Chapter 3 TIMBER SUPPLY ANALYSIS

3.1 Introduction

The ANC mill facility requires about 265,000 Bone Dry Tonnes (approximately 690,000 m^3) of virgin coniferous wood fibre and 17,000 tonnes of recyclable paper annually. The virgin fibre is supplied from both a Forest Management Agreement Area (FMA) #8900026 and a Commercial Timber Quota in FMU W6. Total virgin coniferous fibre available is 391,000 m^3 per year available to ANC from the FMA area and 80,456 m^3 from the quota. Waste paper is supplied through purchases from community recycling programs.

This section of DFMP gives a condensed explanation of the Timber Supply Analysis (Silvacom 1999 and Silvacom 2001).

In the development of the new timber supply analysis, ANC:

- Compiled and integrated regional and operational-based volume sampling data into a consistent database format from which to a) analyze and improve strata estimates, b) direct future sampling efforts, and c) extract pertinent strata, block and yield summaries.

- Determined the new net productive landbase for timber supply analysis.

- Redeveloped empirical conifer and deciduous yield curves from ANC's volume sampling data.

- Generated conifer and deciduous annual allowable cut estimates for the FMA area and individual FMU's within the FMA area.

Analytical work associated with forest inventory, net landbase determination, yield curve construction and AAC is an extension of work submitted in ANC's 1996 Detailed Management Plan. Improvements to methodology and updates to data represent an evolution, rather than a radical departure from earlier procedures. Changes in methods also reflect ANC's interest in cooperating with Alberta Land and Forest Service guidelines and conforming to accepted forest industry standards.

Timber Dispositions

ANC's FMA area consists of approximately 373,800 ha, of which 351,400 ha (94%) are classified forests. Quota holders within the FMA area are granted a percentage of the annual allowable cut by the Province of Alberta through a quota certificate system. Table 3.1 describes existing allocations.

Table 3.1 Quota holders within the FMA Area.

Sustained Yield Unit	Company	Disposition #	Percentage Of Coniferous AAC
W1 – Little Smoky	ANC Timber Ltd.	FMA #8900026	42.85%
	Millar Western Forest Products Ltd.	W1-Q2	6.88%
	Blue Ridge Lumber (1981) Ltd.	W1-Q4	34.33%
	Mostowich Lumber	W1-Q5	15.94
W8 – Pine	ANC Timber Ltd.	FMA #8900026	81.86%
	Millar Western Forest Products Ltd.	W8-Q1	18.14%
E6 – Berland	ANC Timber Ltd.	FMA #8900026	100.00%
E7 – Foothills	ANC Timber Ltd.	FMA #8900026	100.00%

3.2 Historical Timber Supply

The sections that describe the fundamental components of Annual Allowable Cut determination include:

1. The net land base determination
2. Yield curves
3. AAC determination

The timber supply analysis on ANC's FMA area followed 5 steps:

1. A systematic compilation and review of the basic forest inventory data.
2. Development of empirical yield curves based on the observed inventory estimates.
3. Evaluation of the opportunity and management implications.
4. Development of a candidate set of compartment sequences for each sustained yield unit.
5. Compilation of a feasible set of even-flow harvest estimates (including current constraints).

The Alberta Forest Service (AFS) guidelines for the establishment of long-term timber supply levels were followed. The compartment harvesting sequence is unchanged from the 1996 DFMP.

3.3 Growth and Yield Curves

3.3.1 VSP Sample Design

The volume sampling program (VSP) included the collection of detailed field information describing the density and volume, by species, for individual sample strata. The purpose was to acquire sufficient data to calculate conifer and deciduous volume estimates for specific subpopulations of the productive forest landbase. To determine merchantable

volume of timber the 15/10 utilization standard (i.e., minimum stump diameter is 15 cm, minimum top diameter is 10 cm) was used. The field program was also intended to provide temporary plot information relevant to the development of empirical yield curves.

A stratified sample design was initiated in 1992 to obtain estimates of gross and net merchantable volume for each species encountered within each stratum listed in Figure 3.1 and Table 3.2. Sample estimates for each stratum were originally based on a single-stage stratified sample design with fixed-area plots. These plots were allocated to a subset of townships and distributed in proportion to each stratum's relative area and preliminary estimate of variability. A random allocation routine was used to distribute plots proportionally by area to specific stands falling within each stratum and township.

In addition to the regional sampling program, ANC has continued to collect operational timber cruise data on an annual basis. These plots, which have been distributed widely and without bias throughout the FMA area, provide important data to improve and strengthen strata estimates. A review of the distribution and variability of survey data from each cruise program suggested that plot information could be pooled to provide more precise estimates of volume and piece-size by species for each stratum. There was no evidence to suggest that the operational cruise plot data was biased or unrepresentative of conditions in the target strata.

Forest stands with similar characteristics were aggregated into a finite set of sampling strata to aid in plot allocation and to increase sample precision. Strata were assigned by evaluating overstorey attributes for forest stands on the productive landbase.

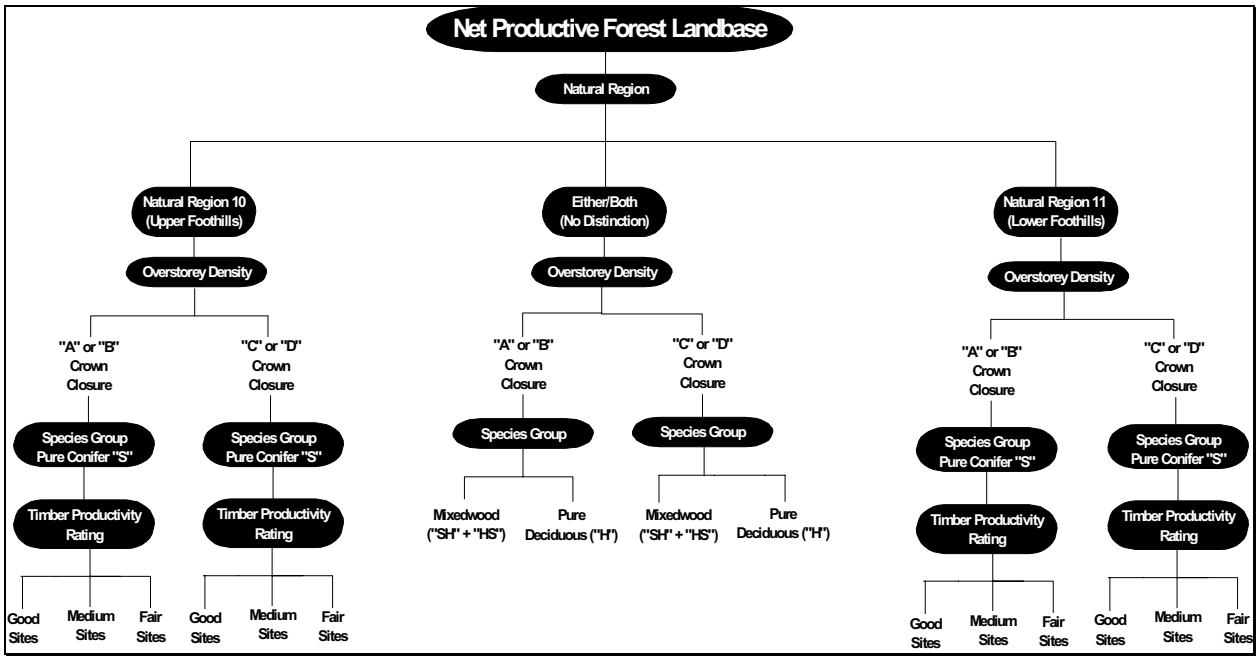

Figure 3.1 Decision Rules

Table 3.2 Yield strata numbers and assignments

NO.	Natural Region	Crown Closure	Species Group	TPR
1	10 (Upper Foothills)	AB	S	G
2	10	AB	S	M
3	10	AB	S	F
4	10	CD	S	G
5	10	CD	S	M
6	10	CD	S	F
7	11 (Lower Foothills)	AB	S	G
8	11	AB	S	M
9	11	AB	S	F
10	11	CD	S	G
11	11	CD	S	M
12	11	CD	S	F
13	Both (no distinction)	AB	Mixedwood	All
14	Both (no distinction)	CD	Mixedwood	All
15	Both (no distinction)	AB	Pure Deciduous	All
16	Both (no distinction)	CD	Pure Deciduous	All

3.3.2 Yield Strata Definition

AVI overstorey attributes for each stand in the net productive landbase were used to assign individual sample plots to specific yield strata (Figure 3.1) within each of the primary natural regions within the FMA area (Upper Foothills and Lower Foothills). Yield strata labels were defined using a combination of the following stand attributes:

1. Crown closure

2. Species group

3. Timber productivity rating (TPR)

Species group was calculated from the AVI overstorey label in the following manner:

1. The percent contribution to the total crown closure of the stand was determined for the coniferous and deciduous species separately.

2. The stand was assigned to one of four classes based on species percentages as follows:
    a. Pure Conifer (C): 80% to 100% of the stand crown closure is dominated by conifer species.
    b. Mixedwood - Conifer Leading (CD): 51% to 79% of the stand crown closure is composed of conifer species.
    c. Mixedwood - Deciduous Leading (DC): 21% to 50% of the stand crown closure is composed of conifer species.
    d. Pure Deciduous (D): 0% to 20% of the stand crown closure is composed of conifer species.

3.3.3 Timber Cruising Procedures

Fixed area plots were allocated to individual sample strata in proportion to relative strata area. Within each stratum, stands were randomly selected on a township basis and a

minimum of two plots was located at random within the polygon's perimeter. In some cases, the plot placement may have coincided with natural clearings or seismic lines (i.e., non-delineated features or linear features with no implied area). The plot was not moved if it landed on (or near) a seismic line or natural clearing. Table 3.3 describes field plot configuration.

Table 3.3 Field plot configuration

Plot size:	100 m^2 (5.64 m radius)[1]
Plot shape:	Circular
DBH limits:	12.5 cm
Measurement records:	Tree species DBH (to nearest 0.1 cm) Total height Condition code
Sample tree:	Age (at 1.3 m)

[1]A test 50 m^2 plot was established within the outer plot to capture small tree information in strata with complex structures.

Additional information recorded at each plot included the following:

1. Administrative data (date, cruisers, township, range, meridian, stand number, stratum, field type).

2. Tie point location and traverse distance/bearing.

3. Plot disturbance indicator.

4. Traverse notes.

ANC staff "check-cruised" survey plots to ensure that the highest quality standards possible were achieved. Validation checks included:

1. Ratio of DBH to height.

2. Species and cull suspect class.

3. Valid entry of plot number, stand number and stratum label.

4. Valid entry of plot size (i.e., reasonable area for plot type).

3.3.4 Cruise Compilation

Individual tree volumes were calculated by using natural region-based, individual tree volume equations (for the Upper Foothills and Lower Foothills Natural Regions), and the original Phase 3 VSR 4 coefficients. All data was compiled to the 15/10 utilization standard (i.e. minimum stump diameter = 15 cm, minimum top diameter = 10 cm) based on the natural region, quadratic DBH-to-stump conversion formula ($DOB_{stp}=b_0+b_1D+b_2D^2$), by species. Total and merchantable volume equations (cull factors were not applied in the cruise compilation) used in the analysis are described below:

METHOD 1: NATURAL REGION TAPER EQUATION AND VARIABLE DEFINITIONS

$$d = a_0 D^{a_1} a_2^{D} X^{b_1 z^2 + b_2 1n(z+0.001) + b_3 \sqrt{Z} + b_4 e^z + b_5 (D/H)}$$

where:

$$X = \left(1 - \sqrt{h/H}\right) / \left(1 - \sqrt{P}\right)$$

and

d = diameter inside bark (cm at *h*)
h = height above the ground (m), $0 \le h \le H$
H = total tree height (m)
D = diameter at breast height outside bark (cm)
Z = *h* / *H*
p = location of the inflection point, assumed to be at 22.5% of total height above the ground
e = base of the natural logarithm (≈2.71828)
$a_0, a_1, a_2, b_1, b_2, b_3, b_4, b_5,$ = parameters to be estimated

METHOD 2: PHASE 3 TREE VOLUME ESTIMATION

A. Merchantable Tree Volume

MV = TV x MR

where:

MV = Merchantable tree volume (m^3)
TV = Total tree volume
MR = Merchantable ratio

B. Total Tree Volume

$TV = b_0 D^{b1} H^{b2}$

where:

TV = Total tree volume (m^3)
D = Diameter outside bark (cm) at 1.3 m
H = Total tree height (m)
b_0, b_1, b_2 = Species and region specific coefficients

C. Merchantable Ratio

$MR = b_3 + b_4 G + b_5 G_2$

where:

MR = Merchantable ratio
G = $(H\text{-}hs)^2 / H^2 - (dib^4 / D^4)$
H = Total tree height (m)
hs = Stump height (m)
dib = Diameter inside bark (cm) - based on utilization
D = Diameter outside bark (cm) at 1.3 m
b_3, b_4, b_5 = Species and region specific coefficients

Individual tree volumes were aggregated for each plot to determine total conifer and deciduous volume in the plot. Plot volumes were converted to per hectare estimates and strata estimates computed as the average of plot volumes within each stratum.

Table 3.4 provides estimates of the gross growing stock on the FMA area, based on the net productive forest landbase.

Table 3.4 Growing stock summary

Species	Total m^3	Contribution to total growing stock (%)	Contribution to species group growing stock (%)
White Spruce	5,577,059	12.23	14.41
Black Spruce	7,882,190	17.29	20.37
Lodgepole Pine	23,731,325	52.05	61.32
Balsam Fir	1,426,640	3.13	3.69
Larch	80,538	0.18	0.21
Conifer Total	**38,697,752**	**84.88**	**100.00**
Aspen	5,370,791	11.78	77.91
Balsam Poplar	1,067,549	2.34	15.49
Birch	455,574	1.00	6.61
Deciduous Total	**6,893,914**	**15.12**	**100.00**

3.3.5 Regenerated Yields

Regenerated yield curves are assigned in the harvest simulation using several decision rules:

1. Low density stands (A and B) are replaced with fully stocked high density (C and D) stands as a result of the strategy to meet the current regeneration standards on all cutovers.

2. Fully stocked empirical conifer yields improve due to the fact that they are managed to meet the minimum regeneration standards. The increased yield is conservatively estimated to be 25% of the difference between empirical C and D density yields and the area weighted average (pine vs. white spruce by site index) of the 1985 LFS PSP based fully stocked natural stand yield curves.

3. In the W8 SYU, fully stocked conifer yields are assumed to improve by 8% across good and medium sites in both natural regions (ANC Tree Improvement Program 1997).

ENR Report No. 60a (Alberta Phase 3 Forest Inventory: Yield Tables for Unmanaged Stands 1985) estimated potential conifer yields in the ANC FMA area to be significantly higher than empirical yield curve estimates generated using ANC TSP data. The PSP data used in the 1985 study reflects potential yields because the PSPs used in that study are generally located on better forest sites. In addition, managed stands are expected to out perform non-managed stands. Therefore a combination of the two yield estimates has been adopted. The 1985 yield estimates were superimposed on the ANC yield curves. Regenerated yields were predicted conservatively to amount to 25% of the difference between the lower prediction (ANC curves) and the higher prediction (ENR PSP curves).

Enhanced regenerated yields as a result of deployment of genetically improved stock are based on the findings in Beck and Beck 1996. They estimate potential yield increases of 8%, assuming the stock is managed after establishment. Obligations to meet provincial standards ensure that management will occur.

Expected yield increases from underestimated empirical data and from tree improvement programs are weakly backed up with growth and yield data. As a result, a sensitivity analysis was done to determine the potential risk of inappropriate assumptions on long-term sustainability of harvest levels. Through this analysis, it was determined that the enhanced levels of harvest could be sustained for at least ten years with a reduction to simple empirical yield expectations and the corresponding AAC levels for the remainder of the planning horizon. Figures 3.2 – 3.5 depict the regenerated yield curves.

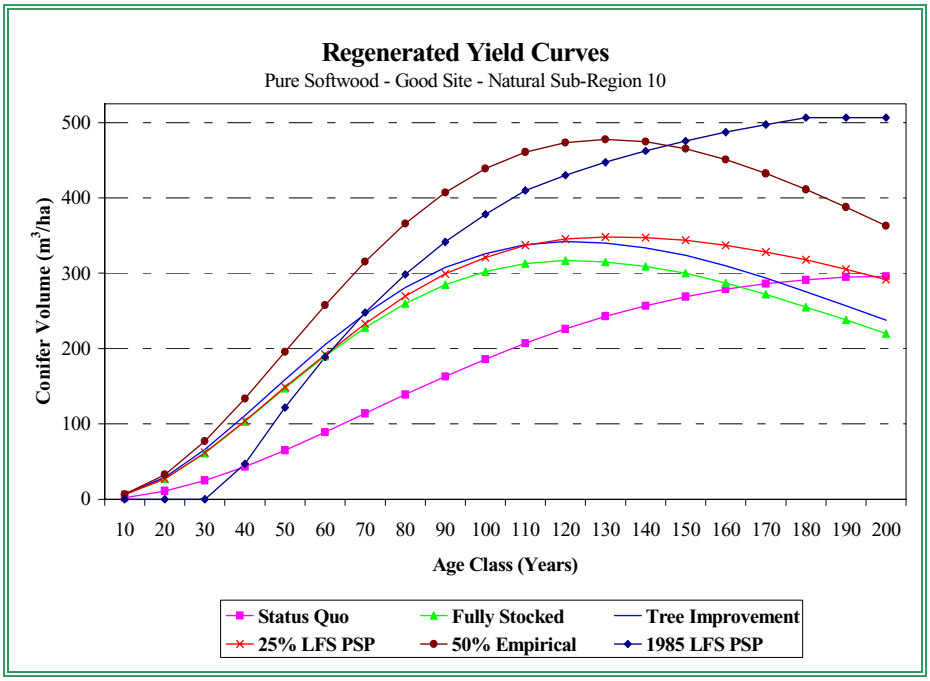

Figure 3.2 Regenerated Yield Curves for Pure Softwood Species Group on Good Sites, Upper Foothills.

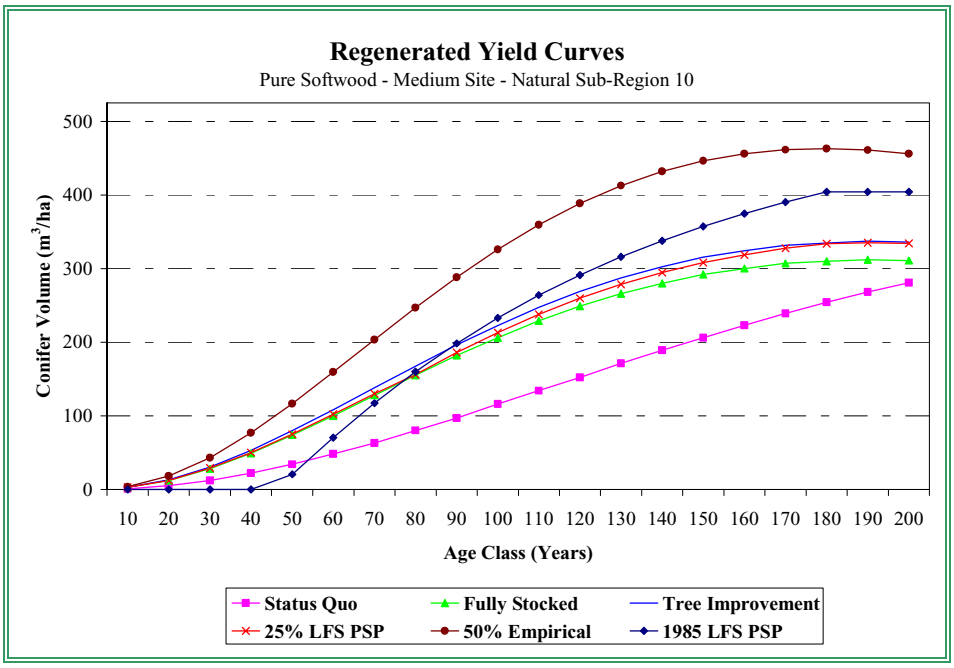

Figure 3.3 Regenerated Yield Curves for Pure Softwood Species Group on Medium Sites, Upper Foothills.

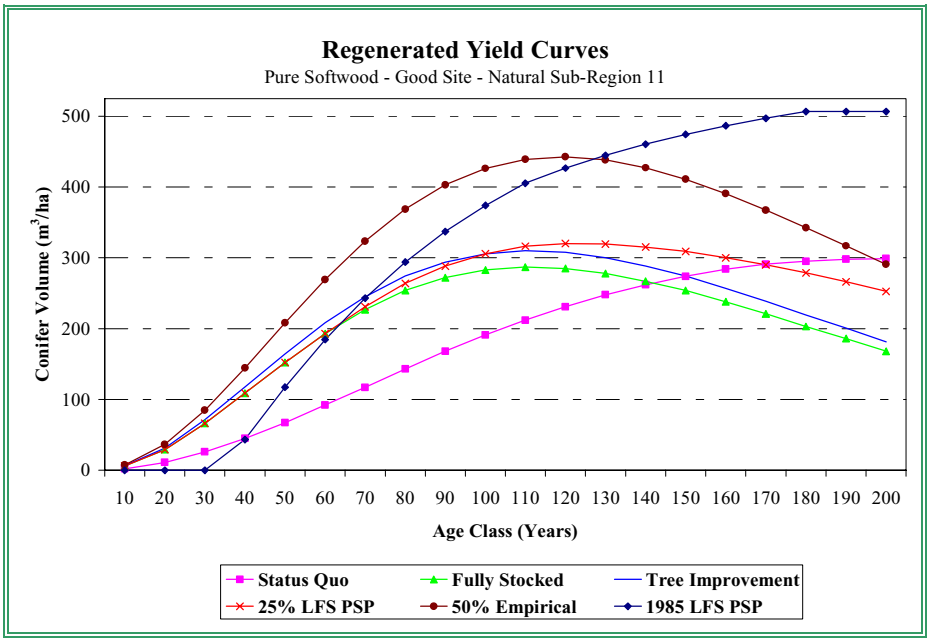

Figure 3.4 Regenerated Yield Curves for Pure Softwood Species Group on Good Sites, Lower Foothills.

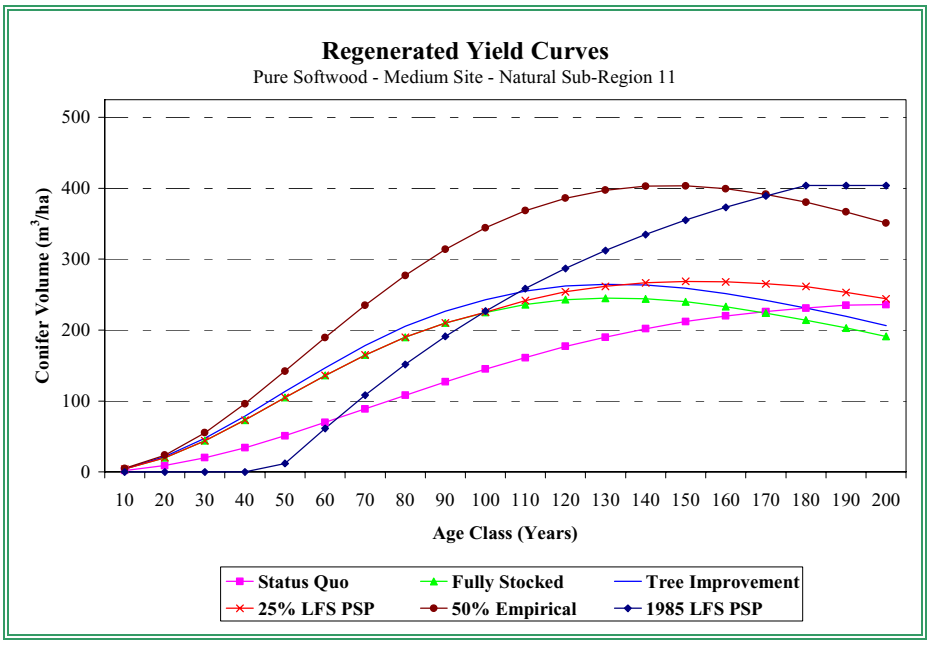

Figure 3.5 Regenerated Yield Curves for Pure Softwood Species Group on Medium Sites, Lower Foothills.

3.4 Landbase Determination

3.4.1 Process for Net Landbase Determination

ANC staff examined the FMA area and assigned the landbase to one of several categories. Ground rule buffers, consistent with current provincial policy, were applied to lakes, rivers and permanent streams across the entire FMA area. Areas identified as cutovers under AVI remain in the net productive landbase. The following areas were identified:

Recreation Areas — ANC staff identified recreational areas are within the extent of the FMA area, primarily around lakes (e.g., Crooked Lake).

Non-forested Areas — The following non-forested areas were identified under AVI:

1. Natural non-forested areas - includes lakes, double-line rivers, flooded areas, grasslands, shrubs, etc. (AVI codes: NWR, NWL, NWF, NMB, NMC, NMS, HG, HF, SO, SC, BR). An override was applied to all cutover areas; these areas were re-assigned to the net productive landbase.

Anthropogenic non-forested areas — “Human-induced” influences on the land. Areas such as well sites, roads and pipelines have been classified in this category. (AVI codes: CA, CP, CPR, CIP, CIW, ASC, ASR, AIH, AIG, AIF, AII).