Appendix 1

1 Woodstock Setup

A wide variety of input parameters and management assumptions must be specified prior to projecting harvest schedules with Woodstock™. These are specified in order to reflect both the biological processes of the forest and the current realities of operational forest management practices.

1.1 Input shapefiles

As part of the net land base determination process, shapefiles are created for each FMU consistent with the requirements for Woodstock. This involves classifying the landscape into themes (described below), and assigning pre-block information.

Due to changes in pre-blocks, as well as the addition of a mountain pine beetle strategy, the input shapefiles have undergone some changes since their initial creation from the net land base determination process. The specifics are documented in the following sections.

1.2 Effective Date

May 1st, 2004 was selected as the effective date and is unchanged from the DFMP. May 1st is the beginning of the timber operating and production tracking year. The start date is defined as the point in time that best reflects the forest attributes at the beginning of the TSA model. Therefore, every reasonable attempt was made to have all input data sets consistent with May 1st, 2004.

1.3 Planning Horizon and Period Length

The planning horizon used in this analysis was 160 years or 32 periods (approximately twice the expected rotation age). The period length was set as 5 years.

1.4 Lifespan

The lifespan identifies the maximum age of a development type before it dies or is replaced by another development type. Table 1-1 outlines the life spans by broad cover group used in this TSA.

The model used five different life spans.

1. Coniferous (C AND CD) broad cover groups [*theme9 = OLD_C*] were assigned a lifespan of 300 years (60 periods).
2. Deciduous (D AND DC) broad cover groups [*theme9 = OLD_D*] were assigned a lifespan of 180 years (36 periods).
3. Areas within the Chip Lake fire (FMU W6) that were not salvaged [*theme11=FN*] were given a lifespan of 10 years (2 periods), consistent with a regeneration lag of 5 years from the model start date (May 1, 2004).
4. NSR areas [*theme13=NSR*] resulting from harvest are assigned a lifespan of 5 years (1 period) corresponding to the regeneration lag.
5. Remaining non-forest cover types [theme7=NONE] were assigned a lifespan of 500 years.

Table 1-1 Lifespan by Broad Cover Group (BCG)

BCG	Lifespan (years)
Deciduous	180
DC Mixedwood	180
CD Mixedwood	300
Coniferous	300

1.5 Landscape

The landscape section defines the variables (called themes) that will be utilized during the modeling process. There are 16 themes identified as detailed below. Themes 15 and 16 were not present in the DFMP but the remaining themes are unchanged.

Theme1 – FMU

Theme1 was the field used to divide the FMA into the 4 respective FMU models and data sets.

E1
E2
W5
W6

Theme2 – Natural Subregion

Natural Subregion as defined by the provincial data sets.

LF – Lower Foothills
UF – Upper Foothills

Theme3 – Harvest Design Area (HDA)

Harvest design areas are a Weyerhaeuser operational/planning designation that divides FMUs into harvest compartments. Table 1-2 presents the HDA's for each FMU.

Table 1-2Harvest Design Areas by FMU

	FMU			
	E1	**E2**	**W5**	**W6**
Harvest Design Area (HDA)	BROCAB - Broken Cabin ERITHX – Erith FICKLE - Fickle Lake RODNEY - Rodney Creek SANGLK - Sang Lake SVEDBG – Svedberg	CRICKS - Cricks Creek DEERHL - Deer Hill GRANDT - Grand Trunk GRANDE - Grande Prairie Trail MEDICI - Medicine Lodge OBEDLK - Obed Lake OLDMAN - Oldman Creek PIONER – Pioneer SHININ - Shiningbank East SUNDAN - Sundance Creek SURPRI - Surprise Lake SWANSN – Swanson TOMHIL - Tom Hill TROUTC - Trout Creek	EASTBK - East Bank EASYFD – Easyford HATTON – Hattonford KEYHOL - Key Hole LOBSTK – Lobstick LODGEP – Lodgepole LOSTER - Lost Elk Ridge MACKAY – MacKay MCLEOD - McLeod Crossing	BIGROK - Big Rock BIGORY – Bigoray CHIPLK - Chip Lake COYOTE - Coyote Creek ETALAK - Eta Lake GRANAD – Granada NINEML - Nine Mile NMINNW – North Minnow NOJACK – Nojack South PEMBIN - North Pembina NRATCK - North Rat Creek PADDYC – Paddy Creek SINKHL - Sinkhole Lake SMINNW – South Minnow SRATCK - South Rat Creek TOWERX – Tower ZETALK - Zeta Lake

Key aggregates:

CARROT – Carrot Land Management Unit (LMU)
LOSTER NINEML NRATCK TOWERX NMINNW

CYNTHIA – Cynthia LMU
BIGORY CHIPLK EASYFD ETALAK GRANAD LOBSTK NOJACK PADDYC SINKHL

WOLFLK – Wolf Lake LMU
BIGROK COYOTE PEMBIN RODNEY SANGLK SRATCK SVEDBG ZETALK SMINNW

Theme4 – Grazing Indicator

Theme4 designates area as either being inside or outside of a grazing disposition. This theme is used to calculate grazing disposition AACs.

GRZ – Grazing Allocated
NOT – No Grazing

Theme5 – Site Quality

Theme5 is a measure of stand site quality as defined in the netdown and yield curve technical reports. These categories are based upon data provided by the *SiteLogix* ecosite definition system. Although the values below are similar to those used for the AVI variable TPR (timber productivity rating); TPR was not used in anyway for this assignment. However, TPR will often match these assignments.

G – Good
M – Medium
P – Poor
X – Not assigned

Theme6 – Land base

Theme6 designates a stand as to being managed primarily for coniferous or deciduous volume. Within the Edson FMA, the assignment of land base is not based strictly on the expressed broad cover group of a stand but additionally operational issues are considered. Therefore, in E1 and E2 only pure coniferous stands are considered part of the coniferous land base whereas, in W5 and W6 only pure deciduous stands are excluded from the coniferous land base (see the land base allocation technical report for more detail).

CON – Coniferous land base
DEC – Deciduous land base
NOT – Neither coniferous or deciduous

Theme7 – Yield Curve

Theme7 assigns each polygon to a yield curve as defined in the yield projection technical report.

C1 to C111 – Coniferous dominated yield curve
D1 to D50 – Deciduous dominated yield curve
NONE – Not assigned to a yield curve (land that does not support forests)

Key aggregates:

CX – Pure coniferous stands (80% to 100% coniferous composition)
C4 C5 C6 C10 C11 C12 C16 C17 C18 C22 C23 C24 C28 C29 C30 C34 C35 C36 C40 C41 C42 C46 C47 C48 C52 C53 C54 C58 C59 C60 C64 C65 C66 C70 C71 C72 C76 C77 C78 C82 C83 C84 C88 C89 C90 C94 C95 C96 C100 C101 C102 C106 C107 C108

CD – Coniferous dominated mixedwood stands (50% to 70% coniferous composition and coniferous leading species)
C1 C2 C3 C7 C8 C9 C13 C14 C15 C19 C20 C21 C25 C26 C27 C31 C32 C33 C37 C38 C39 C43 C44 C45 C49 C50 C51 C55 C56 C57 C61 C62 C63 C67 C68 C69 C73 C74 C75 C79 C80 C81 C85 C86 C87 C91 C92 C93 C97 C98 C99 C103 C104 C105 C109 C110 C111

DC – Deciduous dominated mixedwood stands (30% to 50% coniferous composition and deciduous leading species)
D4 D5 D6 D10 D11 D12 D16 D17 D18 D22 D23 D24 D28 D29 D30 D34 D35 D36 D40 D41 D42 D46 D47 D48 D50

DX – Pure deciduous stands (0% to 20% coniferous composition)
D1 D2 D3 D7 D8 D9 D13 D14 D15 D19 D20 D21 D25 D26 D27 D31 D32 D33 D37 D38 D39 D43 D44 D45 D49

Theme8 – Crown Closure Class

Theme8 designates each polygon to an AVI crown class.

A – "A" density crown closure
B – "B" density crown closure
C – "C" density crown closure
D – "D" density crown closure
N – No crown closure designated

Theme9 – Old Growth Categories

Theme9 assigns each polygon into an old growth category (as defined by Weyerhaeuser's Senior Ecologist – See section 2.10.4 of the Land base Allocation Technical Report), which allows for tracking (and constraining) the change in late seral stage areas across the planning horizon. All stands are assigned to an old growth category regardless of age. Therefore, to obtain the area that is in a late seral stage in an old growth category both the old growth category and stand age must be queried in unison.

OLD_DX – Pure Deciduous
OLD_DC – Deciduous dominated mixedwood
OLD_CD – Coniferous dominated mixedwood
OLD_PL – Pure Coniferous: Pine composition greater than and equal to 80%
OLD_SW – Pure Coniferous: White Spruce composition greater than and equal to 80%
OLD_PS – Pure Coniferous: White Spruce / Pine are the first two species with the composition of either species not greater than 79%
OLD_CX – Pure Coniferous: All other pure coniferous stands that do not fit into any of the other old growth categories (OLD_PL, OLD_SW, or OLD_PS)

Theme10 – Deletion

Theme10 indicates whether a polygon is part of the operable land base or not. This field is a summary of the *[del]* field used with the netdown procedure.

DL – Stand is a deletion and is not part of the net harvestable land base
NO – In the net harvestable land base

Theme11 – Chip Lake Salvage Block

Theme11 designates those areas that were part of the Chip Lake fire (within W6) and identifies salvaged areas. The Chip Lake Fire occurred in 1998, 6 years prior to the base date used in this timber supply analysis.

NN – Not part of the Chip Lake Fire
FN – Areas within the Chip Lake Fire Zone and <u>not</u> salvaged were assumed to be destroyed in the fire. These stands were placed on a regeneration delay of 5 years from the start date of the model and were assumed to regenerate to the cover type present prior to the fire.
FS – Areas within the Chip Lake Fire Zone and salvage harvested were assigned to a yield curve and a stand age in the same manner as cut blocks outside the Chip Lake fire zone. Salvage blocks are assigned to be either 1 or 2 periods (0 to 5 years or 5 to 10 years respectively) old.

Theme12 – Planned Block Operator

Theme12 assigns each sequenced block to an operator. This field is most accurate for the first decade of sequencing (periods 1 and 2).

ANC – Alberta Newsprint Company
BR – Blue Ridge Lumber
CCTL – Cold Creek Timber Limited
EDF – EDFOR
ETP – Edson Timber Products
MW – Millar Western
WEY - Weyerhaeuser
MTU – The MTU (Miscellaneous Timber User) designation was used in three of the FMUs (E2, W5, and W6). However, in each FMU a different user is being referred to.

Theme13 – Regeneration Status

Theme13 keeps track of the regeneration status of each block. Historical data were analyzed to estimate the regeneration lag for different broad cover groups (CX, CD, DC, and DX).

SR – Sufficiently restocked (typically indicates fire origin)

RSR – Regenerating stand – sufficiently restocked
PSR – Operationally planned and sufficiently restocked
NSR - Not sufficiently restocked
NOS – No stocking category

Theme14 – Piece Size Identification

Theme14 assigns each polygon to a stratum that represents average piece size.

P1 – Piece Stratum 1: Coniferous dominated stands (CX, or CD) – Good/Medium Sites – Lower/Upper Foothills – All crown closures (Understory managed stands not included)
P2 – Piece Stratum 2: Deciduous dominated stands (DX, or DC) – Good Sites – Lower/Upper Foothills – All crown closures (Understory managed stands not included)
P3 – Piece Stratum 3: Poor Site (Both coniferous and deciduous dominated stands) – Lower/Upper Foothills – All crown closures (Understory managed stands not included)
P4 – Piece Stratum 4: Understory managed stands (Switch stands) only – All Sites – Lower/Upper Foothills – All crown closures
NA – Not assigned to a piece size stratum

Theme15 – MPB Susceptibility Rating

Alberta's Forest Management Branch has adapted the Shore/Safranyik Stand Susceptibility Index (SSI) Model for use in Alberta. AVI attribute data was processed by the SSI model (version Sept 14, 2006) resulting in a dBase file containing Stand Susceptibility Index (SSI), Climate Factor (CF) and SSICF values for each polygon. The MPB susceptibility rating used in Woodstock is a 3 letter code based on CF, SSI and SSICF. Table 1-3 summarizes the MPB susceptibility rating system for Theme15.

Table 1-3 MPB Susceptibility Rating

Climate Factor Rating (CF)	Pine Component Rating (SSI)	SSI_CF Classification (CF * SSI)
A = 1.0	A = 81-100	L = Low (0-30)
B = 0.8	B = 51-80	M = Medium (31-50)
C = 0.5	C = 31-50	H = High (51-100)
D = 0.2	D = 0-30	
E = 0.1		

Non-pine stands were assigned a value of "ZZ".

Aggregates were used to identify the pine stand ranking (Rank 1, 2 or 3) based on the assigned compartment risk, consistent with the September 2006 (version 2.6) Interpretive Bulletin (Planning Mountain Pine Beetle Response Operations). FMU E1 and E2 were given a "moderate" compartment risk, whereas W5 and W6 were given a "low" compartment risk. Stands were assumed to remain at their initial susceptibility rating until they were harvested or died.

Key aggregates:

mpb ; all mpb (pine) stands
AAH ABH ACM ADL BAH BBM BBH BCL BCM BDL CAM CBL CBM CCL CDL DAL DBL DCL DDL EAL EBL ECL EDL

low1 - rank 1 stands for low compartment risk
AAH ABH BAH
low2 - rank 2 stands for low compartment risk
ACM ADL BBM BBH BCL BCM BDL CAM CBL CBM CCL DAL DBL DCL
low3 - rank 3 stands for low compartment risk
CDL DDL EAL EBL ECL EDL
low - low stands requiring harvest strategy (i.e., managed rank 1 and rank 2)
low1 low2

mod1 - rank 1 stands for moderate compartment risk
AAH ABH ACM BAH BBM BBH CAM
mod2 - rank 2 stands for moderate compartment risk
ADL BCL BCM BDL CBL CBM CCL CDL DAL DBL DCL EAL EBL
mod3 - rank 3 stands for moderate compartment risk
DDL ECL EDL
mod - moderate stands requiring harvest strategy (i.e., managed rank 1 and rank 2)
mod1 mod2

Theme16 – Planned Cut Period

Although most preblocks were hard coded into the Woodstock shapefile, this occasionally resulted in infeasible models. Some preblocks were coded in as themes to give the model more flexibility in scheduling. The Optimize section then constrained harvest of these blocks.

NA – not a preblock
P1 – unscheduled preblock desired in period 1
P2 – unscheduled preblock desired in period 2
P3 – unscheduled preblock desired in period 3
P13 – unscheduled preblock to be harvested from period 1-3
P45 – unscheduled preblock to be harvested from period 4-5

1.6 Areas

The area files were built using the automated Spatial Woodstock function. There were no user-defined locks or proximal analysis.

1.7 Actions

The action section applies activities and/or treatments to the forest. There are two actions used:

CCC – Harvesting of pure coniferous stands (theme7 = CX)
CCD – Harvesting of pure deciduous and mixedwood stands (theme7 = DX, CD, or, DC)

Death is a system-provided action that occurs when a stand reaches the lifespan age.

Minimum Harvest Age
Minimum harvest ages were used to define an "operability window" when a stratum meets the minimum age requirement to be eligible for harvest (i.e., becomes merchantable). Lower operability limits were defined for each land base type based on various components such as tree growth, volume, product sizes, harvesting practices and systems. The minimum harvest ages for the land base groups to be harvested by Weyerhaeuser are specific to FMUs as follows:

Coniferous dominated stands (CX and CD)

- E1 and E2: 80 years for entire planning horizon
- W5: 100 years 1st Rotation, 80 years 2nd Rotation
- W6: 80 years 1st Rotation, 70 years 2nd Rotation

Deciduous (DX and DC stands)

- Entire FMA: 1st Rotation 80 years, 2nd Rotation – 60 years

Operability limits were removed for all pre-blocks.

There were no upper operability limits for timber harvest eligibility in the timber supply model (the lifespan age becomes the *de facto* upper operability limit).

Harvest Design Area (HDA) Sequencing
Harvest design areas (HDAs) are used by Weyerhaeuser foresters as operational planning units. Constraining the ability of the TSA model to allocate blocks within HDAs (especially over the next 20 years) resulted in a spatial sequence that better conforms to the operational intent. Table 1-4 HDAs that are open for harvest are assigned a ZONERES yield of 1. HDAs that are closed for harvest are assigned a ZONERES yield of 0. ZONERES must be 1 for a stand to be actionable. Table 1-4 indicates when HDAs were closed for the allocation of additional harvesting.

Table 1-4 Allowable harvest periods by harvest design area

FMU	Harvest Design Area	Broad Cover Group	Periods* Closed for Harvest Allocation
E1	Broken Cabin	CX, CD, DC, DX	NA
	Erith	CX, CD, DC, DX	NA
	Fickle Lake	CX, CD, DC, DX	1..4
	Rodney Creek	CX, CD, DC, DX	NA

FMU	Harvest Design Area	Broad Cover Group	Periods* Closed for Harvest Allocation
E2	Sang Lake	CX, CD, DC, DX	1..4
	Svedberg	CX, CD, DC, DX	NA
	Cricks Creek	CX, CD, DC, DX	NA
	Deer Hill	CX, CD, DC, DX	NA
	Grande Prairie Trail	CX, CD, DC, DX	NA
	Grand Trunk	CX, CD, DC, DX	1..4
	Medicine Lodge	CX, CD	NA
		DC, DX	1..4
	Obed Lake	CX, CD	NA
		DC, DX	1..4
	Oldman Creek	CX, CD, DC, DX	NA
	Pioneer	CX, CD, DC, DX	1
	Shiningbank East	CX, CD, DC, DX	1..4
	Sundance Creek	CX, CD, DC, DX	NA
	Surprise Lake	CX, CD, DC, DX	1..4
	Swanson	CX, CD, DC, DX	1..4
	Tom Hill	CX, CD, DC, DX	NA
	Trout Creek	CX, CD, DC, DX	NA
W5	East Bank	CX, CD, DC	NA
		DX	1..4
	Easyford	CX, CD, DC, DX	1
	Hattonford	CX, CD, DC, DX	NA
	Key Hole	CX, CD, DC	NA
		DX	1..4
	Lobstick	CX, CD, DC, DX	NA
	Lodgepole	CX, CD, DC, DX	1
	Lost Elk Ridge	CX, CD, DC	NA
		DX	1..4
	MacKay	CX, CD, DC, DX	NA
	McLeod Crossing	CX, CD, DC, DX	NA
W6	Bigoray	CX, CD	NA
		DC, DX	1..4
	Big Rock	CX, CD, DC, DX	NA
	Chip Lake	CX, CD	NA
		DC, DX	1..4
	Coyote Creek	CX, CD, DC, DX	NA
	Eta Lake	CX, CD, DC, DX	NA
	Granada	CX, CD, DC, DX	NA
	North Minnow Lake	CX, CD, DC	NA
		DX	1..4
	Nine Mile	CX, CD, DC, DX	NA
	Nojack South	CX, CD, DC, DX	NA
	North Rat Creek	CX, CD, DC	NA
		DX	1..4

FMU	Harvest Design Area	Broad Cover Group	Periods* Closed for Harvest Allocation
	Paddy Creek	CX, CD, DC, DX	NA
	North Pembina	CX, CD, DC, DX	NA
	Sinkhole Lake	CX, CD, DC, DX	NA
	South Minnow	CX, CD, DC	NA
	Lake	DX	1..4
	South Rat Creek	CX, CD, DC, DX	NA
	Tower	CX, CD, DC, DX	NA
	Zeta Lake	CX, CD, DC, DX	NA

* Excludes pre-blocks

1.8 Yields

The development of yield curve components is described in detail in Appendix 6.2 of the DFMP. The yields section provides output data from the yield projection technical reports into the TSA model. The following yield categories were used in this section.

- Volume Yields – volume (m^3/ha) for each yield curve (Theme7)
    a. Con_V – Coniferous volume
    b. Dec_V – Deciduous volume
    c. AW_V – Trembling Aspen volume
    d. BW_V – White Birch volume
    e. PB_V – Balsam Poplar volume
    f. SW_V – Spruce (White and Black) volume
    g. FB_V – Fir volume
    h. PL_V – Pine volume
- Piece Size – the estimated mean quadratic diameter of the stand as assigned by Theme14
    i. CQMD – Coniferous mean quadratic diameter
    j. DQMD – Deciduous mean quadratic diameter
- Age – yields are equal to the stand age in years
    k. Agey – age (years)
- Operating Areas
    l. ZONERES – A time-dependent yield curve that identifies which HDAs are ineligible for harvest in which periods. Any development type mask with a ZONERES value of 0 is ineligible for harvest. It is used in the Action section as an operability limit to control the timing of harvesting.

1.9 Transitions

The stand transition rules are identical for all FMUs. There are two different types of transitions, those that occur after death and after harvesting. In all cases, stands transition to a non-ranked Mountain Pine Beetle stand (*theme15 = ZZ*).

Death Transitions

Stands that are not harvested are subject to a mortality function when their age reaches the lifespan, as defined in the lifespan section. All stands that undergo death return to their pre-death yield strata.

There are four types of death transitions:

- Forested stands in the Chip Lake fire: Those stands that were not salvaged [*theme11 = FN*] transition to non-burned stands [*theme11 = NN*] at an age of 0. If those stands are on the net landbase, their regeneration status [*theme13*] transitions from NSR to SR.
- Stands within the net land base: if a sufficiently restocked [*theme13 = ALLSR*] stand within the net land base [*theme10 = NO*] dies, the stand age will be reset to 0.
- Forested stands outside the net land base: if a forested stand [*theme9 = OLD_C or OLD_D*] outside the net land base *[theme10 = DL]* dies, the stand age will be reset to 34 periods. This was done to provide a more realistic modeling of a stand that has reached a "stable" species community (perhaps can be viewed as a climax situation).
- NSR stands used for regeneration lag: After harvesting, some area is required to go through a regeneration lag. NSR stands *[theme13 = NSR]* transition to RSR stands *[theme13 = RSR]* after death.

Harvesting Transitions

Stands that are harvested are assumed for the purposes of modeling to regenerate to the fully-stocked pre-treatment state and are assigned an age of zero. Thus, 'A', 'B', 'C', or 'D' density strata are assumed, within the model, to regenerate back to a 'C' density stratum. Transitions in strata are supported with firm commitments to conduct the necessary silviculture treatments to provide sufficient assurance that the transitions proposed are practical and reasonable.

The harvest transitions are defined as follows:

- Change the age: After harvesting the age is re-set to 0.
- Regeneration stand type: Stands were assumed to regenerate with the same composition as the pre-harvest stand (i.e. 100% coniferous composition to 100% coniferous composition). However, it was assumed that harvested stands will come back to fully stocked status (defined as "C" crown closure). Therefore all stands located in the Lower Foothills *[theme2=LF]* on a "good" site *[theme5=G]* with 100% coniferous composition *[theme7=CON10]* regenerate on a "C18" yield curve *[theme7=C18]*.
- Regeneration delay: Portions of the stands regenerate to fully stocked stands [*theme13 = RSR*] or not satisfactorily regenerated stands [*theme13 = NSR*], to incorporate a regeneration delay.

Regeneration Lag

Regeneration lag is the time (number of growing seasons, expressed in years) following harvest required for a new stand of trees to initiate growth as compared to the natural yield curve. The regeneration lag is equivalent to the time a harvested area remains fallow without regenerating trees. The regeneration lag assessment used the timing of historical reforestation activities and the regeneration survey status as the basis for establishing the regeneration lag assumed in the

timber supply analysis (TSA). Additional detail regarding the determination of regeneration lags is located in Appendix 6.10 of the submitted DFMP (2004-2014).

As the harvest projection output is recorded in five-year time periods, this was implemented such that a calculated regeneration lag value of 2.3 years would have 42% (2.1 yrs / 5 yr period) of the area (ha) delayed one five-year period and 58% of the area regenerate with no delay. Table 1-5 presents the regeneration lags by broad cover group used in this analysis and shows how the regeneration lags were calculated for use in Woodstock's transition section.

Table 1-5 Regeneration lag calculations used in the transitions section

Broad Cover Groups	Regeneration Lag (Years)	5-year period conversion percentage of stands with a 5-year regeneration lag =(Column 2) / 5	5-year period conversion percentage of stands with no regeneration lag = 100% - (Column 3)
Column 1	**Column 2**	**Column 3**	**Column 4**
CX	1.7	34%	66%
CD	3.1	62%	38%
DC	2.1	42%	58%
DX	0.4	8%	92%

1.10 Optimize section

The optimize section is where the objective function and constraints are formulated as a linear program. In general terms, the optimize sections are the same among the four FMU. However, idiosyncrasies have resulted in minor differences as explained below.

Objective Function

The primary objective of this analysis was to maximize the total primary volume harvested over the planning horizon. This essentially means maximizing the sum of coniferous and deciduous primary harvest volumes (conifer volume from the conifer land base and deciduous volume from the deciduous land base) over the next 160 years.

An additional factor (*srgpj1*) was added to the objective function to aid in MPB management. Adding conifer volume from pine-leading conifer stands in the first 4 periods of the planning horizon to the objective function provides Woodstock with an incentive to harvest pure pine stands during the main MPB management periods.

Volume Flow Constraints

Constraints were incorporated into the model to ensure that the level of forest management is sustainable over time and to incorporate controls to ensure that any specific strategic or operational requirements are met. Constraints to control the flow of both primary and incidental volumes are implemented in the model.

Due to the introduction of the MPB management strategy requirements, constraints on the primary conifer and deciduous flows had to be applied over distinct timeframes, as follows:

Primary Conifer

- Period 1 – with a 2004 model reference date, the first 3 years were set at the Stanley allocated volumes from the current DFMP. The harvest level for the remaining 2 years was set at the surge harvest level of period 2.
- Periods 2 to 4 – strict even flow during the "surge period".
- Period 5 – in order to allow for 18 years of surge cut, the harvest level for the first year of period 5 was set at the surge harvest level of period 4. The remaining 4 years was set at the post-surge harvest level of period 6.
- Periods 6 to 12 – strict even flow.
- Periods 12 to 32 – ± 5% flow variation from the post-surge average harvest level (periods 6-32).
- The post-surge average was also constrained to a maximum 10% drop from the baseline harvest level (current DFMP average from periods 2-32 for E1, E2 and W5, and periods 5-32 for W6 (to exclude a surge cut)) consistent with Section 5.6(iv)(c) of Annex 1 of the Alberta Forest Management Planning Standard.

Primary Deciduous

- Period 1 – Stanley allocated volume from the current DFMP.
- Periods 2 to 12 – strict even flow.
- Periods 12 to 32 – ± 5% flow variation from the period 2 to 32 average with no drop from the baseline (current DFMP average over periods 2-32) allowed.

Incidental Conifer

- Periods 1 to 32 – ± 10% flow variation. In E1 and W6, this constraint was applied from periods 2 to 32 to prevent an infeasible solution. In E1 and W6, an additional constraint limited the flow variation between period 1 and 2 to 20%.

Incidental Deciduous

- Periods 1 to 4 – 10% flow variation to allow for the surge cut.
- Periods 5 to 32 – 10% flow variation. The variation from period 4 to period 5 was unconstrained.

Additional volume flow constraints were included for FMU W6. In W6 there are three different Land Management Units (LMUs). A business decision was made to limit coniferous operators' activities within each LMU.

- Carrot River LMU includes HDAs: Nine Mile, North Rat Creek, Tower, and North Minnow
  - Operators: Blue Ridge, Millar Western
- Wolf Lake LMU includes HDAs: Big Rock, Coyote Creek, North Pembina, South Rat Creek, Zeta Lake, and South Minnow
  - Operators: ANC
- Cynthia LMU includes HDAs: Bigoray, Chip Lake, Eta Lake, Granada, Nojack South, Paddy Creek, and Sinkhole
  - Operators: CCTL, MTU, Weyerhaeuser

Controls were placed into the model to ensure that the following minimum percentage of the total primary coniferous harvest volume during each of the first 2 decades would come out of each LMU.

- Carrot River - 19%
- Cynthia - 36%
- Wolf Lake - 42%

Growing Stock Constraints

To provide some support to long term sustainability, the following outputs were not permitted to decline over the last 40 years (8 periods) of the planning horizon:

- Total deciduous growing stock on the net landbase (primary + incidental)
- Total coniferous growing stock on the net landbase (primary + incidental)
- Operable deciduous growing stock on the net landbase (primary + incidental)
- Operable coniferous growing stock on the net landbase (primary + incidental)

Seral Stage Constraints

Ensuring a remnant level of old seral stages was deemed to be an important target for this management plan. Representation of all forest cover types across a range of age and seral stages is necessary to address wildlife habitat objectives. Older forest is also represented within harvest openings through what is known as "within-block retention". Patches of mature trees are left to retain some older forest structure within harvested areas. Depending on the size of these retention patches, they may or not be mapped as distinct from the surrounding harvested area. For this model, seral stage targets do not account for within-block retention.

Weyerhaeuser's Senior Ecologist provided a list of critical minimum areas that must be maintained for six old growth broad cover groups (see Appendix 6.1 in the submitted DFMP for more detail). These areas were directly constrained in the TSA model of each FMU.

Seral stages are defined separately for coniferous and deciduous dominated stands as follows:

- Coniferous Dominated Stands ([*theme9 = OLD_C*])
  - Late Seral = 91 to 120 years
  - Very Late Seral = 121 to 170 years
  - Extremely Late Seral = 171+ years

- Deciduous Dominated Stands ([*theme9 = OLD_D*])
  - Late Seral = 71 to 110 years
  - Very Late Seral = 111 to 170 years
  - Extremely Late Seral = 171+ years

Woodstock constraints are formulated so that ranges of late, very late and extremely late seral stages in each old growth broad cover group (as defined by theme 9) were maintained. Due to the number of seral constraints the model initially had a very difficult time processing. It was

determined that aggregations of cover types could be made without removing any integrity of the constraints or the amount of older seral stages in the future. The seral stage constraints are summarized in Table 1-6. Late seral stage constraints were applied across the entire planning horizon. The very late and extremely late seral stage constraints were applied from periods 1 to 8 only.

Table 1-6 Seral Stage Constraints

FMU	Natural Sub-region	Old Growth Broad Cover Group Category	Minimum Area that Must Be Late Seral Stage or Older	Minimum Area that Must Be Very Late Seral Stage or Older	Minimum Area that Must Be Extremely Late Seral Stage or Older
E1	LF	CD	559	112	0
		Other Pure CX	2,398	480	0
		DC	282	56	0
		DX	351	70	0
		Pure CX Pine Leading	1,105	221	0
		Pure CX Pine/White Spruce Mix	188	38	0
		Pure CX White Spruce Leading	301	60	0
	UF	CD	3	1	0
		Other Pure CX	10	5	3
		DC	3	1	0
		DX	4	2	0
		Pure CX Pine Leading	2	1	1
		Pure CX Pine/White Spruce Mix	3	1	1
		Pure CX White Spruce Leading	1	0	0
E2	LF	CD	460	92	0
		Other Pure CX	1,583	317	0
		DC	387	77	0
		DX	1,594	319	0
		Pure CX Pine Leading	291	58	0
		Pure CX Pine/White Spruce Mix	117	23	0
		Pure CX White Spruce Leading	231	46	0
	UF	CD	98	39	0
		Other Pure CX	165	83	41
		DC	103	41	0
		DX	124	50	0
		Pure CX Pine Leading	76	38	19
		Pure CX Pine/White Spruce	62	31	16

FMU	Natural Sub-region	Old Growth Broad Cover Group Category	Minimum Area that Must Be Late Seral Stage or Older	Minimum Area that Must Be Very Late Seral Stage or Older	Minimum Area that Must Be Extremely Late Seral Stage or Older
		Mix			
		Pure CX White Spruce Leading	74	25	12
W5	LF	CD	273	55	0
		Other Pure CX	959	192	0
		DC	220	44	0
		DX	922	184	0
		Pure CX Pine Leading	188	38	0
		Pure CX Pine/White Spruce Mix	35	7	0
		Pure CX White Spruce Leading	167	33	0
W6	LF	CD	1,020	204	0
		Other Pure CX	3,810	762	0
		DC	725	145	0
		DX	2,007	401	0
		Pure CX Pine Leading	1,234	247	0
		Pure CX Pine/White Spruce Mix	217	43	0
		Pure CX White Spruce Leading	1,259	252	0
	UF	CD	49	20	0
		Other Pure CX	908	454	227
		DC	17	7	0
		DX	31	13	0
		Pure CX Pine Leading	87	43	22
		Pure CX Pine/White Spruce Mix	12	6	3
		Pure CX White Spruce Leading	31	10	5

Profile Constraints

To promote sustainability, constraints were used in the model to ensure that there were no significant unforeseen modeling biases toward any strata types. Prior to the inclusion of these controls, operational problems were observed relating to disproportionately high amounts of low density (CC='A') stand areas being scheduled for harvest. When unconstrained, the model was attempting to take maximum benefit from moving understocked stands to fully-stocked status as soon as possible.

To avoid this problem, crown closure and site class were identified as the two selection factors which most strongly influence the volume obtained from a stand. In the TSA each FMU is identified as a sustained yield unit and the area by crown closure class and site class were estimated for each unit. The goal was to identify a range of areas for each class that allowed for flexibility in the model yet ensured that most harvest strata types are harvested in the same proportion to their distribution within the operable land base. Therefore, the goal harvest range for each site and crown closure class was to harvest between +50% or –50% of the proportional harvest area based on the rotation age. Table 1-8 and Table 1-9 present the harvest area targets by site class and crown closure class respectively. The profile constraints were applied for periods 1 to 12 only (the spatial planning horizon). To improve the flexibility of the model surrounding the surge cut, the "G" site class and "C" density class targets were not constrained.

Table 1-7 Five-Year Operational Harvest Area Targets by Site Class

FMU	Land Base	Site	Lower 50% Harvest Range (ha)	Upper 50% Harvest Range (ha)
E1	**CON**	**G**	**517**	**1,550**
		M	**552**	**1,657**
		P	**91**	**272**
	DEC	**G**	**501**	**1,504**
		M	**27**	**80**
		P	**5**	**16**
E2	**CON**	**G**	**450**	**1,351**
		M	**171**	**512**
		P	**32**	**96**
	DEC	**G**	**1,396**	**4,189**
		M	**43**	**128**
		P	**8**	**24**
W5	**CON**	**G**	**244**	**733**
		M	**96**	**288**
		P	**43**	**128**
	DEC	**G**	**540**	**1,621**
		P	**2**	**6**
W6	**CON**	**G**	**1,711**	**5,132**
		M	**812**	**2,437**
		P	**200**	**599**
	DEC	**G**	**1,213**	**3,638**
		P	**4**	**13**

Table 1-8 Five-Year Operational Harvest Area Targets by Crown Closure Class

FMU	Land base	AVI Crown Closure	Lower 50% Harvest Range (ha)	Upper 50% Harvest Range (ha)
E1	CON	A	172	515
		B	192	577
		C	523	1,570
		D	272	817
	DEC	A	44	131
		B	96	288
		C	318	954
		D	75	226
E2	CON	A	119	357
		B	148	444
		C	293	879
		D	93	279
	DEC	A	94	282
		B	280	839
		C	909	2,728
		D	164	493
W5	CON	A	139	418
		B	50	150
		C	169	508
		D	24	73
	DEC	A	45	136
		B	93	280
		C	285	854
		D	119	356
W6	CON	A	398	1,193
		B	541	1,624
		C	1,659	4,976
		D	125	376
	DEC	A	37	112
		B	163	490
		C	891	2,673
		D	125	376

Mountain Pine Beetle Constraints

The Prevention (Pine) Strategy proposed by SRD aims to decrease the spread and outbreak potential of MPB by reducing the area of susceptible pine stands to 25% of that in the baseline scenario (DFMP 2004-2014) at a point 20 years in the future. Weyerhaeuser's strategy for the Preferred Forest Management Scenario attempts to reduce the area of Rank 1 and Rank 2 stands on the net land base by 75% from the initial (year 0) inventory over the first 25 years.

Constraints limiting the decline in the post-surge harvest levels to 90% of those in the baseline (submitted DFMP) make it impossible to realize a 75% reduction in MPB susceptible stands. As a result, whether the target reduction is based on the DFMP inventory after 20 years or the initial inventory in the current model has no effect on the model results.

Rather than implement a 20-year MPB strategy, Weyerhaeuser has utilized an 18 year surge cut on primary conifer, effective May 1, 2007. With a model reference date of May 1, 2004, this means the surge cut extends for the remaining two years in period 1 through to the first year of period 5.

To further reduce the area of Rank 1 and Rank 2 stands beyond the first 25 years, the model is constrained, from period 5 onwards, to harvest all operable Rank 1 and Rank 2 stands in the period in which they are (or become) operable. This constraint is goal programmed to ensure the remaining sustainability constraints are not broken.

Reconciliation Volumes

The previously submitted DFMP contained constraints on first-period volume to account for reconciliation volumes from earlier cut quadrants. Due to the surge cut, primary volumes for the first 3 years of period 1 were directly constrained to be equal to the Stanley allocated volumes in the submitted DFMP. As those values considered reconciliation volume, it was not necessary to otherwise constrain for reconciliation volume in the model. Since reconciliation volumes are determined on a quadrant basis, the volumes were unchanged from the 2006 DFMP submission, as shown in Table 1-9.

Table 1-9 Gross quadrant reconciliation volume volume by FMU

Vol	Operator	Gross Volume (m^3)			
		E1	*E2*	*W5*	*W6*
Coniferous	Weyerhaeuser	454	8,923		-30,530
	MTU		-747	7,594	27,523
	ETP	-8,912			
	EDFOR		-28,113		
	CCTL				15,080
	ANC				233,532
	Blue Ridge				24,586
	Millar Western				6,360
	Total	-8,458	-19,936	7,594	276,551
Deciduous	Weyerhaeuser	78,772	66,233	-8,066	260,632
	MTU				33,340
	ETP				
	EDFOR				
	CCTL				
	ANC				
	Blue Ridge				
	Millar Western				
	Total	78,772	66,233	-8,066	293,972

* ETP - Edson Timber Products, MTU - Miscellaneous Timber Unit, CCTL - Cold Creek Timber Ltd, ANC - Alberta Newsprint Company

1.11 Outputs

Below are a list of the main outputs that were used in the model and their meaning.

Harvested Volume

*fmu*CON5YR: Coniferous primary 5-year volume (m^3)
*fmu*DECIN5YR: Deciduous incidental 5-year volume (m^3)
*fmuDE*C5YR: Deciduous primary 5-year volume (m^3)
*fmu*CONIN5YR: Coniferous incidental 5-year volume (m^3)
*fmu*TOTPRIM: Total Coniferous and Deciduous primary volumes (= *fmu*CON5YR + *fmu*DEC5YR)

oPCV_HDA: Primary coniferous harvest volume by HDA
oIDV_HDA: Incidental deciduous harvest volume by HDA
oPDV_HDA: Primary deciduous harvest volume by HDA
oICV_HDA: Incidental coniferous harvest volume by HDA
oDV_HDA: Total deciduous harvest volume by HDA
oCV_HDA: Total coniferous harvest volume by HDA

Growing Stock

*fmu*_Tdecgs: Total deciduous growing stock on the net landbase
*fmu*_Tcongs: Total coniferous growing stock on the net landbase
*fmu*_MOdecgs: Operable deciduous growing stock
*fmu*_MOcongs: Operable coniferous growing stock

Seral Stages

LF_O1DX: Lower foothills Late seral stage pure deciduous area
LF_O1DC: Lower foothills Late seral stage deciduous dominated mixedwood area
LF_O1CD: Lower foothills Late seral stage coniferous dominated mixedwood area
LF_O1PL: Lower foothills Late seral stage pine leading pure coniferous area
LF_O1PS: Lower foothills Late seral stage pine/white spruce mix coniferous area
LF_O1SW: Lower foothills Late seral stage white spruce leading pure coniferous area
LF_O1CX: Lower foothills Late seral stage pure coniferous (that do not fit into any other pure coniferous category) area

LF_O2DX: Lower foothills Very Late seral stage pure deciduous area
LF_O2DC: Lower foothills Very Late seral stage deciduous dominated mixedwood area
LF_O2CD: Lower foothills Very Late seral stage coniferous dominated mixedwood area
LF_O2PL: Lower foothills Very Late seral stage pine leading pure coniferous area
LF_O2PS: Lower foothills Very Late seral stage pine/white spruce mix coniferous area
LF_O2SW: Lower foothills Very Late seral stage white spruce leading pure coniferous area
LF_O2CX: Lower foothills Very Late seral stage pure coniferous (that do not fit into any other pure coniferous category) area

UF_O1DX: Upper foothills Late seral stage pure deciduous area
UF_O1DC: Upper foothills Late seral stage deciduous dominated mixedwood area

UF_O1CD: Upper foothills Late seral stage coniferous dominated mixedwood area
UF_O1PL: Upper foothills Late seral stage pine leading pure coniferous area
UF_O1PS: Upper foothills Late seral stage pine/white spruce mix coniferous area
UF_O1SW: Upper foothills Late seral stage white spruce leading pure coniferous area
UF_O1CX: Upper foothills Late seral stage pure coniferous (that do not fit into any other pure coniferous category) area

UF_O2DX: Upper foothills Very Late seral stage pure deciduous area
UF_O2DC: Upper foothills Very Late seral stage deciduous dominated mixedwood area
UF_O2CD: Upper foothills Very Late seral stage coniferous dominated mixedwood area
UF_O2PL: Upper foothills Very Late seral stage pine leading pure coniferous area
UF_O2PS: Upper foothills Very Late seral stage pine/white spruce mix coniferous area
UF_O2SW: Upper foothills Very Late seral stage white spruce leading pure coniferous area
UF_O2CX: Upper foothills Very Late seral stage pure coniferous (that do not fit into any other pure coniferous category) area

UF_O3PL: Upper foothills Extremely Late seral stage pine leading pure coniferous area
UF_O3PS: Upper foothills Extremely Late seral stage pine/white spruce mix pure coniferous area
UF_O3SW: Upper foothills Extremely Late seral stage white spruce leading pure coniferous area
UF_O3CX: Upper foothills Extremely Late seral stage pure coniferous (that do not fit into any other pure coniferous category) area

Harvest Profile by Crown Closure

CON_A: “A” crown closure area harvested from the coniferous land base
DEC_A: “A” crown closure area harvested from the deciduous land base

CON_B: “B” crown closure area harvested from the coniferous land base
DEC_B: “B” crown closure area harvested from the deciduous land base

CON_C: “C” crown closure area harvested from the coniferous land base
DEC_C: “C” crown closure area harvested from the deciduous land base

CON_D: “D” crown closure area harvested from the coniferous land base
DEC_D: “D” crown closure area harvested from the deciduous land base

Harvest Profile by Site Class

CON_G: “Good” site area harvested from the coniferous land base
DEC_G: “Good” site area harvested from the deciduous land base

CON_M: “Medium” site area harvested from the coniferous land base
DEC_M: “Medium” site area harvested from the deciduous land base

CON_P: “Poor” site area harvested from the coniferous land base

DEC_P: “Poor” site area harvested from the deciduous land base

Miscellaneous Indicators
Area harvested
CONLBHAR: Area harvested from the coniferous land base
DECLBHAR: Area harvested from the deciduous land base
oHARV_AREA: Area harvested by HDA

Piece Size
CONLB_PC: Coniferous piece size harvested from the coniferous land base
CONLB_PD: Deciduous Piece size harvested from the coniferous land base
DECLB_PC: Coniferous Piece size harvested from the deciduous land base
DECLB_PD: Deciduous Piece size harvested from the deciduous land base

Death Area
DECDEATH: Area of net deciduous land base that undergoes death
CONDEATH: Area of net coniferous landbase that undergoes death

Harvest Age
CON_H_AS: Coniferous Harvest Age times area harvested
DEC_H_AS: Deciduous Harvest Age times area harvested

PINEVOL1: Conifer volume harvested from pine leading pure coniferous stands on the conifer landbase

Harvested Volume by Operator
*operator*_CL_CV: Operator Primary Coniferous harvest volume
*operator*_DL_CV: Operator Incidental Coniferous harvest volume
*operator*_TL_CV: Operator Total Coniferous harvest volume

*operator*_CL_DV: Operator Primary Deciduous harvest volume
*operator*_DL_DV: Operator Incidental Deciduous harvest volume
*operator*_TL_DV: Operator Total Deciduous harvest volume

Mountain Pine Beetle Outputs
GMPB_AREA: Gross area of ranked MPB stands
NMPB_ AREA: Net area of ranked MPB stands
MNMPB_ AREA: Net area of Rank 1 and Rank 2 (“managed”) MPB stands
OMPB_ AREA: Harvest operable area of MPB stands
MOMPB_ AREA: Harvest operable area of Rank 1 and Rank 2 MPB stands
HMPB_ AREA: Harvested area of ranked MPB stands
MHMPB_ AREA: Harvested area of Rank 1 and Rank 2 MPB stands
MDMPB_ AREA: Area of Rank 1 and Rank 2 MPB stands that have undergone death

Unscheduled Preblocks
IPD12: Inventory of unscheduled preblocks to be harvested in periods 1-2

HPD12: Harvested area of unscheduled preblocks to be harvested in periods 1-2
IPD13: Inventory of unscheduled preblocks to be harvested in periods 1-3
HPD13: Harvested area of unscheduled preblocks to be harvested in periods 1-3
IPD45: Inventory of unscheduled preblocks to be harvested in periods 4-5
HPD45: Harvested area of unscheduled preblocks to be harvested in periods 4-5

1.12 LP Schedule

Preblocks were re-populated and consist of known harvests from start date to current date.