TFL 52 - TYPE II SILVICULTURE STRATEGY - 2005 UPDATE

ANALYSIS RESULTS

Prepared for:

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1.0 Background

In 2001, Timberline was contracted to develop a Type II Silviculture Strategy for Tree Farm Licence (TFL) 52. At this time the mountain pine beetle infestation in the interior of British Columbia was growing in size but was not having a significant impact on the TFL and as such was not addressed in the Type II Silviculture Strategy. Since that time the mountain pine beetle infestation has grown considerably and is now projected to have a significant impact on timber supply in the TFL. The objective of this analysis is to provide a generalized assessment of the potential role of fertilization in mitigating negative mid-term timber supply impacts. It is anticipated that a more detailed analysis will be conducted with more specific and refined fertilization assumptions.

2.0 Modelling Assumptions

This analysis is based on the Type II Silviculture Strategy for TFL 52 developed in 2001. Various updates have been incorporated into this analysis to address new disturbance since 2001 and to incorporate mountain pine beetle assumptions into the model. Unless stated below, all assumptions are the same as the original Type II Base Case scenario. Please refer to the original Type II documentation for a detailed description of the data and management assumptions used in this analysis.

The following represents the changes in data and assumptions that have been incorporated into the original Type II analysis.

- Void planting as per the original Type II Silviculture Strategy is included.
- 100% mountain pine beetle attack and mortality in all pine-leading stands, age class 4 and greater;
- 50% mountain pine beetle attack and mortality in all pine-leading, age class 3 stands. These stands are randomly selected;
- All mountain pine beetle attack is assumed to have occurred between 2001 and 2005;
- Disturbances have been updated to April 2005;
- Ages have been projected to 2006;
- The model uses five-year planning periods. Period 1 runs from Jan. 1, 2006 to Dec. 31, 2010.
- Shelf life for mountain pine beetle killed stands (Sawlog and Pulplog) has been modelled as follows:
    - Wet Subzones[1]: 0-5 years - 100% sawlog, 5-10 years - 100% pulp, >10 years - 0% pulp.

[1] Assumptions based on shelf life information from *Provincial Level Projection of the Current Mountain Pine Beetle Outbreak: An Overview of the Model and Results of Year 2 of the Project – Appendix 4. Details of the Self-Life Model.* (Marvin Eng, 2004).

    - ESSFwc3: 01/02/03, ESSFwk1: 01/02/03/04/05/06/07, ICHwk4: 01/07, SBSwk1: 01/02/03/04/05/06/07/08/09/11
  - Moist Subzones: Same as wet, except 10-15 years - 50% pulp.
    - ICHmk3: 01/04/05/06, SBSdw1: 01/03/04/07/08, SBSmh: 01, SBSmw: 01/03/04/05/06/07/08/09/10
- Sawlog prices – same as original Type II Silviculture Strategy
- Pulp prices for mountain pine beetle killed stands

Value (delivered):	$35.00/m3
Average logging cost:	$17.35/m3
Road Cost:	$2.22/m3
Stumpage:	$0.25/m3
Net Value:	**$15.18/m3**

- Standard silviculture and void planting costs as per original Type II Silviculture Strategy
- Only mountain pine beetle stands above minimum harvest age (MHA) will be salvaged
- Maintain a harvest of non- mountain pine beetle wood to supply the plywood mill in period #1
  - Maximum 200,000 m^3/yr
  - Minimum 170,000 m^3/yr
- After 15 years a mountain pine beetle killed stand that has not been salvaged loses all its merchantable volume. At this time it will be converted to an appropriate natural stand yield with a 10 year regeneration delay (it will be zero years old in 25 years (15 year shelf-life + 10 year regeneration delay) after it has been attacked)
- Forest cover constraints will be relaxed to allow for mountain pine beetle salvage.
- Accelerated initial harvest level in the first period (900,000 m^3/yr for years 1, 2, 3 and 570,000 m^3/yr for years 4 and 5).
- Only spruce fertilization was done in this analysis using growth response - yield assumptions developed by qualified experts[2]. Lodgepole pine stands were not fertilized because of the latest research[3] showing consistently smaller and more variable growth responses and growth disruptions for fertilized interior lodgepole pine study sites versus spruce study sites.
- A discount rate of 4.0% was used in this analysis for the full cost fertilization scenario.

[2] *Ian Cameron and Eleanor McWilliams of J.S. Thrower and Associates Ltd. developed the spruce growth response- yield assumptions for this analysis. The Mean Annual Increment (MAI) increases for managed, existing spruce stands were approximately 8.0 -10.5 m3/ha per treatment at rotation. MAI increases for existing, natural spruce stands were approximately 7.0- 8.2 m3/ha per treatment at rotation.*

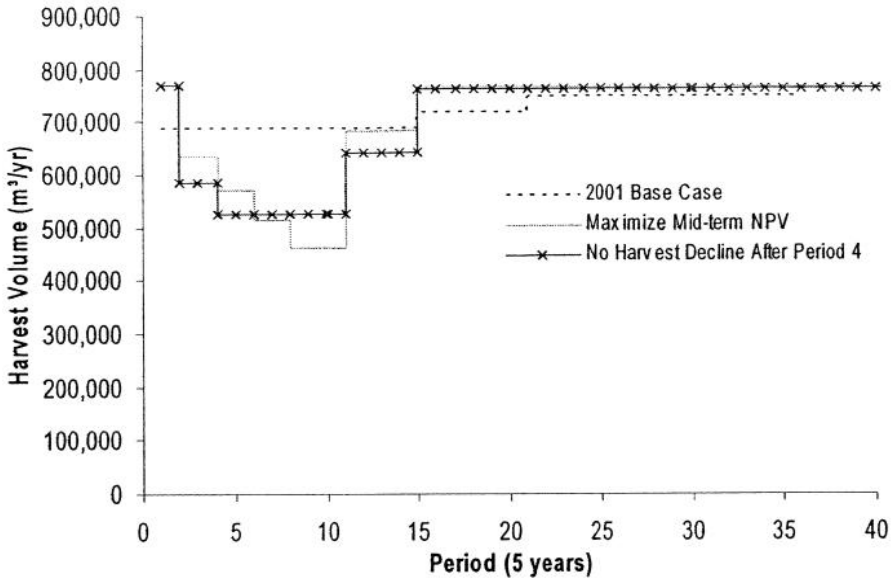

Figure 1: Harvest Forecast – Base Case

Table 1: Harvest Forecast - Base Case

Period (5-year)	2001 Base Case (m^3/yr)	Base - Maximize Mid-term NPV (m^3/yr)	Base - No Harvest Decline After Period 4 (m^3/yr)
1	687,649	767,987	767,989
2	687,649	633,839	584,190
3	687,649	633,808	584,165
4	687,649	570,441	525,764
5	687,649	570,423	525,747
6	687,649	513,387	525,753
7	687,649	513,402	525,762
8	687,649	462,057	525,761
9	687,648	462,060	525,764
10	687,649	462,056	525,761
11	687,649	680,703	642,248
12	687,649	680,700	642,244
13	687,649	680,698	642,242
14	687,649	680,695	642,240
15	716,600	766,151	762,552
16	716,600	766,158	762,553
17	716,600	766,157	762,555
18	716,600	766,161	762,564
19	716,600	766,163	762,560
20	716,600	766,161	762,564
21	748,025	766,175	762,573
22	748,025	766,161	762,568
23	748,025	766,168	762,566
24	748,025	766,168	762,563
25+	748,025	766,160	762,559
TOTAL	**159,396,346**	**156,485,399**	**155,312,145**

Table 2 shows a comparison of other key factors between the two base case scenarios. The total volume of mountain pine beetle sawlog is similar for both scenarios, however there is considerably more pulp volume harvest in the *Maximize Mid-Term NPV* scenario. More area is left unsalvaged in the *No Harvest Decline After Period 4* scenario. These factors, in combination with a higher total harvest volume all contribute to a lower net revenue and lower NPV net revenue when the mid-term even flow restriction is applied to the *No Harvest Decline After Period 4* scenario.

Table 2: Planning Horizon Totals – Base Case

200 Year Totals	Base - Maximize Mid-term NPV	Base - No Harvest Decline After Period 4	% Difference
Total MPB Sawlog Volume Harvested (m^3)	2,989,952	2,989,951	-0.0%
Total MPB Pulp Volume Harvested (m^3)	606,815	322,119	-46.9%
MPB Area Unsalvaged (ha)	17,488	19,208	9.8%
Total Net Revenue ($)	7,134,345,192	7,078,935,600	-0.8%
Total NPV Net Revenue ($)	1,002,288,382	986,525,240	-1.6%

2.2 Fertilization Scenarios

Two primary fertilization scenarios are described in this report: one with full $350/ha/treatment fertilization cost; the other with no fertilization cost. Each of these scenarios is based on the same general harvest flow restrictions as the *Base - No Harvest Decline After Period 4* scenario and both are described in Figure 2 and Table 3. The reported harvest volumes have no reductions for non-recoverable losses.

Each fertilization scenario has the following potential treatment regimes:

- Early fertilization of managed stands – 3 treatments
- Late fertilization of natural stands – 1 treatment
- Late fertilization of natural stands less than 60 years of age – 2 treatments

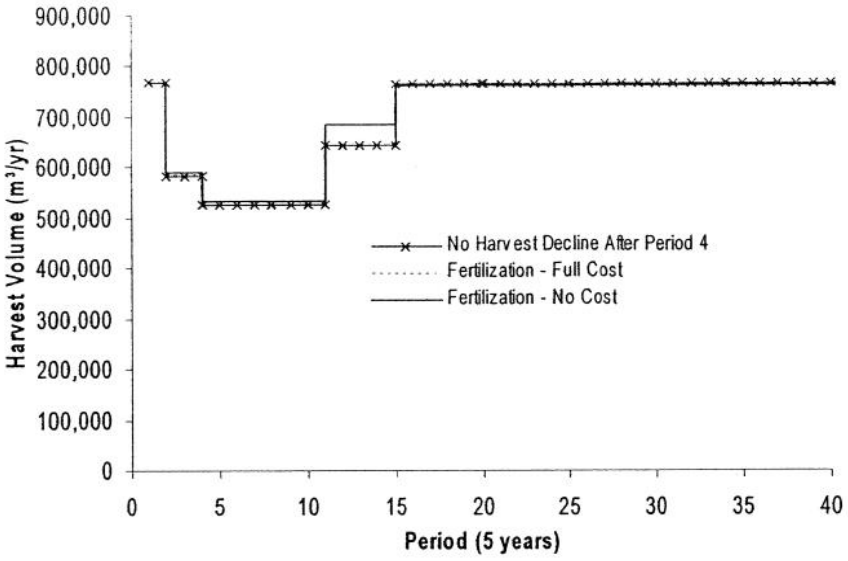

Figure 2: Harvest Forecast – Fertilization Scenarios

Table 3: Harvest Forecast – Fertilization Scenarios

Period (5-year)	Base - No Harvest Decline After Period 4 (m³/yr)	Fertilization - Full Cost (m³/yr)	% Difference	Fertilization - No Cost (m³/yr)	% Difference
1	767,989	767,991	0.0%	767,990	0.0%
2	584,190	585,998	0.3%	591,726	1.3%
3	584,165	585,972	0.3%	591,703	1.3%
4	525,764	527,394	0.3%	532,546	1.3%
5	525,747	527,374	0.3%	532,529	1.3%
6	525,753	527,381	0.3%	532,533	1.3%
7	525,762	527,390	0.3%	532,547	1.3%
8	525,761	527,389	0.3%	532,546	1.3%
9	525,764	527,393	0.3%	532,549	1.3%
10	525,761	527,390	0.3%	532,545	1.3%
11	642,248	643,834	0.2%	684,704	6.6%
12	642,244	643,828	0.2%	684,700	6.6%
13	642,242	643,826	0.2%	684,693	6.6%
14	642,240	643,824	0.2%	684,691	6.6%
15	762,552	762,883	0.0%	760,636	-0.3%
16	762,553	762,884	0.0%	760,621	-0.3%
17	762,555	762,887	0.0%	760,632	-0.3%
18	762,564	762,895	0.0%	760,641	-0.3%
19	762,560	762,889	0.0%	760,636	-0.3%
20	762,564	762,892	0.0%	760,633	-0.3%
21	762,573	762,905	0.0%	760,650	-0.3%
22	762,568	762,898	0.0%	760,643	-0.3%
23	762,566	762,895	0.0%	760,645	-0.3%
24	762,563	762,893	0.0%	760,640	-0.3%
25+	762,559	762,891	0.0%	760,632	-0.3%
TOTAL	**155,312,145**	**155,468,590**	**0.1%**	**156,185,145**	**0.6%**

Table 4 shows a summary of key factors for each of the fertilization scenarios relative to the base case scenario. When the full cost of fertilization is included, 4,651 ha of area is scheduled for fertilization, resulting in slight increases in total harvest volume, total net revenue, and total NPV net revenue. It should be noted that the increases are quite small when averaged over the entire 200-year planning horizon but these increases will generally occur in the mid-term, when timber supply is most limited. It is not unreasonable to expect that lumber prices might increase as the provincial timber supply becomes limited, thereby increasing the potential return from fertilization.

Approximately the same amount of area is left unsalvaged in each scenario. For the *Fertilization – Full Cost* scenario 18,475 ha is in natural stands and 697 ha is in managed stands. Of the natural stands left unsalvaged, 7,323 ha are from pure pine stands while 11,152 ha are from pine-leading mixed stands.

Table 4: Planning Horizon Totals – Base Case

200 Year Totals	Base - No Harvest Decline After Period 4	Fertilization – Full Cost	% Difference	Fertilization – No Cost	% Difference
Total MPB Sawlog Volume Harvested (m^3)	2,989,951	2,989,954	0.0%	2,989,951	-
Total MPB Pulp Volume Harvested (m^3)	322,119	327,079	1.5%	335,229	4.1%
MPB Area Unsalvaged (ha)	19,208	19,173	-0.2%	19,124	-0.4%
Total Net Revenue ($)	7,078,935,600	7,084,691,552	0.1%	7,108,951,760	0.4%
Total NPV Net Revenue ($)	986,525,240	986,800,144	0.0%	996,739,277	1.0%

Table 5 and Table 6 show the timing of fertilization treatments for each of the fertilization scenarios. These tables show both the area scheduled for fertilization (aspatially) as well as the area actually fertilized once the minimum 20 ha treatment unit requirement is applied.

Table 5: Fertilized Area (ha) – Full Cost Scenario

Period (5-year)	Total Area Scheduled for Fertilization in Woodstock (ha)	Area Fertilized With 20 ha Minimum Treatment Unit in Stanley (ha)		
		Early Fertilization of Managed Stands	Late Fertilization of Natural Stands	Late Fertilization of Natural Stands less than 60 years of age
1	0	0	0	0
2	76	61	0	0
3	2,169	1,265	131	0
4	616	0	614	0
5	70	0	0	0
6	1,216	0	433	0
7	504	0	0	0
TOTAL	**4,651**	**1,326**	**1,178**	**0**

Table 6: Fertilized Area (ha) – No Cost Scenario

Period (5-year)	Total Area Scheduled for Fertilization in Woodstock (ha)	Area Fertilized With 20 ha Minimum Treatment Unit in Stanley (ha)		
		Early Fertilization of Managed Stands	Late Fertilization of Natural Stands	Late Fertilization of Natural Stands less than 60 years of age
1	16,636	8,648	6,067	1,919
2	20,598	11,855	4,000	487
3	14,540	10,949	1,915	51
4	9,118	3,394	2,662	51
5	4,909	1,337	562	0
6	2,759	1,213	265	0
7	658	99	149	0
TOTAL	**69,218**	**37,493**	**15,620**	**2,508**

3.0 Discussion

The results of this preliminary analysis suggest that there are potential gains to mid-term timber supply from fertilization but these gains are sensitive to the cost of the fertilization treatment (i.e short discount period -fertilization of stands late in the rotation.) The no cost fertilization treatment shows considerable gains to both harvest volume and revenue. Fertilization without an associated cost is not an operational reality however; this scenario does help to address some of the uncertainty in the model namely:

- As provincial timber supply is reduced in the next 10-15 years, the price of pulp and lumber will likely increase, which will increase the return on fertilization investment.

- Reduced per hectare fertilization costs may be realized through economies of scale associated with a larger fertilization program.

- Severe timber supply reductions in the mid-term could result in mill closures with a widespread economic impact throughout the region. Preventing such a situation would have considerable value beyond what could be captured in a forest estate model.

The following are factors that should be considered as part of a more detailed analysis of incremental silviculture investment:

- Incorporate an updated inventory of managed stands with specific attention to potential fertilization candidates.

- Re-design analysis units to address potential silviculture investment; specifically availability and response to fertilization

- Develop more detailed growth and yield assumptions into the model with specific focus on fertilization response and expected volumes in unsalvaged stands.

- Consider the incorporation of merchandized (product) volumes directly into the model.

- Evaluation of additional types of incremental silviculture investment. With the projected impacts on mid-term timber supply, treatments that were of marginal benefit in the original Type II Silviculture Strategy may now provide a greater return (i.e. rehabilitation of balsam Intermediate Utilization (IU) and backlog Not Satisfactorily Restocked (NSR)).

- Incorporate lumber price projections into the model.

- Revisit and revise shelf-life and regeneration delay for mountain pine beetle - killed stands.

- Examine various combinations of treatments (fertilization and other) and allow the model to select treatments based on maximizing financial return.