14,200
Douglas-fir bark beetle	500
Disease (years 1-94)	5,720
Disease (years 95+)	0
Wildfire	5,800
Windthrow/blowdown	2,500
Total (years 1-94)	**28,720**
Total (years 95+)	**23,000**

These values are the same as those used in TSR 2. Concern was expressed during the Arrow Boundary Forest District review of the data package that the values should be updated. However, at the time of the analysis, no evidence was available to prove that any changes were warranted. Therefore, the current values have been accepted by MoF as still appropriate for use in TSR 3 (B.C. MoF, 2003h).

8.0 RESOURCE MANAGEMENT EMPHASIS

Current forest resource management practices are modelled using forest cover requirements. These have been defined in the KBHLP, or in the KBHLPO. Table 8.1 provides a summary of the forest cover objectives.

Table 8.1. Resource emphasis zone forest cover requirements

Zone	Disturbance Limits		Retention Requirements		Application Land Base
	Min Ht (m)	Max %	Min Age	Min %	
Integrated Resource Management (IRM)	2.5	25	70	40	Timber harvesting land base
Enhanced Resource Development Zone (ERDZ)	2.5	25	70	40	Timber harvesting land base
Connectivity corridors	Application of landscape biodiversity requirements				Corridor land base with < 80% slope
Caribou					Productive forest less parks and protected areas, < 80% slope
ESSF below Caribou line	2.5	25	140 250	37 10	
ICH below Caribou line	2.5	25	140 250	40 10	
ESSF/ICH above Caribou line	2.5	25	140	70	
Ungulate winter range	2.5	25	100	40	Operable
Visual quality objectives					
VQO-retention	average 6.8	5	n/a	n/a	Crown forest
VQO-partial retention	average 6.0	15	n/a	n/a	Crown forest
VQO-modification	average 5.5	25	n/a	n/a	Crown forest
Watersheds					
Class 1 domestic	6	15	n/a	n/a	Crown forest
Class 2 domestic	6	20	n/a	n/a	Crown forest
Class 3 domestic	6	25	n/a	n/a	Crown forest
Community watersheds	6	20	n/a	n/a	Crown forest

8.1 ESTIMATING GREEN-UP AGE

A green-up age was not required for the 2003/2004 analyses. In timber supply analysis, age is often used as a surrogate for height when modelling height based constraints. For this analysis, the average stand heights were projected along with the estimated yields from TIPSY. The height based constraints were then applied according to this height.

8.2 VISUAL RESOURCES

Past timber supply analyses have shown high levels of sensitivity to visual management modelling assumptions. In order to ensure that existing visual inventory information is used in the most appropriate fashion to represent current visual management in timber supply analysis, a number of projects were undertaken in conjunction with the preparation of this data package including:

- Visual landscape inventory (VLI) refinement: This project entailed refining the existing line work to ensure conformance with new Provincial VLI standards. It is not a new inventory and does not change polygon labels. In some cases it does amalgamate adjacent polygons and in other cases resulted in minor changes to polygon boundaries.

- Grouping of VLI polygons for analysis purposes: In TSR 2 all VLI polygons with similar VQOs within a landscape unit were grouped and disturbance limits were applied to the entire area for analysis purposes. In the 2002/2003 uplift analysis (Timberline, 2003a) disturbance requirements were applied to individual VLI polygons. In practice the judgment of meeting a VQO at the operational level is based on area seen from particular viewpoints. In order to approximate this for timber supply analysis purposes, VLI polygons were grouped according to the original inventory viewpoints with disturbance requirements applied to the group. In some cases this resulted in grouping several polygons, in others individual polygons were used. A sensitivity analysis exploring the impacts of not grouping the visual polygons was performed.

The TSR 2 AAC rationale acknowledges uncertainty in TSR 2 methods to establish both green-up heights and maximum allowable disturbance values. Previous analyses used a visually effective green-up (VEG) height of five meters for all VQOs.

Accurate VEG heights can be calculated for each VQC following the methodology outlined in the 1998 MoF publication *Procedures for Managing Visual Resources to Mitigate Impacts on Timber Supply*. This process calculates VEG heights using digital terrain model (DTM) data to provide slope class information. This process was carried out for the 2003/2004 analyses. New VEG heights were calculated for the THLB area within each VLI polygon for use in the 2003/2004 analyses. This differs from previous calculations that used the productive area instead of the THLB only. The use of the THLB was considered more appropriate since it does not include areas considered inoperable due to steep slopes that would skew results.

A summary of the THLB that is within the visual management area is provided in Table 8.2. The area is broken down by the new VEG heights to provide an understanding of the distribution of the new values. The maximum disturbance limits for visual polygons with recommended VQO of retention was set to 5% of the productive area below the polygon VEG height. The maximum for partial retention was 15% and modification maximum was 25%.

Table 8.2. VEG heights for visual management area within THLB

VEG Height (m)	THLB (ha)
4.0	1,497
4.5	9,963
5.0	7,981
5.5	13,963
6.0	15,428
6.5	9,953
7.0	15,664
7.5	11,239
8.0	1,083
8.5	24
Total Visual Area	86,793

In order to explore visual resources issues further, a sensitivity analysis studying the impact of adjusting the maximum denudation percentages was also performed.

8.3 WILDLIFE

8.3.1 Caribou

Caribou habitat areas were mapped as part of the KBLUP. Specific disturbance and retention requirements for these areas were provided by the KBHLPO. The management constraints vary slightly between areas within the ICH and ESSF BEC zones. Criteria were also set relative to a "caribou line" under the KBLUP which appears to be an old operability line. The requirements are listed in Table 8.1. For areas in the ESSF below the Caribou line, an additional 7% was added to the original requirement of 30% > 140 years. This was done to represent the impact of the requirement that an additional 20% of caribou habitat area in the ESSF must be managed by partial cutting to maintain suitable caribou habitat attributes.

8.3.2 Ungulate Winter Range

Areas identified as ungulate winter range were mapped as part of the KBLUP. The retention and disturbance requirements were not explicitly set in the KBHLPO. Disturbance requirements created as part of an Interagency Management Committee (IAMC) implementation strategy were used for the 2003/2004 analyses.

New West Kootenay ungulate winter range mapping has recently been completed. However, the new mapping and associated management criteria have not yet been implemented as current practice and were therefore not used in the 2003/2004 analyses. To estimate the potential impact resulting from the implementation of the new mapping in the future a sensitivity analysis was performed using the new mapping and associated management criteria (Section 10.2.3).

8.3.3 Species at Risk

The wildlife species that are currently at risk in the Arrow TSA are listed in Table 8.3. The impact of managing for these species is currently unknown. In order to anticipate the impact on future management, the MoF maximum reduction of 1% of the THLB area was applied for identified wildlife.

Table 8.3. Species at risk

Common Name	Scientific Name
Bull trout	*Salvelinus confluentus*
Coeur d'Alene salamander	*Plethodon idahoensis*
Western screech owl	*Otus kennicottii macfarlanei*
Lewis woodpecker	*Melanerpes lewis*
Grizzly bear	*Ursus arcto*
Fisher	*Martes pennanti*
Wolverine	*Gulo gulo*
Badger	*Taxidea taxus jeffesonii*

8.4 ADJACENT CUTBLOCK GREEN-UP

All modelling in the 2003/2004 analyses was conducted spatially for the first 20 years. Under a spatial analysis, a block may not be harvested until the adjacent block reaches the oldest estimated green-up age for the management zones within which it is located. Adjacency information was included in the model input data in order to apply adjacency constraints on harvesting. Treatment unit mapping was also utilized to model a more realistic pattern of harvesting across the land base. See Section 9.6.1. A sensitivity analysis with no consideration of adjacency was also performed.

8.5 BIODIVERSITY

Within the Arrow TSA, biodiversity is primarily managed through old-seral forest retention. In recent years, members of the AFLG have been working to identify and refine old growth management areas (OGMAs). The refined OGMAs were amalgamated by the MoF in a coverage current to 2003. Timberline updated this coverage with a submission from Slocan Forest Products for use in the 2003/2004 analyses. The OGMAs were used directly to meet old growth landscape level biodiversity requirements in the 2003/2004 analyses.

8.5.1 Landscape Level Biodiversity

Biodiversity seral stage requirements are set in the *Biodiversity Guidebook* (B.C. MoF, 1995). They are established at the Biogeoclimatic (BEC) variant level within each landscape unit. The OGMA were used to explicitly reserve the quantity of area needed to meet the old growth seral stage requirements. In the 2003/2004 analyses, the OGMA were reserved from the timber harvesting land base during the classification process (Section 3.2.10). Subsequently the old growth retention requirements were assumed to be met.

The KBHLPO requires that a mature seral component of the land base must be maintained for biodiversity objectives. This requirement is only applied to specific landscape units. The target landscape units and their biodiversity emphasis option (BEO) are listed in Table 8.4.

Table 8.4. Landscape units managed for mature biodiversity objectives

Landscape Unit		BEC Subzone / Variant	BEO
N501	Sheep Creek	ICH dw	Intermediate
N504	Pend' Oreille	ICH dw	Intermediate
N505	Stagleap	ICH dw	Intermediate
N508	Blueberry	ICH dw	Intermediate
N509	Dog	ICH dw	Intermediate
N511	Cayuse	ICH dw	Intermediate
N513	Pedro	ICH dw	Intermediate
N514	Perry	ICH dw	Intermediate
N518	Gladstone	ICH dw	Intermediate
N515	Lemon	ESSF wc1	High
		ESSF wc4	High
		ICH dw	High
		ICH mw2	High
N525	Wilson	ESSF wc1	High
		ESSF wc4	High
		ICH dw	High
		ICH mw2	High
		ICH wk1	High
N528	Kuskanax	ESSF wc1	High
		ESSF wc4	High
N529	Halfway	ESSF wc1	High
		ESSF wc4	High
N530	Trout	ESSF wc1	High
		ESSF wc4	High
		ICH mw2	High
		ICH vk1	High
		ICH wk1	High

The minimum target retention percentages for the mature seral component are summarized in Table 8.5.

Table 8.5. Mature seral stage requirements

BEO	NDT	ESSF		ICH		IDF	
		Max %	Min Age (yrs)	Max %	Min Age (yrs)	Max %	Min Age (yrs)
Low	1	19	120	17	100		
	2	14	120	15	100		
	3	14	120	14	100		
	4			17	100	17	100
Intermediate	1	36	120	34	100		
	2	28	120	31	100		
	3	23	120	23	100		
	4			34	100	34	100
High	1	54	120	51	100		
	2	42	120	46	100		
	3	34	120	34	100		
	4			51	100	51	100

8.5.2 Stand Level Biodiversity - Wildlife Tree Retention

After other land classification was completed, additional reductions to the harvesting land base were required to provide sufficient reserves of productive timber for wildlife at the site-specific level. These small reserves were designated as wildlife tree patches.

In order to identify the net harvestable area requiring WTP reserves, all areas removed from the productive forest land base were identified. These included areas specifically identified as wildlife tree patches in the current inventory and forest development plans. Also included are stands with veteran layers which are assumed to not contribute to harvest. All of these forest components were then given a 250-metre buffer to reflect half of the maximum acceptable distance between wildlife tree patches according to Forest Practices Code (FPC) Biodiversity Guidebook (please see map 14).

Harvestable areas not included within these buffers were deemed to require additional retention of WTP reserves. Table 8.6 summarizes percentage reservations calculated based on Table 20(a) of the *Biodiversity Guidebook.*

Veteran layers do not contribute to volume estimates used in timber supply analysis. They do provide old growth characteristics valuable for stand level biodiversity. The assumption that stands with veteran layers contribute to the WTP is based on the assumption that operations will leave the veterans standing, probably in the context of WTPs or snag recruitment.

Yield table reduction for WTPs was chosen over area reductions to maintain the integrity of the spatial analysis.

Table 8.6. Wildlife tree patch reductions

1	2	4	5	6	7	8	9	10	11	12
					(6/5)	(5/4)		(9/5)		(11*10)
Landscape Unit	**BEC Zone/ Subzone**	**Productive Area (ha)**	**Net Area (ha)**	**Net Logged Area (ha)**	**% of Net Logged**	**% of Productive that is Net**	**Net > 250m (ha)**	**Ratio Net 250/Net**	**WTP % Gross**	**WTP % Net**
Arrow Lakes	ICH mw	5	0	0	0	0	0	1.00	0	0.0
Barnes-Whatshan	ESSFwc	1	1	0	3	77	0	0.27	5	1.4
Barnes-Whatshan	ICH dw	948	834	64	8	88	392	0.47	7	3.3
Barnes-Whatshan	ICH mw	565	479	122	26	85	271	0.57	8	4.5
Bear	ESSFwc	677	434	58	13	64	130	0.30	4	1.2
Bear	ICH dw	13,676	6,305	1,427	23	46	4,276	0.68	4	2.7
Bear	ICH mw	6,424	4,174	1,108	27	65	1,625	0.39	6	2.3
Bear	ICH xw	75	0	0	0	0	0	0.00	0	0.0
Blueberry	ESSFwc	9,321	5,919	2,487	42	64	3,296	0.56	7	3.9
Blueberry	ICH dw	5,420	1,611	319	20	30	1,185	0.74	2	1.5
Blueberry	ICH mw	10,902	7,977	3,104	39	73	4,652	0.58	8	4.7
Caribou	ESSFwc	16,719	5,124	1,975	39	31	3,432	0.67	4	2.7
Caribou	ICH mw	17,007	11,005	3,547	32	65	7,125	0.65	6	3.9
Caribou	ICH wk	36	28	31	112	79	0	0.01	0	0.0
Cayuse	ESSFwc	2,616	961	106	11	37	608	0.63	2	1.3
Cayuse	ICH dw	2,815	1,919	587	31	68	1,355	0.71	7	4.9
Cayuse	ICH mw	2,236	1,386	306	22	62	783	0.56	5	2.8
Cayuse	IDF un	375	169	58	34	45	94	0.56	5	2.8
Dog	ESSFdc	26	22	5	22	82	13	0.61	7	4.3
Dog	ESSFwc	5,179	2,970	1,039	35	57	1,523	0.51	6	3.1
Dog	ICH dw	8,149	2,628	111	4	32	2,176	0.83	1	0.8
Dog	ICH mw	8,485	4,822	1,391	29	57	2,847	0.59	6	3.5
Eagle	ESSFwc	14,574	8,992	2,528	28	62	4,641	0.52	6	3.1
Eagle	ICH dw	4,651	3,533	221	6	76	1,477	0.42	6	2.5
Eagle	ICH mw	22,105	16,397	2,639	16	74	7,642	0.47	6	2.8
Erie	ESSFwc	7,507	1,687	278	17	22	1,056	0.63	1	0.6
Erie	ICH dw	5,339	2,834	329	12	53	1,919	0.68	3	2.0
Erie	ICH mw	8,450	4,317	1,120	26	51	1,953	0.45	5	2.3
Erie	ICH xw	224	117	21	18	52	113	0.97	4	3.9
Fish	ESSFwc	3,495	44	10	22	1	39	0.89	0	0.0
Fish	ICH mw	2,237	1,250	173	14	56	856	0.68	4	2.7
Fish	ICH vk	881	511	315	62	58	376	0.74	9	6.6
Fish	ICH wk	879	269	50	19	31	203	0.75	2	1.5
Fosthall	ESSFwc	65	63	63	100	97	54	0.86	17	14.7
Fosthall	ICH mw	527	452	231	51	86	226	0.50	11	5.5
Fosthall	ICH wk	480	460	185	40	96	61	0.13	11	1.5
Glade		11	0	0	0	1	0	0.87	0	0.0
Glade	ESSFwc	1,558	494	51	10	32	358	0.73	1	0.7
Glade	ICH dw	6,750	3,437	462	13	51	2,023	0.59	3	1.8
Glade	ICH mw	2,354	1,366	62	5	58	632	0.46	3	1.4

1	2	4	5	6	7	8	9	10	11	12
					(6/5)	(5/4)		(9/5)		(11*10)
Landscape Unit	**BEC Zone/ Subzone**	**Productive Area (ha)**	**Net Area (ha)**	**Net Logged Area (ha)**	**% of Net Logged**	**% of Productive that is Net**	**Net > 250m (ha)**	**Ratio Net 250/Net**	**WTP % Gross**	**WTP % Net**
Gladstone	ICH dw	137	122	8	6	89	47	0.39	7	2.7
Gladstone	ICH mw	23	16	0	0	70	13	0.79	4	3.2
Halfway	ESSFwc	11	6	0	6	54	6	0.97	3	2.9
Halfway	ICH mw	376	282	125	44	75	171	0.61	9	5.5
Halfway	ICH wk	887	722	292	40	81	257	0.36	9	3.2
Hills	ESSFwc	6,868	1,557	844	54	23	1,069	0.69	4	2.7
Hills	ICH dw	729	453	5	1	62	276	0.61	3	1.8
Hills	ICH mw	9,640	5,618	582	10	58	3,760	0.67	4	2.7
Hills	ICH wk	1,169	617	255	41	53	309	0.50	6	3.0
Hoder	ICH mw	5	2	0	0	39	2	1.00	1	1.0
Idaho	AT	6	0	0	0	0	0	0.00	0	0.0
Idaho	ESSFwc	14,697	1,388	541	39	9	1,287	0.93	2	1.9
Idaho	ICH dw	1,003	549	39	7	55	401	0.73	3	2.2
Idaho	ICH mw	10,698	5,244	577	11	49	3,844	0.73	3	2.2
Johnston	ICH mw	2	2	1	53	86	1	0.58	11	6.3
Koch	ESSFwc	1	0	0	28	22	0	0.89	2	1.8
Kuskanax	ESSFwc	17,965	1,952	619	32	11	1,423	0.73	1	0.7
Kuskanax	ICH mw	10,860	5,673	1,711	30	52	3,666	0.65	5	3.2
Kuskanax	ICH wk	4,130	1,309	480	37	32	977	0.75	4	3.0
Ladybird	ESSFwc	17,553	7,343	2,823	38	42	4,706	0.64	5	3.2
Ladybird	ICH dw	9,030	4,176	337	8	46	2,303	0.55	3	1.7
Ladybird	ICH mw	8,783	5,896	1,652	28	67	2,450	0.42	7	2.9
Ladybird	IDF un	146	2	0	0	1	2	1.00	0	0.0
Lemon	AT	19	0	0	0	0	0	0.00	0	0.0
Lemon	ESSFwc	17,589	4,638	2,000	43	26	3,595	0.78	4	3.1
Lemon	ICH dw	2,375	1,104	509	46	46	774	0.70	7	4.9
Lemon	ICH mw	10,182	5,830	1,719	29	57	3,825	0.66	6	3.9
Pedro	ESSFwc	4,724	1,620	346	21	34	1,072	0.66	2	1.3
Pedro	ICH dw	4,474	1,795	175	10	40	1,168	0.65	2	1.3
Pedro	ICH mw	4,794	2,596	252	10	54	1,247	0.48	3	1.4
Pend Oreille	ESSFwc	358	210	45	21	59	78	0.37	5	1.9
Pend Oreille	ICH dw	5,804	3,408	1,100	32	59	2,004	0.59	6	3.5
Pend Oreille	ICH mw	2,617	1,891	534	28	72	1,024	0.54	7	3.8
Pend Oreille	ICH xw	2,001	806	433	54	40	613	0.76	6	4.6
Perry	ESSFwc	2,217	1,088	1	0	49	565	0.52	2	1.0
Perry	ICH dw	1,830	1,001	15	1	55	566	0.57	2	1.1
Perry	ICH mw	2,249	1,188	0	0	53	624	0.53	2	1.1
Rossland	ESSFdc	58	0	0	0	0	0	0.00	0	0.0
Rossland	ESSFwc	2,109	430	234	54	20	327	0.76	4	3.0
Rossland	ICH dw	5,585	2,317	632	27	41	1,703	0.73	4	2.9
Rossland	ICH mw	2,926	2,091	414	20	71	851	0.41	6	2.4

1	2	4	5	6	7	8	9	10	11	12
					(6/5)	(5/4)		(9/5)		(11*10)
Landscape Unit	**BEC Zone/ Subzone**	**Productive Area (ha)**	**Net Area (ha)**	**Net Logged Area (ha)**	**% of Net Logged**	**% of Productive that is Net**	**Net > 250m (ha)**	**Ratio Net 250/Net**	**WTP % Gross**	**WTP % Net**
Rossland	ICH xw	103	0	0	0	0	0	1.00	0	0.0
Sheep	ESSFdc	3,916	1,159	318	27	30	650	0.56	3	1.7
Sheep	ESSFwc	4,750	1,926	694	36	41	1,040	0.54	5	2.7
Sheep	ICH dw	13,268	3,172	199	6	24	2,763	0.87	1	0.9
Sheep	ICH mw	11,196	5,235	2,236	43	47	3,086	0.59	6	3.5
Stagleap		151	39	5	12	26	33	0.85	1	0.8
Stagleap	ESSFwc	18,207	2,296	443	19	13	1,815	0.79	1	0.8
Stagleap	ICH dw	8,013	2,362	77	3	29	2,165	0.92	1	0.9
Stagleap	ICH mw	14,990	4,516	870	19	30	3,407	0.75	2	1.5
Stagleap	ICH xw	548	22	0	2	4	22	0.99	0	0.0
Trout	ESSFwc	2,922	13	0	0	0	2	0.17	0	0.0
Trout	ICH mw	345	204	117	57	59	59	0.29	9	2.6
Trout	ICH vk	170	0	0	0	0	0	0.00	0	0.0
Trout	ICH wk	817	286	130	45	35	157	0.55	6	3.3
Vipond	ICH mw	1,290	1,058	429	41	82	493	0.47	9	4.2
Wilson	ESSFwc	15,823	2,453	888	36	16	1,827	0.74	3	2.2
Wilson	ICH dw	675	410	90	22	61	302	0.74	5	3.7
Wilson	ICH mw	12,792	6,720	2,285	34	53	4,502	0.67	5	3.3
Wilson	ICH wk	1,110	305	126	41	28	204	0.67	4	2.7
Woden	ICH mw	1,394	1,219	344	28	87	502	0.41	9	3.7
								Productive Area Weighted Average		**2.5**

Column 4: Total productive area
Column 5: Net harvestable area
Column 6: Net harvestable area with logging history
Column 7: Percentage of harvestable area which has been logged
Column 8: Percentage of productive area which is available (harvestable)
Column 9: Net area > 250 metres distant from unharvestable
Column 10: Ratio of net area > 250 m / total net area
Column 11: Gross WTP area from Biodiversity Guidebook (Table 20(a)) based on Columns 7 and 8
Column 12: Net WTP area (reduced by Column 10 ratio)

Overall, the summary indicates that it was necessary to leave approximately 2.5% of stand volumes in cutblocks, to provide for wildlife tree patches. This is in addition to areas reclassified as unavailable for harvest (Table 3.1). The balance can be accommodated outside of the harvestable land base. To account for this, all of the yield tables were reduced by 2.5% in the 2003/2004 analyses.

8.5.3 Connectivity Corridors

Connectivity corridors were designated for the Arrow TSA in the KBLUP. These corridors were set as a management zone in the 2003/2004 analyses. The KBHLPO is not clear on what constraints are expected within connectivity corridors. The interpretation of KBHLPO Objective 5 is that mature biodiversity constraints must be completely met within the connectivity corridor land base. Therefore, the mature biodiversity constraints for the target landscape units were maintained within the connectivity corridors where they intersected the landscape units.

8.6 WATERSHEDS

Domestic and community watersheds have been identified within the Arrow TSA as part of the KBLUP. The watersheds were used to define management zones to which harvesting constraints were applied. The domestic watershed were managed using disturbance constraints set during TSR 2.

An attempt was made to set the disturbance limits for the community watersheds at a level below the recommended maximum equivalent clearcut area (ECA). ECA's were proposed during hydrological surveys performed on behalf of the Licencees. The maximum ECA values for each surveyed watersheds were intended to be applied as the maximum disturbance constraint for the watershed. However, there were insufficient hydrological survey data for all of the community watersheds in the Arrow TSA. Therefore, under the recommendation of MoF (B.C. MoF, 2003h) the community watersheds disturbance constraints were set to the original TSR 2 values. A maximum of 20% of the productive area in community watersheds was allowed to be below 6 m in height.

8.7 RIPARIAN MANAGEMENT ZONES

Specific high value fish bearing streams have been identified in the KBLUP process. In the TSR 2 analysis, the watersheds associated with these streams were identified and a forest cover constraint was applied to the entire watershed. The watershed level constraint was set to approximate all riparian management considerations within the watershed (B.C. MoF, 2000a).

Proper riparian management area classifications were not available for the streams at the time of TSR 2. A set of estimates were generated through an automated process using the ministry's watershed atlas and TRIM digital elevation data (B.C. MoF, 2000a). This process has resulted in some suspect results, particularly the absence of S4 class streams from the land base. Unfortunately, better classification data is still not available at the time of this analysis.

8.8 SLOCAN VALLEY

For the Licencees operating in the Slocan Valley, the ability to access timber has sometimes proven to be difficult in the past. In order to reflect this issue, a limit to the harvest level in the valley has been proposed. However, after studying harvest level records within the Slocan Valley over the past ten years, it was decided by the MoF that harvest performance has matched expectations and should not be limited (B.C. MoF, 2003h). A sensitivity analysis investigating the impacts of limiting Slocan Valley harvest levels was also performed.

8.9 INTEGRATED RESOURCES MANAGEMENT ZONES

All area within the timber harvesting land base was assigned to the integrated resources management (IRM) zone. In the TSR 2 analysis disturbance and retention limits were applied to the IRM zone to ensure a reasonable distribution of the harvest across the land base. With the implementation of spatially

explicit modelling in the 2002/2003 uplift analysis these constraints were no longer required since the model regulated the spatial distribution of the harvest. However, the spatial control is only applied for the first two decades so the constraints were maintained to ensure harvest distribution was controlled over the remainder of the modelled time horizon.

The KBLUP process identified specific areas as being part of an enhanced resource development zone (ERDZ). These areas were designated for timber harvesting as the highest priority and were intended to be modelled as having no retention or disturbance requirements. However, MoF has requested that these areas should have at least the same constraints as the IRM zones. Therefore, the IRM disturbance and retention constraints were also applied to the ERDZ land base.

8.10 HIGHER LEVEL PLANS

This section clarifies the modelling methodology to be used to meet the requirements of the *Kootenay-Boundary Higher Level Plan* (KBHLP) and the *Kootenay-Boundary Higher Level Plan Order* (KBHLPO). Part 1 of the KBHLPO establishes resource management zones while Part 2 establishes objectives for the resource management zones. Each objective is discussed below.

8.10.1 Objective 1 - Biodiversity Emphasis

> ***To contribute to the conservation of biodiversity, biodiversity emphasis is assigned to each landscape unit …***

The KBHLPO provides mapping of biodiversity emphasis definitions associated with landscape units based on BEC zones. These emphasis levels prescribe biodiversity requirements that were addressed in modelling through OGMAs or landscape level constraints.

8.10.2 Objective 2 - Old and Mature Forest

> ***To contribute to the conservation of biodiversity, maintain mature forests in those areas identified … and old forests … to all landscape units and associated biodiversity emphasis as defined …***

The KBHLPO seral stage distribution requirements for conservation of biodiversity were taken directly from the FPC Biodiversity Guidebook. Existing modelling protocols were sufficient to apply these requirements.

8.10.3 Objective 3 - Caribou

> ***(1) To retain seasonal habitats for mountain caribou in order to contribute to maintaining viability of the existing subpopulations according to the forest cover requirements … within the caribou habitat areas …***

The KBHLPO provides mapping of caribou habitat areas. Caribou habitat established under the HLPO was met through forest cover requirements.

8.10.4 Objective 4 - Green-up

(1) To provide for more cost-effective timber harvesting based on Section 68(4) of the Operational Planning Regulation (OPR), establish the green-up height as 2.5 metres for areas adequately stocked and 3.0 metres for areas not adequately stocked, based on the criteria in the regulations, except in:

- ***i. community watersheds;***
- ***ii. visually sensitive areas to be defined and determined by the District Manager, Ministry of Forests MOF), within known scenic areas as identified in objective 9;***
- ***iii. Enhanced Resource Development Zones - Timber as identified in objective 7 and***
- ***iv. the specified fire-maintained ecosystems as identified in objective 8(d).***

Green-up requirements were met using standard disturbance constraints by resource emphasis area. A green-up height of 2.5 m was applied to all integrated resource management areas.

8.10.5 Objective 5 - Grizzly Bear Habitat and Connectivity Corridors

(1) To maintain mature and/or old forests adjacent to important grizzly bear habitat (avalanche tracks, denning sites, etc.).

The avalanche mapping used to define grizzly bear habitat was not available for the 2003/2004 analyses. Therefore, no specific constraints were applied to account for grizzly bear habitat. Biodiversity requirements under the KBHLPO met using the OGMAs and the mature seral requirement and are assumed to provide adequate grizzly bear habitat as was described in the TSR 2 rationale for AAC determination.

(3) To maintain mature and/or old forests within connectivity corridors… for purposes of regional forest ecosystem connectivity.

(4) Forests situated on slopes greater than 80 percent do not contribute to the connectivity component of this objective.

(5) Where applicable, mature targets must be used to address this objective if connectivity corridors and/or grizzly bear habitat have been identified. Protected areas must first be used to reduce the mature target where available within the biogeoclimatic unit.

(6) ***Old targets should be used to address this objective unless other conservation values such as protection of rare or under represented old growth forests would be adversely affected. Protected areas must first be used to reduce the old target where available within the biogeoclimatic unit.***

The KBHLPO connectivity corridor map will be used to define the area concerned. Since the old requirements were met through the use of OGMAs, the guidelines above were used to locate the landscape unit biodiversity requirements for the mature components in the target landscape units (seral stage constraints defined in Objective 2 and shown in Table 8.1). According to the KBHLPO, when implemented on the ground, target mature stands should be reserved from harvest according to the following descending priority:

1) Inside and outside the connectivity corridor:
   - Protected areas and riparian reserves
   - Ungulate winter range
   - Community watersheds
   - Other resource emphasis areas
   - Rare ecosystems
   - HLPO caribou management zone
   - HLPO fire maintained ecosystems
   - Sensitive areas and recreation sites and trails
   - Wildlife tree patches
   - Visual quality areas
2) Non-contributing land base inside corridor < 80% slope
3) Contributing land base inside corridor < 80% slope
4) Non-contributing land base outside corridor < 80% slope
5) Contributing land outside the corridor; or
   i. Non-contributing land base inside corridor >= 80% slope; or
   ii. Contributing land base inside corridor >= 80% slope; or
   iii. Non-contributing land base outside corridor >= 80% slope

8.10.6 Objective 6 - Consumptive Use Streams

(1) To reduce the impacts of forest development on streams licenced for human consumption …

S5 and S6 management reserves have been defined to assess the impacts of forest development on streams licenced for human consumption.

8.10.7 Objective 7 - Enhanced Resource Development Zones – Timber

(1) To support intensive forest management for the purpose of increasing volumes of merchantable timber and to reduce industry costs while maintaining adequate environmental stewardship:
a) Pursuant to Section 68(4) of the OPR, the green-up height for Enhanced Resource Development Zones – Timber (ERDZ-T) is established as successful regeneration of cutblocks provided this is consistent with any landscape unit patch size objectives that are established for any landscape unit that incorporates the ERDZ-T.
b) This objective does not apply within connectivity corridors.

The HLPO provides mapping of enhanced resource management zones. Due to overlapping management objectives there has been no application of these zones in current practice within the Arrow TSA.

8.10.8 Objective 8 - Fire-Maintained Ecosystems

Prescribed management activities are assumed to have no effect on the timber supply analysis.

8.10.9 Objective 9 - Visuals

> ***(1) To conserve the quality of views from communities, major waterways and major highways by establishing the areas identified … as known scenic areas consistent with Section 1 of the OPR.***

Visual quality was managed within known scenic areas only. To date, no visual quality objectives have been established under the KBHLPO. Consequently, recommended visual quality classes from the visual landscape inventory were used within the scenic areas.

9.0 TIMBER HARVESTING

This section describes all of the assumptions used to model the timber harvesting systems employed in the Arrow TSA.

9.1 MINIMUM HARVEST AGE

Minimum harvest ages were determined as the age of stands at which 95% of the culmination mean annual increment (MAI) is achieved. This approach follows direction from the Chief Forester's TSR 2 AAC rationale document. The minimum harvest ages for each analysis unit are presented in Table 9.1.

Table 9.1. Minimum harvest ages

Existing Natural Stand Types				Future Manage Stand Types			
Analysis Unit	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**	**Analysis Unit**	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**
1	ICHdw 01a Fd	2.36	100	201	ICHdw 01a Fd	5.66	70
2	ICHmw2 04 Fd	2.60	80	202	ICHmw2 04 Fd	4.72	60
3	ICHmw2 01 Fd	2.36	90	203	ICHmw2 01 Fd	5.96	70
4	ICHmw2 01 Lw	2.24	110	204	ICHmw2 01 Lw	5.93	60
5	ICHmw2 03 Fd	2.35	100	205	ICHmw2 03 Fd	5.24	70
6	ICHmw2 04 Hw	2.81	100	206	ICHmw2 04 Hw	3.53	70
7	ICHmw2 01 Hw	2.83	80	207	ICHmw2 01 Hw	3.70	60
8	ICHmw2 01 Pl	2.03	110	208	ICHmw2 01 Pl	5.90	70
9	ICHdw 01b Fd	2.58	110	209	ICHdw 01b Fd	6.77	60
10	ICHdw 01b Lw	2.47	110	210	ICHdw 01b Lw	6.14	70
11	ESSFwc4 02 Bl	1.45	120	211	ESSFwc4 02 Bl	3.86	90
12	ICHmw2 04 Lw	2.32	120	212	ICHmw2 04 Lw	5.35	60
13	ESSFwc4 01 Bl	1.65	130	213	ESSFwc4 01 Bl	3.72	90
14	ESSFwc1 01 Bl	1.71	110	214	ESSFwc1 01 Bl	5.46	70
15	ESSFwc1 01 Sx	2.15	130	215	ESSFwc1 01 Sx	5.59	70
16	ICHdw 01a Lw	2.55	110	216	ICHdw 01a Lw	4.58	80
18	ICHmw2 04 Pl	2.05	110	218	ICHmw2 04 Pl	6.23	60
19	ICHmw2 03 Pl	1.98	110	219	ICHmw2 03 Pl	5.94	70
20	ICHdw 01a Pl	2.03	110	220	ICHdw 01a Pl	4.58	80
21	ESSFwc4 01 Sx	1.92	130	221	ESSFwc4 01 Sx	5.48	60
22	ICHmw2 01 Bl	1.72	110	222	ICHmw2 01 Bl	3.24	80
23	ESSFwc1 02 Pl	2.23	100	223	ESSFwc1 02 Pl	4.17	70
24	ESSFwc1 01 Pl	1.95	110	224	ESSFwc1 01 Pl	5.64	70
25	ICHdw 01b Pl	2.07	100	225	ICHdw 01b Pl	6.14	70
26	ICHmw2 03 Lw	2.15	110	226	ICHmw2 03 Lw	4.45	60
27	ESSFwc1 02 Bl	1.75	110	227	ESSFwc1 02 Bl	4.20	80
28	ICHmw2 03 Hw	2.59	100	228	ICHmw2 03 Hw	3.75	60
29	ESSFwc4 02 Sx	1.72	130	229	ESSFwc4 02 Sx	3.61	90
31	ESSFwc4 02 Pl	1.91	110	231	ESSFwc4 02 Pl	3.88	90
32	ESSFwc1 01 Hw	2.28	90	232	ESSFwc1 01 Hw	3.66	90

Existing Natural Stand Types				Future Manage Stand Types			
Analysis Unit	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**	**Analysis Unit**	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**
33	ESSFwc4 04 Bl	1.49	120	233	ESSFwc4 04 Bl	3.58	90
34	ICHwk1 04 Hw	1.96	110	234	ICHwk1 04 Hw	3.93	70
35	ESSFwc1 02 Sx	2.18	140	235	ESSFwc1 02 Sx	4.20	80
36	ICHmw2 01 Cw	2.56	80	236	ICHmw2 01 Cw	3.35	60
37	ICHmw2 04 Sx	2.14	120	237	ICHmw2 04 Sx	6.13	60
38	ESSFwc4 01 Pl	2.01	110	238	ESSFwc4 01 Pl	5.50	60
39	ICHmw2 05 Hw	2.07	100	239	ICHmw2 05 Hw	3.53	60
41	ICHmw2 05 Fd	1.85	80	241	ICHmw2 05 Fd	6.48	50
42	ICHdw 01b Hw	3.09	80	242	ICHdw 01b Hw	3.21	70
43	ICHdw 02 Fd	2.29	100	243	ICHdw 02 Fd	2.40	110
44	ICHmw2 04 Cw	2.70	80	244	ICHmw2 04 Cw	3.53	70
45	ICHmw2 03 Sx	2.47	110	245	ICHmw2 03 Sx	4.23	60
47	ICHmw2 04 Bl	2.10	110	247	ICHmw2 04 Bl	3.49	70
48	ESSFwc1 01 Lw	1.99	130	248	ESSFwc1 01 Lw	6.05	60
49	ESSFwc1 01 Fd	2.03	100	249	ESSFwc1 01 Fd	5.44	70
50	ICHmw2 03 Cw	2.61	80	250	ICHmw2 03 Cw	2.16	70
51	ICHmw2 05 Lw	3.14	110	251	ICHmw2 05 Lw	6.44	50
52	ESSFwc4 04 Sx	2.04	140	252	ESSFwc4 04 Sx	5.47	60
53	ICHdw 01b Cw	2.64	80	253	ICHdw 01b Cw	3.21	70
55	ICHmw2 03 Bl	2.21	120	255	ICHmw2 03 Bl	2.14	90
56	ICHdw 01a Hw	2.29	90	256	ICHdw 01a Hw	3.19	70
57	ICHmw2 05 Sx	1.82	160	257	ICHmw2 05 Sx	6.04	50
58	ESSFwc4 04 Pl	2.35	110	258	ESSFwc4 04 Pl	5.68	60
59	ESSFwc1 02 Lw	2.23	110	259	ESSFwc1 02 Lw	4.80	70
60	ESSFwc1 03 Bl	1.92	110	260	ESSFwc1 03 Bl	5.27	70
61	ICHdw 01b Bl	3.84	80	261	ICHdw 01b Bl	6.14	70
62	ICHwk1 04 Fd	3.04	80	262	ICHwk1 04 Fd	6.44	50
63	ESSFwc1 02 Fd	1.95	100	263	ESSFwc1 02 Fd	4.21	80
64	ICHdw 01a Bl	3.81	100	264	ICHdw 01a Bl	3.19	70
65	ESSFwc1 02 Hw	2.09	110	265	ESSFwc1 02 Hw	3.16	100
66	ESSFwc1 03 Sx	2.45	100	266	ESSFwc1 03 Sx	4.48	80
68	ICHwk1 01 Sx	2.32	130	268	ICHwk1 01 Sx	4.33	70
69	ESSFdc1 01 Pl	2.58	100	269	ESSFdc1 01 Pl	3.43	100
70	ESSFwc1 01 Cw	2.60	80	270	ESSFwc1 01 Cw	3.66	90
71	ICHdw 01a Cw	2.30	100	271	ICHdw 01a Cw	2.19	80
73	ICHwk1 01 Hw	2.51	100	273	ICHwk1 01 Hw	4.78	60
74	ICHmw2 05 Cw	3.12	100	274	ICHmw2 05 Cw	3.60	60
75	ICHwk1 04 Cw	2.32	100	275	ICHwk1 04 Cw	3.87	70
76	ICHdw 02 Pl	1.89	120	276	ICHdw 02 Pl	4.49	80
77	ICHxw 01 Fd	3.01	80	277	ICHxw 01 Fd	4.13	80
78	ICHwk1 04 Sx	1.75	150	278	ICHwk1 04 Sx	2.69	90
80	ICHxw 03 Fd	1.88	80	280	ICHxw 03 Fd	3.07	70

Existing Natural Stand Types				Future Manage Stand Types			
Analysis Unit	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**	**Analysis Unit**	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**
82	ESSFdc1 01 Bl	2.03	120	282	ESSFdc1 01 Bl	2.43	120
83	ICHdw 02 Lw	2.24	120	283	ICHdw 02 Lw	4.49	80
84	ESSFdc1 01 Sx	3.37	100	284	ESSFdc1 01 Sx	3.13	100
85	ICHdw 01b Sx	2.25	110	285	ICHdw 01b Sx	6.18	60
86	ESSFwc4 02 Lw	2.38	130	286	ESSFwc4 02 Lw	4.35	80
87	ESSFwc1 03 Pl	2.59	100	287	ESSFwc1 03 Pl	4.69	80
88	ESSFwc1 02 Cw	1.86	80	288	ESSFwc1 02 Cw	3.01	100
90	ICHmw2 09 Hw	2.69	80	290	ICHmw2 09 Hw	4.30	100
92	ESSFwc4 02 Fd	2.05	100	292	ESSFwc4 02 Fd	3.80	90
93	IDF	2.33	100	293	IDF	3.05	80
94	ICHmw2 Pl Partial Harvest	2.08	120				
95	ICHmw2 Pl Partial Harvest	1.96	110				
96	ICHmw2 Pl Partial Harvest	2.05	110				
Existing Manage Stand Types							
101	ICHdw 01a Fd	4.97	70				
102	ICHmw2 04 Fd	4.56	80				
103	ICHmw2 01 Fd	5.06	70				
104	ICHmw2 01 Lw	5.61	70				
105	ICHmw2 03 Fd	4.18	60				
106	ICHmw2 04 Hw	3.61	90				
107	ICHmw2 01 Hw	3.37	60				
108	ICHmw2 01 Pl	5.54	70				
109	ICHdw 01b Fd	5.64	70				
110	ICHdw 01b Lw	5.50	70				
111	ESSFwc4 02 Bl	3.48	100				
112	ICHmw2 04 Lw	5.17	60				
113	ESSFwc4 01 Bl	3.23	100				
114	ESSFwc1 01 Bl	4.81	80				
115	ESSFwc1 01 Sx	4.76	80				
116	ICHdw 01a Lw	4.07	70				
118	ICHmw2 04 Pl	6.05	60				
119	ICHmw2 03 Pl	5.61	70				
120	ICHdw 01a Pl	4.07	70				
121	ESSFwc4 01 Sx	4.76	70				
122	ICHmw2 01 Bl	3.21	80				
123	ESSFwc1 02 Pl	3.95	80				
124	ESSFwc1 01 Pl	4.87	70				
125	ICHdw 01b Pl	5.50	70				
126	ICHmw2 03 Lw	4.18	60				
127	ESSFwc1 02 Bl	3.70	80				

Existing Natural Stand Types				Future Manage Stand Types			
Analysis Unit	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**	**Analysis Unit**	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**
128	ICHmw2 03 Hw	3.45	60				
129	ESSFwc4 02 Sx	3.34	90				
131	ESSFwc4 02 Pl	3.34	90				
132	ESSFwc1 01 Hw	3.28	100				
133	ESSFwc4 04 Bl	3.23	100				
135	ESSFwc1 02 Sx	3.73	90				
136	ICHmw2 01 Cw	3.01	70				
137	ICHmw2 04 Sx	5.22	60				
138	ESSFwc4 01 Pl	5.11	70				
142	ICHdw 01b Hw	3.03	100				
143	ICHdw 02 Fd	2.40	110				
144	ICHmw2 04 Cw	3.61	90				
145	ICHmw2 03 Sx	3.73	60				
147	ICHmw2 04 Bl	3.61	90				
148	ESSFwc1 01 Lw	5.39	70				
149	ESSFwc1 01 Fd	4.76	80				
150	ICHmw2 03 Cw	2.04	80				
152	ESSFwc4 04 Sx	4.61	70				
153	ICHdw 01b Cw	3.27	70				
155	ICHmw2 03 Bl	2.04	80				
156	ICHdw 01a Hw	2.94	70				
157	ICHmw2 05 Sx	6.02	50				
158	ESSFwc4 04 Pl	5.11	70				
160	ESSFwc1 03 Bl	4.75	80				
161	ICHdw 01b Bl	5.50	70				
163	ESSFwc1 02 Fd	3.76	80				
166	ESSFwc1 03 Sx	3.81	90				
168	ICHwk1 01 Sx	3.76	70				
169	ESSFdc1 01 Pl	3.23	100				
170	ESSFwc1 01 Cw	3.28	100				
171	ICHdw 01a Cw	2.13	110				
173	ICHwk1 01 Hw	5.78	60				
176	ICHdw 02 Pl	4.49	80				
177	ICHxw 01 Fd	3.59	100				
183	ICHdw 02 Lw	4.49	80				
184	ESSFdc1 01 Sx	3.05	110				
185	ICHdw 01b Sx	4.24	80				
187	ESSFwc1 03 Pl	4.01	80				
188	ESSFwc1 02 Cw	3.09	100				
192	ESSFwc4 02 Fd	4.59	70				
193	IDF	3.44	70				
194	ICHmw2 Pl	2.10	30				

Existing Natural Stand Types				Future Manage Stand Types			
Analysis Unit	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**	**Analysis Unit**	**Description**	**MAI (m^3/ha/yr)**	**Minimum Harvest Age**
	Partial Harvest						
195	ICHmw2 Pl Partial Harvest	2.00	30				
196	ICHmw2 Pl Partial Harvest	2.10	30				

A sensitivity analysis investigating the impact of increasing or decreasing the minimum harvest age by ten years was also performed (Section 10.2)

9.2 HARVEST SYSTEMS

An investigation among the Licencees of the current management practices within the Arrow TSA revealed that the majority of harvesting is performed using a clearcut silviculture system. The one exception was within the BCTS chart area where a partial cutting system is utilized. In this chart area, all pine leading stands in the ICH mw2 BEC zone were prescribed to be partially harvested. This exception was modelled using a special analysis units designated for these stands.

9.3 INITIAL HARVEST RATE

The initial harvest rate for all of the 2003/2004 analyses was set to the current AAC of 550,000 m^3 per year.

9.4 HARVEST RULES

In the previous IFPA analyses, the timber supply model was set to harvest the oldest stands first. This deviated from the TSR 2 analysis which used relative oldest first. In the AAC rationale the Chief Forester contends that a more realistic approach would be somewhere between relative oldest first and a random ordering approach.

A relative oldest first harvest pattern was selected for the 2003/2004 analyses. Under this harvest pattern stands that have the largest difference between their minimum harvest age and their current age are prioritized first. This approach keeps the analyses consistent with the TSR 2 analyses. The relative oldest first approach also seems to help address the age class distribution issues which have proven to be problematic in previous Arrow TSA analyses.

9.5 DISTURBANCE OF INOPERABLE LAND BASE

A special harvest profile was designed to allow the model to more realistically model natural disturbance in the areas outside of the timber harvesting land base. In previous analyses, the productive non-contributing land base was not available for harvest so it was continuously aged in the timber supply model. This is of concern because it eventually becomes old and over contributes to the fulfillment of certain forest cover requirements. In reality there will be some level of natural disturbance within the non-contributing land base component

For the 2003/2004 analyses a procedure was designed that allowed the timber supply model to disturb the productive non-contributing land base. The methodology used is documented in the report *Disturbing the Productive Non-Contributing Land Base* (Timberline, 2003c).

The procedure imposed within the model is an annual disturbance to the productive non-contributing component of each BEC zone. The amount of area disturbed each year was set to 295 ha for the first 50 years and then was set to 1,016 ha for the remainder of the modelled time horizon. This approach uses a low initial disturbance area in recognition that the land base has had a disproportionately high disturbance rate (*i.e.* fires from historic mineral exploration). The higher long-term disturbance area was set using the *Biodiversity Guidebook* natural range of variation to represent a more realistic natural frequency. A seral stage distribution requirement was also imposed on the productive non-contributing of each BEC variant, which forced the productive non-contributing to achieve a seral zone distribution similar to the natural range of variation from the FPC biodiversity guidebooks.

Concern was also raised that post disturbance stands may still contribute biodiversity values. For example old growth trees may survive a fire and still provide important habitat values. Therefore it is important to consider that the disturbance values can be viewed as more conservative.

In the report *Disturbing the Productive Non-Contributing Land Base* (Timberline, 2003c), the assumption is made that the disturbed non-contributing area will not contribute to the visual quality objective disturbance limitations. This assumption is based on the opinion that the natural disturbances occurring in the non-contributing land base will be small and well distributed resulting in no reduction to the visual quality of the land base. The report therefore documents a methodology for adjusting the VQO limits so that management objectives within the THLB will not be penalized by the natural disturbances. This assumption was not accepted by the MoF for use in the Arrow TSA (B.C. MoF, 2003h). The rejection was based on the view that the average natural disturbance that occurs within the Arrow TSA was considered to be large enough that it would reduce the visual quality of the land base. Therefore, disturbances in the non-contributing land base were accounted for along with harvesting disturbances when modelling harvesting limitations dues to VQOs in the 2003/2004 analyses.

A sensitivity analysis to investigate the impact of disturbing the non-contributing areas was also performed. In this analysis areas outside of the THLB were not disturbed and allowed to continually grow. The impact of not accounting the disturbance of the non-contributing in the calculation of VQO limits was also explored in a sensitivity analysis.

9.6 TIMBER SUPPLY MODEL

All analyses were undertaken using Timberline's proprietary spatial timber supply model CASH6 (**C**ritical **A**nalysis of **S**chedules for **H**arvesting). CASH6 was benchmarked to the MoF model the Forest Service Simulator (FSSIM) Version 3.0 during the *Updated Arrow IFPA Base Case and Spatial Analysis* (Timberline, 2002) as a bridge to facilitate its use in further analyses. CASH6 has several features which enhance spatial analyses. These include spatial analysis features which can be employed to demonstrate explicit spatial aspects of the timber supply.

With CASH6, maximum depletion and minimum disturbance constraints on forest cover are explicitly implemented. Resource management at a landscape level is modelled and future states predicted. The characteristics of all land within the study area contribute to the analysis allowing comprehensive modelling of forest structure.

CASH6 is a sequential forest inventory projection simulation model with the following characteristics:

- Spatial - the locale of management activities is used to capture the spatial consequences of changes in management policy;
- Disaggregate - forest inventory need not be aggregated beyond mapable contiguous blocks;
- Discrete - separately identified management blocks are the basic spatial unit for simulation; and
- Sequential - interaction of harvest and regeneration rules as modified by constraints results in a sequential progression of the forest state from current status into the future.

Key features of CASH6 are:

- Operates in either spatial or aspatial mode;
- Adjacency and distribution of forest structure are explicitly modelled;
- Area or volume management may be practiced on different parts of a forest simultaneously;
- Using a unique implementation of forest cover constraints methodology, harvesting can be directed to locales which will produce the least deviation from desired structural goals;
- A range of post-establishment silviculture treatments are available;
- Stand tending goals may be specified by either area or volume;
- A wide variety of types of constraints on harvesting are implemented; and
- Forest cover constraints can be either age or height based.

9.6.1 Spatial Analysis

The 2003/2004 analyses were conducted as spatial analyses. Although a fully spatial analysis is not required under the DFAM regulations a spatial analysis was performed to reduce uncertainty around the operational realism of the modelled harvest. The future harvest blocks identified in the current forest development plan were input to the model to be selected first for harvest. This ensures an even higher degree of realism. Block to block adjacency information was also included in the model input data in order to apply green-up adjacency constraints on harvesting. The spatial analysis was only maintained for twenty years. The harvest pattern modelled spatially over longer time frames increasingly deviates from a reasonable operational pattern and can have unreasonable impacts on timber supply if spatial analysis is maintained for longer.

Treatment unit mapping was utilized to model a more realistic pattern of harvesting across the land base. Treatment unit mapping provides a pattern of blocks across the land base that define the units of harvest or retention. Predictably, when constructing a block resultant with abundant Arc/Info™ GIS overlays a large number of undersized polygons (stand area < 2.0 hectares) result. Undersized polygons significantly reduce the efficiency of the analysis by increasing the number of blocks to be processed and creating blocks that are, in effect, operationally infeasible.

To reduce the complexity of the data set, and perhaps more importantly, in order to move towards more favourable block size distributions, these areas are targeted to be eliminated and merged into adjacent polygons. An undersized polygon is considered a candidate for eliminating if, for example:

- It does not share a legal boundary, or legislated reserve;
- It does not define a break between the harvestable and non-harvestable land base;
- It does not define a break between age classes; and
- It is not a forest development plan block.

The boundaries of the above features were considered to be hard lines. Other boundaries are generally interpreted, and therefore, were considered soft lines (Table 9.2). Polygon elimination was permitted across soft line boundaries only.

The **ELIMINATE** procedure was employed to remove undersized polygons. **ELIMINATE**, a resident Arc/Info™ command, was invoked after establishing and encoding all hard line features. **ELIMINATE** is a polygonal based function, therefore, it does not assess area to perimeter ratios of resultant pseudo-blocks. Consequently, there are no attempts to "square-up" pseudo-blocks during the elimination process. Upon completion of the elimination process, these "*pseudo-block"* boundaries are permanent.

Table 9.2. Treatment unit mapping definitions

Module	Data Description	Input Coverage	Status[1]
Administration	Landscape units	tbecb_ar	H
	Ungulate winter range	luwr_ar	S
	Scenic (class 1)	tsce_ar	S
	Ownership	town_ar	H
	Caribou management zones	qcari_ar	S
	Enhanced resource development zones	erdz_dar_r	S
	Regional connectivity	qcnt_ar	S
	Resource management zones	qrmz_ar	S
	Regionally significant fish streams	tfbs_ar	H
Availability	Netdown	landbase	H
	Operability	topr_ar	S
Forest cover	Species groupings	tfic_species	H
	Age class groupings	tfic_age	H
	Site index groupings	tfic_si	H
	Wildlife tree patches	wtp_ar	S
Ecological	BEC Variants	tbecb_ar	S
Water	Community watersheds	tcws_ar	H
	Domestic watersheds	tdws_ar	H
	Lakes	tlks_ar	H

[1]Defines nature of linework:
H = hard lines; linework will be coded as –1 and will not be impacted by an eliminate; and
S = soft lines; linework will potentially be impacted by an eliminate.

10.0 TIMBER SUPPLY FORECASTS

Two base case scenarios were required for the 2003/2004 project: a TSR 3 base case; and an uplift base case. These two overlapping analyses were undertaken in parallel. The fundamental difference between the two analyses was the nature of the decision the analysis was intended to support. The uplift analysis was intended to support an IFPA AAC uplift decision made by the Regional Manager, which is legislated under Section 59.1 of the Forest Act. The TSR 3 analysis was intended to support an AAC determination process made by the Chief Forester, which is legislated under Section 8 of the Forest Act.

The overlapping responsibilities of the Chief Forester and the Regional Manager complicate the analysis process. The uplift analysis was intended to quantify the impacts of the innovative forest practices carried out by the AFLG. This was accomplished through modelling a scenario similar to the most recent timber supply review (TSR 2) and then incrementally adding the innovative forest practices in order to quantify the impacts to produce an uplift composite scenario. The TSR 3 analysis, on the other hand, used the 'best available information'. In this case the best available information included the information collected by the AFLG in order to support their uplift.

In fact, the uplift composite scenario and the TSR 3 base case are one and the same. The uplift base case demonstrates what the timber supply would have been, had the AFLG not proactively mitigated downward pressures on the AAC.

10.1.1 TSR 3 Base Case

The base case analysis was built from the uplift application analysis started in 2002/2003. The details of this analysis are documented in *Support and Analysis for Uplift Application 2002/2003 Timber Supply Information Package* (Timberline, 2003b). The previous uplift analysis itself closely followed the base case established in the *Updated Arrow IFPA Base Case and Spatial Analysis* (Timberline, 2002). These analyses took direction from the comments made by the Chief Forester in the April 2001 TSR 2 AAC rationale for the Arrow TSA.

The TSR 3 base case used the best available information and was fully spatial. It included the following new data sources added since TSR 2:

- New vegetation resource inventory (VRI);
- New predictive ecosystem mapping (PEM);
- Improved site productivity estimated using SIBEC;
- Improved terrain stability mapping;
- Improved modelling of areas managed for visuals with localized VEG heights;
- Implementation of OGMAs refined by licencees in place of seral requirements;
- Use of tree improvement program seed;
- Improved methodologies for defining wildlife tree patch requirements;
- Updated conventional operability line;
- Disturbing the non-timber harvesting land base;
- Relative oldest first harvest rule;
- Green-up of 2.5 m as indicated in higher level plan;
- Fully spatial for 20 years;
- One percent volume reductions for identified wildlife; and

- Inclusion of connectivity corridor with proportional representation.

10.1.2 Uplift Base Case

The uplift base case was designed to be a benchmark, upon which the gains associated with the innovative forest practices could be accumulated. The intention of the uplift analysis was to quantify the impacts of the projects carried out by the AFLG. The uplift base case is the TSR 3 base case minus the AFLG projects. The following major changes from TSR 2 were not attributed to the AFLG and will be maintained in the uplift base case:

- Implementation of original MoF OGMAs without Licencee revisions;
- Use of tree improvement program seed;
- Alternative methodologies for defining wildlife tree patch estimates;
- Updated conventional operability line;
- Disturbing the non-timber harvesting land base;
- Relative oldest first harvest rule;
- Green-up of 2.5 m as indicated in higher level plan;
- Fully spatial for 20 years;
- One percent volume reduction for identified wildlife; and
- Inclusion of connectivity corridor with proportional representation.

10.1.3 Uplift Composite

The uplift composite resulted in the same analysis as the TSR 3 base case. This was done through the incremental addition of the following information sources:

- New vegetation resource inventory (VRI);
- Improved site productivity estimated using SIBEC;
- Improved terrain stability mapping;
- Improved modelling of areas managed for visuals with localized VEG heights; and
- Licencee refined OGMAs.

Each of the information sources listed above will be added to the previously combined sources until once composite run matching the TSR 3 base is created. At each step, an analysis of timber supply availability will be calculated. Through comparison of the timber supply availability, the impact of the AFLG projects will be demonstrated.

10.2 SENSITIVITY ANALYSES

A series of sensitivity analyses were required for the TSR 3 analysis. Sensitivity analysis provides a measure of the reasonable upper and lower bounds of the harvest forecast that reflects the uncertainty of assumptions made in the base case. The magnitude of the increase and decrease in the sensitivity variable reflects the degree of uncertainty surrounding the assumption associated with that given variable. By developing and testing a number of sensitivity analyses, it is possible to determine which variables most influence results. To allow meaningful comparison of sensitivity analyses, they are usually performed using the base case (*i.e.* current performance) and varying only the assumption being tested (*i.e.* all other assumptions remain the same as in the base case). Each scenario was fully documented with respect to

the data and assumptions employed. The sensitivity analyses performed for the TSR 3 analysis are listed in Table 10.1.

Table 10.1. Sensitivity analyses

Issue	Sensitivity Levels to be Tested
Harvest flow	Establish a non-declining even flow (NDEF) Highest initial harvest level Oldest first harvest priority
Land base	Adjust timber harvesting land base by +/- 10%
Growth and yield	Adjust existing stand yields by +/- 3m Adjust managed stand yields by +/- 3m
Visual landscape	Adjust denudation percentages +/- 5% Do not group visual polygons
Green-up	Adjust green-up heights +/- 1.5m
Adjacency	Do not consider adjacency in harvest
Minimum harvest ages	Adjust minimum harvest ages +/- 10 years
Slocan valley	Removed using contentious area definition Removed using contentious five landscape unit definition Limited harvest based on past practice Partial retention based on basal area retention guidelines
SIBEC	Site index assigned based on first PEM decile only Over and underestimation in SIBEC
West Kootenay ungulate winter range	Use new ungulate winter range mapping and management constraints
Disturbance of inoperable areas	Do not disturb areas outside of the THLB
	Disturbances do not contribute to VQO limits
Root Rot	Adjust managed stand yields for root rot losses
Landscape biodiversity	Apply seral requirements in place of OGMAs

The methodology used to carry out some of the more complex sensitivity analyses is documented in the following sections.

10.2.1 Slocan Valley Sensitivies

The inclusion of Slocan Valley in the timber harvesting land base is a contentious issue when considering timber supply in the Arrow TSA. Licensees have had difficulty accessing timber in the Slocan Valley, but the government has not provided special designation for the valley. Such a designation would allow particular consideration of the area for timber supply. Four sensitivities were carried out in order to reduce the uncertainly associated with access to timber in the Slocan Valley:

- Completely remove the Slocan Valley from the land base using the contentious area linework;
- Completely remove the Slocan Valley from the land base using the five landscape unit definition;
- Limited harvest in the Slocan Valley based on past practice; and
- Model the Slocan Valley managed using partial retention based on basal area retention guidelines.

The last sensitivity evaluated the impact of making the transition from management using clearcut harvesting to a partial harvest system in the Slocan Valley. This was proposed for consideration as an

acceptable alternative to current management practices. The partial harvest system was defined with basal area retention requirements, which are drawn from Section 6.3.10 of the FSC BC Regional Standards and designed to preserve genetics, species, and ecosystem diversity:

> ***6.3.10 Average stand level retention within cutblock areas in stand-replacement management regimes (including retention of dominant and co-dominant trees referred to in Indicator 6.3.9):***
>
> | NDT 1 | | NDT 2 | | NDT 3 | | NDT 4 | |
> |---|---|---|---|---|---|---|---|
> | ESSF | Other | ESSF | Other | ESSF | Other | ESSF | Other |
> | 15 | 24 | 8 | 12 | 4 | 5 | 1 | 3 |
>
> ***b) or is consistent with average and min/max ranges established through an assessment of the range of natural variability at the stand level and landscape level.***

The basal area retention required in the Slocan Valley is indicated in Table 10.2.

Table 10.2. Basal area retention in the Slocan Valley

Zone	Variant	NDT	THLB	Basal Area Retention by Stand (m^2/ha)
ESSF	wc	2	5,767	8
ICH	dw	3	6,520	5
ICH	mw	2	18,076	12
ICH	wk	1	530	24

In this sensitivity the Slocan Valley was defined using the definition based on the contentious area linework.

10.2.2 SIBEC Sensitivities

Sensitivity analyses explored the risk associated with uncertainty surrounding the PEM and its associated SIBEC productivity values. The MoF raised issues that were addressed:

- Influence of minor site series within a polygon on assigned site index;
- Impact of inaccuracy of minor site series; and
- Evaluation of trends noticed in evaluation (over- or under-estimation in certain site series).

Sensitivity analysis of SIBEC based productivity estimates tested were:

1) The assignment of site index based on the major site series only; and
2) The possible over- and under-estimations directly:
   ICHmw2 – overestimation of site series 03, 04 and underestimation of 01;
   ICHdw – overestimation in 01b and underestimation of 01a, 02; and
   ESSFwc4 – overestimation in 02, 04 and underestimation in 01.

These sensitivities included the use of alternate sets of yield curves, minimum harvest age and green-up estimates.

10.2.3 West Kootenay Ungulate Winter Range Sensitivity

Ungulate winter range mapping across the West Kootenay was refined in 2002. This refined mapping was a legislative requirement set in the Forest Practices Code. The new mapping will replace the previous coverage produced as part of the KBLUP. The refinement process is documented in the report *West Kootenay Ungulate Winter Range Mapping 2002* (Mowat, 2002). These new regulations have not yet been implemented as current practice so they are included as a sensitivity.

The refined mapping is based on a single ungulate species for each area identified. Priority forage areas within each zone are also delineated. The report presents a new set of best management practice guidelines for each zone. The retention and disturbance limits set in these guidelines were applied in sensitivity analyses and are listed in Table 10.3. Crown cover and opening size guidelines were not implemented because crown closure and patch size attributes were not modelled.

Table 10.3. Ungulate winter range management guidelines

Zone	BEC Subzone	Retention Requirements	Retention Age (years)	Disturbance Limits for Forage Maintenance
Mule deer	IDFun, ICHxw	20%	Age ≥81	Maximum proportion in age <20 years=33%
	ICHdw	30%	Age ≥81	
	ICHmw	40%	Age ≥101	
White-tailed deer	IDFun, ICHxw	30%	Age ≥81	
	ICHdw	40%	Age ≥81	
	ICHmw	50%	Age ≥101	
Elk	IDFun, ICHxw	10%	Age ≥81	
	ICHdw	20%	Age ≥81	
	ICHmw	30%	Age ≥101	
Moose	All ICH subzones	20%	Age ≥61	
Forage Area	All ICH subzones	10%	Age ≥81	none

10.2.4 Root Rot

There is concern that the impact of root rot is underestimated in this analysis. A project to estimate the extent and impact of *Armillaria* was conducted concurrently by Stearns-Smith & Associates, Forestry Consultants. Suggested OAF values reflecting the impact of the root rot were provided from this project along with data to identify susceptible stands. The OAF values were applied to reduce yields from the susceptible stands and run as a sensitivity analysis.

10.2.5 Landscape biodiversity

This sensitivity explores the impact of using the biodiversity seral stage requirements set in the *Biodiversity Guidebook* (B.C. MoF, 1995) in place of OGMAs. In this analysis the areas within OGMAs were not removed from the THLB and the biodiversity constraints implemented instead. The original guidebook retention constraints for both the old and mature seral components are listed in Table 10.4 and Table 10.5.

Table 10.4. BEC/NDT seral stage requirements (minimum percent)

Emphasis	NDT	Mature + Old			Old		
		ESSF	ICH	IDF	ESSF	ICH	IDF
Low	1	19	17		19[(1)]	13[(1)]	
	2	14	15		9[(1)]	9[(1)]	
	3	14	14		14[(1)]	14[(1)]	
	4		17	17		13[(1)]	13[(1)]
Intermediate	1	36	34		19	13	
	2	28	31		9	9	
	3	23	23		14	14	
	4		34	34		13	13
High	1	54	51		28	19	
	2	42	46		13	13	
	3	34	34		21	21	
	4		51	51		19	19

[(1)]Full biodiversity requirements in low will be met in stages over three 70-year rotations

Table 10.5. BEC/NDT seral stage requirements (minimum age)

NDT	Mature + Old			Old		
	ESSF	ICH	IDF	ESSF	ICH	IDF
1	120	100		250	250	
2	120	100		250	250	
3	120	100		140	140	
4		100	100		250	250

10.3 HARVEST FLOW OBJECTIVES

In developing a base case timber flow projection, a mix of the following objectives was sought:

- Maintain the initial harvest levels without compromising the mid and long-term levels;
- Decrease the periodic harvest rate in acceptable steps (≤ 10%) when declines are required to meet all objectives associated with the various resources on the land base;
- Do not permit the mid-term harvest to fall below a level reflecting basic maintenance of the productive capacity of the TSA (ex. VDYP-based long-run sustained yield estimate); and
- Achieve an even-flow long-term supply over a 250-year time horizon.

Timber supply in the Arrow TSA has traditionally been most constrained at the transition from the harvest of existing natural stands to the harvest of regenerated managed stands. This occurs around 70 years in the future. Timber harvest patterns were structured to ensure that there are no shortages at this point. Once past this point, the timber supply is generally stable and is referred to as the long-term timber supply. A harvest level that is sustainable for the remaining 180 years after this point was identified and verified by running the model an additional 100 years to a total of 350.

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