

SOO TSA STRATEGIC SILVICULTURE ANALYSIS



ANALYSIS INFORMATION PACKAGE -SOO TSA -

**Submitted to the Vancouver Forest Region,
B.C. Ministry of Forests**

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TABLE OF CONTENTS

<u>1.0 INTRODUCTION</u>	5
<u>2.0 PROCESS</u>	6
<u>2.1 GROWTH AND YIELD</u>	6
<u>2.2 DATA PREPARATION AND MISSING DATA</u>	6
<u>3.0 ANALYSIS OPTIONS AND SENSITIVITY ANALYSIS</u>	7
<u>3.1 ANALYSIS METHODS</u>	7
<u>3.2 SCENARIOS</u>	7
<u>3.2.1 Base Case (Scenario 1)</u>	8
<u>3.2.2 Revised Base Case (Scenario 3)</u>	8
<u>3.2.3 Genetic Improvement (Scenario 3)</u>	8
<u>3.2.4 Silviculture Strategy Base Case (Scenario 4)</u>	9
<u>3.2.5 Optimized Base Case (Scenario 5)</u>	9
<u>3.2.6 Timber Volume Scenarios (Scenario 6)</u>	9
<u>3.2.7 Preferred Scenario (Scenario 9)</u>	9
<u>3.3 ASSUMPTIONS</u>	9
<u>3.3.1 Data Preparation Assumptions</u>	10
<u>3.3.2 Analysis Assumptions</u>	10
<u>4.0 MODELS</u>	11
<u>4.1 LANDSCAPE DESIGN MODEL - FSOS</u>	11
<u>5.0 FOREST INVENTORY</u>	14
<u>6.0 DESCRIPTION OF LANDBASE</u>	15
<u>6.1 TIMBER HARVESTING LAND BASE</u>	15
<u>6.2 TOTAL AREA</u>	16
<u>6.3 NON-FOREST</u>	16
<u>6.4 NON-OWNERSHIP</u>	16
<u>6.5 NON-COMMERCIAL COVER</u>	16
<u>6.6 ROADS, TRAILS AND LANDING</u>	16
<u>6.7 FUTURE ROADS</u>	16
<u>6.8 NEWLY CREATED PARKS</u>	16
<u>6.9 OPERABILITY</u>	17
<u>6.10 ENVIRONMENTALLY SENSITIVE AREAS</u>	17
<u>6.11 RETENTION DEER MANAGEMENT ZONE</u>	17
<u>6.12 LOW SITE</u>	17
<u>6.13 PROBLEM FOREST TYPES</u>	18
<u>6.14 EXCLUSION OF GEOGRAPHICALLY DEFINED AREAS</u>	18
<u>6.15 RIPARIAN MANAGEMENT AREAS</u>	19
<u>6.16 WILDLIFE TREE PATCHES</u>	19
<u>6.17 TIMBER LICENCE REVERSIONS</u>	19
<u>7.0 INVENTORY AGGREGATION</u>	20
<u>7.1 MANAGEMENT ZONES</u>	20
<u>7.2 ANALYSIS UNITS</u>	21
<u>8.0 REGENERATION ASSUMPTIONS</u>	22
<u>8.1 YIELDS FOR BASE CASE MANAGED STANDS</u>	22

<u>8.1.1 Species Conversion</u>	22
<u>8.1.2 Genetic Gain Allowances</u>	23
<u>8.1.3 Existing Managed Immature</u>	23
<u>8.2 NOT SATISFACTORILY RESTOCKED</u>	24
<u>8.3 TASS CURVES</u>	24
<u>8.3.1 Minimum Harvest Age Criteria</u>	28
<u>8.3.2 Site Index Adjustments</u>	29
<u>8.3.3 ISS Integration</u>	29
<u>8.3.4 Regeneration Delay</u>	29
<u>8.3.5 TASS Modeling of Balsam</u>	29
<u>9.0 PROTECTION</u>	30
<u>9.1 UNSALVAGED LOSSES</u>	30
<u>10.0 INTEGRATED RESOURCE MANAGEMENT</u>	31
<u>10.1 FOREST COVER REQUIREMENTS</u>	31
<u>10.2 SPOTTED OWL SPECIAL RESOURCE MANAGEMENT ZONES (SRMZ)</u>	32
<u>10.2.1 Treatment Regime</u>	33
<u>10.3 DEER HABITAT</u>	33
<u>11.0 TIMBER OBJECTIVES</u>	34
<u>11.1 TIMBER VALUES</u>	34
<u>11.2 HARVESTING COSTS</u>	36
<u>11.2.1 Tree to Truck</u>	36
<u>11.2.2 Hauling</u>	38
<u>11.2.3 Towing</u>	38
<u>11.2.4 Dump, Boom, Sort and Scale</u>	38
<u>11.2.5 Road Construction</u>	39
<u>11.2.6 Administration</u>	39
<u>11.2.7 Basic Silviculture</u>	39
<u>11.3 TREATMENT COSTS</u>	41
<u>11.4 COMMERCIAL THINNING</u>	41
<u>11.5 FERTILIZATION</u>	41
<u>11.6 STAND DENSITY DETERMINATION</u>	41
<u>11.7 VALUE ANALYSIS</u>	41

LIST OF APPENDICES

APPENDIX I – VDYP Yield Tables

APPENDIX II – TIPSYP Yield Tables - Current Managed

APPENDIX III – TIPSYP Yield Tables - Future Managed

LIST OF TABLES

Table 3.1:	Summary of Scenarios
Table 6.1:	Timber Harvesting Land Base – Base Case
Table 6.2:	Area Reductions for Environmentally Sensitive Areas
Table 6.3:	Reductions for Stands with Low Productivity
Table 7.1:	Management Zones
Table 7.2:	Analysis Units
Table 8.1:	Existing and Future Managed TIPSYS Curves – Planted and Spaced
Table 8.2:	Regeneration Assumptions
Table 8.3:	Existing Managed Immature by Age Class
Table 8.4:	Summary of NSR Restocking Strategy
Table 8.5:	TASS Regeneration Curves
Table 8.6:	Site Index Adjustments
Table 8.7	Comparisons of TIPSYS Yields for 2 Initial Densities
Table 8.8	Initial Densities for H, C and S Analysis Units
Table 10.1:	Management Zones and Forest Cover Objectives – Base Case Scenario
Table 10.2:	Cut block Size Requirements in Management Zones
Table 10.3:	Stand Structure Objectives for Spotted Owl Habitat
Table 11.1	Summary of Second Growth Selling Prices by Diameter Class
Table 11.2	Soo TSA – Landscape Unit Attributable Harvest Costs per m ³
Table 11.3	Treatment Costs

LIST OF FIGURES

Figure 11.1	Second Growth Timber Value by Species Grade; Sort at Howe Sound
Figure 11.2	Net Present Value at Different Interest Rates

1.0 INTRODUCTION

The Ministry of Forests (Squamish Forest District and Vancouver Forest Region) has initiated the development of a Type 2 Forest Level Silviculture Strategy for the Soo TSA. This information package documents the procedures, assumptions, data and model used in the analysis. Hugh Hamilton Limited (HHL) has been engaged to prepare the information package and conduct the Type 2 analysis on behalf of the MoF. While not as detailed as an information package for a timber supply analysis, this package will utilize where appropriate format and requirements within the *Provincial Guide for the Submission of Timber Supply Information Packages for Tree Farm Licences, Version 3*.

The purpose of this information package is to:

- Provide a mechanism for communication of technical analysis issues (land base net down, analysis assumptions and analysis scenarios) between the participants (HHL, MoF, licencees) prior to undertaking the Type 2 analysis;
- Provide an opportunity for the MoF and participants to review those technical issues and assumptions that will be used in the preparation of the Type 2 analysis;
- Create a dynamic document which, over time, will ensure that all relevant information is accounted for appropriately in the Type 2 analysis; and
- Increase the efficiency of the Type 2 analysis process by reducing the risk of having analyses discarded due to inappropriate content.

Base data for the Type 2 analysis will come from the TSR II resultant dataset. This dataset includes the 1992 re-inventory (FC1 and FIP) and other resource data layers that were utilized in TSR II completed in August 1999.

Appropriate treatment regime curves will be generated with TASS and existing yield tables from TSR II will be used for natural growth stands and managed stands. The Soo TSA was updated for depletions to January 1, 1998 and has been projected for growth to January 1, 2000.

All data summarized in this package used spatial GIS data and forest inventory polygon (FIP) labels, allowing all **FSOS** (Forest Simulation Optimization System) analyses to be spatially and temporally referenced. **FSOS** will be used to assess silviculture strategies for the Soo TSA over a 250 year planning horizon.

2.0 PROCESS

The Type 2 analysis for the Soo TSA is directed through the project contract and the original proposal, which was initially submitted to the Ministry on August 24, 1999.

This information package will be included as an Appendix in the Type 2 analysis report.

The background information that guided the assumptions and processes employed in this information package includes, but is not limited to, the following reports:

- *Soo Timber Supply Area Analysis Report, August 1999*
- *Incorporating Biodiversity and Landscape Units in the Timber Supply Review*
- *Site Index Adjustments for Old-Growth Stands Based on Veteran Trees (Working Paper 36, 1998)*
- *Site Index Conversion Equations for Mixed Species Stands - MoF Research Branch, 1998*
- *Timber Supply Review Base Case Modeling Assumptions for Biodiversity and Landscape Units*
- *Tree Farm Licence Information Package Guidelines*
- *Request for Proposals – Development of Type 2 Forest Level Silviculture Strategies – Soo TSA (July 27, 1999)*

2.1 Growth and Yield

Base case growth and yield data will utilize those curves that were generated for TSR II and were generated using the following models:

- VDYP, Version 6.4, for unmanaged stands; and
- TIPSYS, Version 2.1e, for existing and future managed stands.

Research Branch, using TASS Version 2.07.12, will develop growth and yield information for the intensive silviculture regimes.

2.2 Data Preparation and Missing Data

A large resultant spatial database (the result of overlaying spatial resource coverages) was delivered to Hugh Hamilton Limited and used in the general condition it was received, with some exceptions noted in Section 3. This master database is a complete resultant polygon list, each with unique identification numbers.

Though accurate net down procedures were applied, HHL reserved the right to modify any data, if it is deemed to enhance the accuracy of the analysis. Any modifications to the dataset will be documented.

3.0 ANALYSIS AND SCENARIO PLANNING

3.1 Analysis Methods

The objective of the Type 2 analysis is to meet forest-level objectives using incremental silviculture activities.

Through forest level modeling using FSOS, the variety of treatments can be considered in light of their ability to satisfy forest-level objectives. A single treatment at the stand level may result in a yield improvement. However, at the forest level, this treatment may be a poor investment when considered together with all other investments, budgets and objectives. Conversely, a treatment at the stand-level that does not represent a significant benefit may in fact be an important action and satisfy an objective at the forest-level.

Stand management options or treatment regimes describe a series of silviculture actions that are possible for a given stand type. Each treatment within the regime occurs in sequential order and has an associated set of costs, values, employment levels, and timber quality and quantity effects at a given point in time.

FSOS will determine the appropriate treatment regime for each stand following harvest, or for those stands that were previously harvested and are still treatable. Each regime provides a timeframe of treatments, including harvesting, and stand development. Following harvest, the stand may follow the same treatment regime or transform to another regime or receive no treatment at all, based on decisions of costs, values and overall satisfaction of objectives.

A number of forest-level scenarios will be developed and analyzed. These scenarios will eventually lead to the preferred option. This approach presents a sequential and iterative process of analysis - each step providing insight, understanding and direction for the next.

3.2 Scenarios

The development of a strategic silviculture plan is not an easy process. A variety of stand- and forest-level objectives or desired future outcomes, elaborate stand treatment regimes and long time horizons create complexity in forest dynamics, making understanding difficult and complicating the development of an incremental silviculture plan.

Scenario planning helps to understand those significant issues that control future outcomes related to the stated objectives by simplifying the complex interactions. Scenarios are developed to test options through either sensitivity analysis, or they can be based on individual management interests and questions. Understanding of these issues and outcomes allow the forest managers to develop management decisions based on improved information and understanding of the consequences and interactions.

Each scenario plan or result describes the silvicultural and forest-level outcome given the management approach defined in that scenario. The scenarios are assessed individually for the development of the preferred option. The actual final silvicultural strategy may be composed of constituents of some or all of the other scenarios. The scenarios provide an incremental process of understanding of the minimum and maximum values of future forest conditions and possibilities.

Key items that are assessed within each scenario are the response of important indicators (i.e. timber supply), similar trends across scenarios, and tradeoffs between scenarios, near and long-term variations.

Both simulation and heuristic analysis techniques will be used in the Soo TSA analysis. Table 3.1 provides a summary of different analysis scenarios.

Table 3.1: Summary of Scenarios

Scenario	Title	Scenario Description
1	HHL Base Case	Re-creation of the TSR II Base Case to calibrate model and to test model reliability.
2	Revised Base Case	Base Case with new yield curves for OGSi and SIBEC adjustments. Owl habitat on 2 CT regime.
3	Genetic Improvement	Scenario 2 with genetic improvement.
4	Silviculture Strategy Base Case	Deciduous conversion after initial future harvest. Existing 0-40 year-old stands on TASS curves. No treatments beyond past treatments incorporated.
5	Optimized Silviculture Strategy Base Case	Same as scenario 4 except the optimization algorithms are applied instead of simulation.
6	Timber Volume Scenarios	A set of scenarios varying annual investment budgets. Intent is to determine impact on volume.
7	Preferred Scenario	Preferred management options combined.

3.2.1 HHL Base Case (Scenario 1)

Re-creating the TSRII base case will allow us to evaluate the model's performance as well as monitor differences between our analysis and TSRII. Any differences between the base cases will be useful in understanding volume differences in the simulations. The base case assumed some incremental silviculture: spacing of all good, medium, and some poor sites. Also, fertilization on 17% of the THLB was assumed at ages of 20, 30 and 40 years.

3.2.2 Revised Base Case (Scenario 2)

- HHL Base Case revised to incorporate TASS curves with SIBEC and OGSi adjustments. Site index adjustments are listed in Table 8.6
- Spacing treatments were as in the base case.
- The management of existing managed stands as in the base case.
- Pine conversion to fir was assumed after the first rotation.
- Elimination of backlog NSR at the same schedule as the TSRII base case (8 years).
- Partial cutting (2 CT) strategies were fixed in fir stands in the owl habitat zones.

3.2.3 Genetic Improvement (Scenario 3)

Identical to scenario 2, with the exception of a 4% increase in Douglas-fir leading stands and a 2% increase in other softwood yield volumes to account for potential future yield gains

associated with planting of genetically improved stock. This was applied to 75% of the area with the lower site balsam and hemlock units (25% of the THLB) excluded.

3.2.4 Silviculture Strategy Base Case (Scenario 4)

This scenario introduces all management assumptions to be used in the silviculture strategies analyses:

- All past treatments indicated in both ISS and FIP files were placed on appropriate curves.
- The productive land base was increased through deciduous (except cottonwood) conversion (1,216 ha net area) and converted to low site fir (to err on the conservative side) after the first rotation. Stands less than 10 years old (additional 313 ha, 133 ha of which is NSR) were converted immediately.
- Deciduous polygons (except cottonwood) were considered only 50% productive due to proximity to riparian areas.
- Genetic improvements are incorporated as per scenario 3.
- Managed stands defined as 40 years or less
- Stands between 40 and 100 years have value and product information added to their curves.
- No incremental silviculture treatments are incorporated aside from continuing fertilization of previously fertilized stands and some commercial thinning in spotted owl areas.

3.2.5 Optimized Base Case (Scenario 5)

Same as scenario 4, except the optimization algorithms are applied instead of simulation. A tolerance of 5% around some targets was set to allow flexibility for transition strategies and natural fluctuation within the land base. Owl habitat had a lower tolerance, so it effectively remained a constraint.

3.2.6 Timber Volume Scenarios (Scenario 6)

This is a set of scenarios, which vary the annual investment budget and incorporate multiple transition options, including commercial thinning. The intent is to determine the increases in timber quantity.

- No timber value or harvest costs yet incorporated.
- Investment levels are 0% (Scenario 5), 50% (\$870,000/year), 100% (1,750,000/year), 150% (2,600,000/year) and a maximum limit (\$5,000,000/year). The higher investment levels may not be tested if it is apparent that after a certain level of funding there is no improvement in harvest levels.
- Helicopter logging treatments were fixed on the do-nothing option.

3.2.7 Preferred Scenario (Scenario 7)

Based on the results of all previous scenarios, scenario 7 is the ‘best’ option that includes all preferred management. Map output will be limited to the presentation of a 20-year ‘optimized’ silviculture treatment schedule.

3.3 Assumptions

To ensure understanding of the strategic silviculture analysis, the readers and reviewers must have a thorough comprehension of the assumptions that were used to prepare the data and represent analysis parameters.

3.3.1 Data Preparation Assumptions

Upon receiving and reviewing the resultant data set, several omissions were noted and corrected and updates were made. The following documents show the procedures for ensuring the data set was accurate:

- Forest cover was replaced with a more ‘up-to-date’ data set.
- VQO information was built from line work and then rated to the resultant database. Rating involves finding a “best fit” based on the existing polygon configuration.
- The Old Whistler LRUP boundary was digitized from existing B.C. topographic maps (1981) and rated to the master database. This rating closely approximated the boundary as another resource boundary had utilized the LRUP boundary.
- Botanical forest products coverage was obtained and included in the overlay process.
- Two parks were missing from the original database. New, complete parks coverage was obtained and included in the overlay process.

3.3.2 Analysis Assumptions

1. “Normal” market conditions will prevail for demand and prices for timber and fiber.
2. A status quo THLB will be used in the TSR II base case and any modifications will be utilized in the “Silviculture Strategies Base Case”.
3. All current FPC requirements will be utilized and maintained in the analysis.
4. MoF timber supply concepts and harvest flow rules will be followed (maintain current harvest as long as possible with reasonable declines in the future - 10%/decade). No patch *objectives* will be applied to this analysis on seral requirements.
5. Specific levels of precision to be used in the optimization analysis are as follows:
 - +/- 10% change in timber flow between decades.
 - Silviculture investment not to exceed maximum budget level by more than 10%.
 - Maximum 5% tolerance around age-class targets specified in TSRII for optimization to allow for smooth transition strategies to be achieved without impacting timber flows.

4.0 MODELS

The following software will be used in the preparation of the strategic silviculture analysis and data package for the Soo TSA:

- *FSOS* time-step simulation model and *FSOS* forest estate optimization model in conjunction with the *FORUM* analysis approach;
- MoF Variable Density Yield Program (VDYP);
- MoF Table Interpolation Program for Stand Yields for Microsoft Windows (WinTIPSY).
- MoF Tree and Stand Simulator (TASS)

4.1 Landscape Design Model - *FSOS*

Model Name:	<i>FSOS</i>
Model Developer:	Guoliang Liu
Model Development:	HHL and UBC
Model Type:	Landscape Design Model

Description:

FORUM (Forest Optimization and Resource Utilization Management) planning approach was developed by HHL to conduct resource analysis. *FORUM* combines the power of advanced computer modeling techniques and GIS tools with expert professional experience. At the center of *FORUM* is a landscape optimization model called *FSOS* (Forest Simulation Optimization System). The model uses C++ programming language and can be run with both Windows '98 and Windows NT operating systems. The model interfaces directly with Microsoft Access for data management. The Timber Supply Branch of the MoF accepted the use of *FSOS* for timber supply analysis in August 1998. *FSOS* uses dynamic heuristic and simulation techniques to schedule harvest units based on 1) patch and seral objectives defined by non-timber (e.g. old-growth, biodiversity, visuals, habitat, watershed, etc.) resource values and 2) timber management objectives (e.g. even flow, volume levels, opening size distribution, species quotas). Harvest and approximate cut block shape and size over the planning horizon are an output of the model. Modeling of strict adjacency and seral constraints is accomplished using simulation modeling. The data structure is identical for both heuristic and simulation models, which prevents extensive data loading procedures when switching between techniques.

FSOS uses the multiple resultant polygons created by GIS overlay as the basic model unit, allowing great flexibility in creating a variety of potential harvest unit configurations by amalgamating these resultant polygons. Amalgamations of the harvest units through time create early seral openings and mature and old growth patches consistent with planned patch management strategies defined by higher level plans. Managing for specific patch size distributions within each seral class is also inherent within the model framework and is an extremely effective way to meet long-term biodiversity objectives. High weightings can be applied to relatively important resource objectives or objectives which are difficult to achieve. The objective function (evaluation equation) provides the means to evaluate the relative "success" between differing solutions. For each iteration, the model calculates a "penalty" based on the deviation of a given solution from the target values. Optimal solutions achieve targets quickly for highly weighted parameters in order to minimize the total "penalty" over the planning

horizon. With optimization, “constraints” can be violated. As all resource values are tracked throughout the planning horizon, where and when this occurs is part of the model output.

The initial inventory data represents the gross land base, which includes both operable and inoperable areas and the contributing and non-contributing timber harvesting land base. This is required, as inoperable and other reserve areas contribute to the achievement of non-timber objectives. From GIS overlay, the land base is divided into resultant polygons, each with a unique set of attributes. Treatments are applied to each polygon based on these attributes. Analysis unit, forest type, forest age, silvicultural treatment, user allocation, site index, non-timber resource objectives or any other parameter can define treatment type and regime.

FSOS uses individual stand ages to project the current age structure of stands in the analysis area. As stands age, they move into and out of age classes established as a basis for meeting target objectives. For example, age classes may be established as ≤ 40 yrs, 41-120 yrs, 121-250 yrs, and >250 yrs.

The planning horizon length can vary as required. **FSOS** can produce spatially and temporally explicit plans over 20 years or for multiple rotations. A unique feature of **FSOS** is its ability to integrate strategic, tactical and operational planning phases into one process. Analysis runs include harvest timing and location for each period, as well as long-term, sustainable harvest levels.

Harvest rules that are used in **FSOS** are:

- Minimum stand age before a stand can be harvested;
- Maximum stand age, at which the stand is scheduled for cutting within a certain number of years (i.e. 10);
- Green-up period required before adjacent patches can be harvested (this is not between openings but between patches. Patch size in early seral can reflect desired cut block size distributions).

A range of priorities can also be applied to include the following:

- Stands at risk from fire, disease or insects;
- Species preferences to meet mill requirements;
- Opening size distribution;
- Piece size requirements;
- Silviculture investment;
- Even volume flow; and
- Minimize transportation costs.

All possible regeneration alternatives and treatment regimes can be incorporated into the model. Adjusting growth curves or harvesting percentages of the block at specified intervals incorporates complex harvest systems (i.e. partial cutting) and silvicultural treatments. **FSOS** can also account for re-entry delays. **FSOS** can apply multiple regeneration assumptions.

The reporting functions of *FSOS* are extensive. The data for each period is easily accessible for any analysis unit, zone, polygon, landscape unit, etc. and gives an overview of the forest state at any point in time. Species compositions, age structure, patch distribution, harvest scheduling, treatment cost, product values and many other variables are tracked and reported by period. Reporting functions are highly effective for the direct comparison of sensitivity analysis and scenario options. *FSOS* is linked directly to the powerful ArcView environment for the easy production of high-quality map production.

Updates to the land base can be applied by two methods. Changes to applied net downs occur in the database framework by reapplying net down percentages. Changes to layer boundaries or additions or subtractions from the land base require the data be altered in the G.I.S. environment.

Cover targets are usually applied by age as a surrogate for height. Using patch and age class distribution indicators can achieve all cover targets. Age class distribution targets can be set as minimums, maximums, or desired levels. For example, wildlife habitat cover requirements may be achieved by having 70% of the management zone greater than 100 years of age.

Some other capabilities of *FSOS* include:

- Negative ages;
- Multiple constraints (guidelines) by unit, zone or group;
- Yearly age distribution;
- Volume Operational Adjustment Factors (OAFs) and land OAFs;
- Spatial and temporal referencing of neighbouring polygons;
- Multi-species stands;
- No maximum planning horizon;
- Opening size distribution;
- Timber flow management;
- Landscape metrics options; and
- Economic indicators.

5.0 FOREST INVENTORY

All spatial information was received in ARC/INFO format. All data is controlled to the North American Datum (NAD) 83 base. The previous re-inventory for the Soo TSA updated forest cover spatial and non-spatial attributes to 1992. The forest cover inventory has been updated since the re-inventory for depletions to January 1, 1998 and for growth to January 1, 2000. Annual projections are completed using VDYP. The spatial and attribute data are stored in both the FC1 and FIP file formats, as per the provincial inventory standard database. The spatial inventory data is currently managed through ARC/INFO, which maintains the spatial relationships within the forest inventory as well as the other resource inventory information.

The adjacency file was set for a tolerance of 15 m. This means that the maximum distance between two polygons must be 15 m or less if the two polygons are to be considered adjacent. This distance affects polygon aggregation into harvest units and patches. Generating polygon adjacency at 15 m will prevent small sliver polygons, which may be present in the database, from being a barrier for adjacency.

6.0 DESCRIPTION OF LANDBASE

Determination of the timber harvesting land base (THLB) results from a sequential procedure where stands ineligible for harvest due to poor stand quality, non-merchantable species, specific geographical or management reductions or site sensitivity are systematically removed from the land base. This section describes the procedures used in determining the THLB. Although portions of the land base are reserved from harvesting, their attributes within forested crown land still contribute to forest cover objectives.

6.1 Timber Harvesting Land Base

The net down procedure is an exclusionary process. Once an area has been removed, it cannot be deducted further along in the process. For this reason, the gross area removed is often greater than the net area removed, a result of overlapping resource issues.

Table 6.1: Timber Harvesting Land Base – Base Case

	HHL Base Case	TSR II
Classification	Area Reductions (ha)	Area Reductions (ha)
Total Land base:	721,230	826,160
Non-forest	396,995	483,392
Not directly managed by B.C. Forest Service	24,396	43,856
Total Productive Forest	299,838	298,912
Reductions to Total Productive Forest:		
Non-commercial	384	685
Roads, trails, landings	7,195	7,200
Newly created parks	12,256	11,221
Inoperable	99,634	99,075
Environmentally sensitive areas	15,389	17,117
Retention deer management	4,504	4,071
Low productivity	18,056	22,530
Problem forest types	3,119	3,166
Geographically designated areas	3,244	2,057
Riparian areas	6,531	6,326
Wildlife Tree Patches	1,770	2,072
Total Reductions to Land base	172,082	175,520
Current THLB	127,756	123,392
Includes 4,068 ha of net NSR area and 2290 net ha of Timber Licences		
Future Reductions:		
Future Roads	3,444	2,827
Long-Term THLB	124,312	120,565

6.2 Total Area

The total TSA area varies between this and the TSR II analysis. It is believed that this difference originates as a result of elimination of some large parks (i.e. Garibaldi) and non-forest or non-ownership along the outer boundaries of the TSA, which was not compiled in the generation of this database. The difference is approximately 105,000 ha; however, this has no impact on the analysis, as the area of Crown forest is almost identical in both analyses.

The productive Crown forest area, as reported between the two databases, varies less than 0.5%. Reductions to Crown forest are similar in most circumstances. Potential reasons for differing reductions are described in the relevant sections.

Only productive Crown forest contributes to seral objectives, with the exception of productive forest in provincial parks, ecological reserves, recreation areas and timber reversions in ownership codes 60 to 70.

6.3 Non-Forest

All areas classed as non-forest are removed from the Productive Forest Area. These include all areas with a Projected Type ID of 6 or 8.

6.4 Non-Ownership

These land base reductions include areas of non-crown ownership as well as ownership areas, which are not part of the contributing land base such as parks, reserves etc. but still contribute to biodiversity objectives.

6.5 Non-commercial Cover

Non-commercial cover is removed from the Productive Forest Area and is identified in the forest inventory database information as Projected Type ID 5.

6.6 Roads, Trails and Landing

The estimates of loss of productive forests due to existing roads were completed using geographic information system. The length of the existing roads (~4,800 km) was measured and a 15-meter width assumed which also accounts for landing areas. The total net area removed at this stage of the net down is 7,195 ha. This reduction is applied evenly across stands with a projected age class less than 5.

6.7 Future Roads

Based on a survey of integrated silviculture information system (ISIS) and major licence silviculture information system (MLSIS) reports for areas logged since 1987, losses for future roads, trails and landings reductions were estimated at 5.4% of the available THLB. Therefore, all existing stands with a current projected age class ≥ 5 were subject to a 5.4% land base reduction after the first harvest.

6.8 Newly Created Parks

Several newly created parks are protected from harvest activities and have been 100% excluded from the THLB. The area of parks differs slightly as only 5 of the 7 parks were accounted for in

the TSRII report. The additional area added in this analysis for Brackendale and Indian Arm (1073 ha) is essentially the difference between this analysis and the TSRII.

6.9 Operability

Three operability codes are used in the TSA, I (inoperable), A (conventional), and H (helicopter). Helicopter logging areas were updated in the fall of 1997 by the Squamish Forest District staff based on the criteria defined in the TSR II Data Package. These criteria were duplicated in this analysis to determine stands eligible for heli-logging. Inoperable stands were removed from the THLB, while helicopter logging stands, though outside the original operability line, were considered part of the THLB.

6.10 Environmentally Sensitive Areas

ESA information was derived from forest cover polygon labels. A portion of the area within these polygons is excluded from harvesting based on the percentages in Table 6.1. W1d and W2d are mapped and are on the FIP file; however, deer ESAs were not used in this analysis in favour of draft deer management plan requirements.

Though the net area is slightly lower in this analysis than TSRII, the productive area is very similar. Shifts may have resulted from adding in the parks or differences in FIP files between the two analyses. Also, the updated FIP file may have had additional harvesting in the ESAs, which receive 0% reduction if a harvesting history is present.

Table 6.2: Area Reductions for Environmentally Sensitive Areas

ESA Type	ESA Description	Productive Area (ha)	% Reduction	Net Area Reduction (ha)
S1	Soils - high	16,355	90 ^a	4,023
S2	Soils - moderate	11,830	60 ^a	3,990
R1 ^b	Recreation - high	3,988	90	2,050
W1g, W1m, W1o	Wildlife (goat, moose, birds) - high	2,508	90	1,360
P1	Regeneration - high	49,156	90 ^a	3,807
A1	Avalanche - high	731	60	90
W2g	Wildlife (goat) - moderate	775	90	90
Total		85,700		15,389

^a No reduction if the area has a harvesting history

^b Includes ESA and recreation from Recreation Features Inventory. Stands from the Recreation Features Inventory were those labeled as Feature significance A, B, and C with management class 0.

6.11 Retention Deer Management Zone

A draft deer management plan provides the direction for forest management in the Soo TSA. One of the five resource management zones, the retention classification, excludes all timber harvesting activities.

6.12 Low Site

Some sites do not have sufficient timber volumes to make them viable harvest opportunities or are not likely to generate feasible volumes in the future. These stands are defined using a minimum site criteria for each leading species. Stands less than the minimum site index are

removed from the land base. All stands with a harvesting history were included in consideration of the THLB.

Net low site areas were approximately 20% less than in the TSR analysis. Differences may arise out of different forest cover information between the data sets or shifts in net downs prior to the low site net down.

Table 6.3: Reductions for Stands with Low Productivity

Species	Characteristics	SI Limit	Percent (%) excluded	Productive Area (ha)	Net Area (ha)
Fir	Existing stands with volumes less than 350 m3/ha and sites projected not capable of producing 350m3/ha by age 140	16	100	7,336	2,521
Cedar	Existing stands with volumes less than 350 m3/ha and sites projected not capable of producing 350m3/ha by age 140	13	100	144	30
Hemlock/ Balsam	Existing stands with volumes less than 350 m3/ha and sites projected not capable of producing 350m3/ha by age 140	13 conventional 15 helicopter	100	75,786	13,661
Spruce	Existing stands with volumes less than 350 m3/ha and sites projected not capable of producing 350m3/ha by age 140	13	100	124	74
Pine	Existing stands with volumes less than 350 m3/ha and sites projected not capable of producing 350m3/ha by age 140	20	100	8,306	1,581
Cottonwood	Existing volume less than 150 m3/ha	20	100	329	158
Total				92,312	18,056

6.13 Problem Forest Types

Problem forests types are stands, which are physically operable but are not currently utilized or are of marginal merchantability. These types are 100% excluded from the THLB.

Cottonwood has been left in the THLB to show potential levels of harvest even though currently, no cottonwood harvest licences exist.

6.14 Exclusion of Geographically Defined Areas

Current management excludes timber management activities in two areas. The operability in the inventory file currently does not account for this.

- East Howe Sound (region 9, compartment 86) has limited harvesting chances and most would require heli-logging involving transport over public highways and railways. The net down is 788 ha.
- Whistler Local Resource Use Plan excludes timber harvesting activities within the Whistler old municipal boundary. Upon application of the forest cover polygon exclusion method used in TSR II, the selected polygons did not appear to encompass the areas within the LRUP boundary. Therefore, a spatial coverage was generated using 1:50,000 topographical maps (1981) and overlaid with the data set and a very close fit was achieved. This spatial net down resulted in a higher area (2455 ha net down) being removed from the land base than did the forest polygon removal method. The spatial net down is considered accurate.

6.15 Riparian Management Areas

The THLB was reduced, as per TSR II, by 4.8% to account for riparian reserve and management zone retention.

6.16 Wildlife Tree Patches

After all other reductions are completed, additional reductions are required to account for the amount of timber retention required to provide for wildlife tree patches (WTPs). The *Biodiversity Guidebook* provides a methodology for determining the volume reductions for WTPs based on the current state of the land base. Using these principles, Forest District staff reviewed the amount, location, and type of WTPs in current and past harvest areas, dispersed in the productive forest and estimated that the amount required for WTPs is 5.8%. Based on the assumption of three-quarters of the requirement can be met within the non-THLB, a 1.45% WTP reduction was applied. This is an 1107 ha net reduction to the THLB.

As part of the overall management objectives for the spotted owl resource management areas, a 5% reduction (663 ha) within the spotted owl special resource management zone was applied.

No area reductions were applied to areas that are under retention VQO, partial retention VQO or community watershed management strategies. Under these strategies, sufficient timber is left standing to account for WTP requirements.

6.17 Timber Licence Reversions

Timber licences are old tenure arrangements managed by the B.C. Forest Service that give a licensee exclusive rights to harvest Crown merchantable timber within the licence area and do not contribute to the TSA allowable cut. Once harvested and regenerated to a free-to-grow status, the timber licence reverts to the Soo T.S.A. The forest inventory shows that 15,786 productive ha still exist in the TSA. After accounting for stands that have reverted to the TSA (age class ≤ 4) and other area removals, approximately 2,290 ha remain available for harvest. Of the 2,290 ha, 700 ha are expected to be harvested in the next 3 years and the rest proportionally over the next 3 decades. The harvests have been prioritized by age, with the oldest stands being harvested first. The licence areas are managed as Crown land throughout, and are assumed to contribute to serals, though no volumes are generated in the first harvest.

7.0 INVENTORY AGGREGATION

Inventory aggregation is a process of simplifying the landscape into similar units. It identifies management zones or resource emphasis areas for the application of unique forest cover and spatial structure requirements, as well as for the application of growth and yield information. The aggregation must recognize both the similarities and differences in forest stand productivity as well as management objectives and prescriptions. This section describes the criteria and rationale behind the aggregation.

7.1 Management Zones

Management zones are geographically referenced areas that require unique management considerations. Areas requiring the same management regime or the same forest cover requirements are grouped into management zones. Table 7.1 lists the management zones in the TSA and the rationale used to define these zones.

Multiple resource issues may be present on the same forest area. For example, the watershed management zone may also have areas, which are visually sensitive and require an old growth objective. *FSOS* can accommodate multiple overlapping resource layers. Establishing target levels for each layer does this. The model then schedules harvest units which best meet the target levels for all resource layers as a whole.

Table 7.1: Management Zones

Management Zone	Net Area (Productive) (ha)	Criteria used to Delineate Zone	Rationale/Comment
IRM Zone	72,963	All areas on which standard integrated resource management practices occur.	The timber harvesting land base which is considered to be free of extraneous constraints
Visually Sensitivity Retention Partial Retention Modification	5,744 (16,001) 31,508 (69,267) 17,539 (36,029)	High sensitivity to alteration Moderate sensitivity to alteration Low sensitivity to alteration	
BEC Variants: AT p CWH dm CWH ds1 CWH ms1 CWH vm1 CWH vm2 ESSF mw ESSF mwh IDF ww MH mm1 MH mm2 MH mm2e	58 (3,877) 7,585 (14,487) 34,497 (59,322) 45,541 (98,918) 5,647 (8,579) 13,028 (24,339) 1,093 (12,751) 1,121 (4,105) 8,904 (15,576) 5,432 (17,911) 4,847 (39,482) 0 (485)	Defined in the Biodiversity Guidebook, determine the natural disturbance regime, and old growth objectives within these zones. Full biodiversity percentages were applied from year 1 and a 45/45/10 rule was applied to each landscape unit.	Old growth objectives will be applied by landscape unit and by variant to ensure representation within each unit.
Deer Habitat • Migration • Retention • Rotation • Selection • Spring	2,491 (4,041) 0 (6,064) 6,154 (9,154) 58 (692) 471 (798)	A range of deer management zones has been defined. A final strategy defined from sensitivity scenarios.	Some harvesting allowed in all zones except retention.
Community Watersheds	1,687 (6,012)	Areas defined by Squamish District Staff	Max (1% *length of 1 st period) disturbance rate.

Mushroom Area	513 (836)	Area defined by Squamish District Staff	Harvesting permitted within age class requirements. Two CT treatment strategy.
Spotted Owl Habitat	25,630 (53,410)	Increased WTPs, significant old growth requirements, special harvest.	Harvesting permitted. Significant mature/old forest requirement. Two CT strategy applied.

Biodiversity, IRM and VQO objectives were applied by landscape unit. All other objectives were applied TSA wide.

7.2 Analysis Units

Table 7.2 lists the principal criteria used in the aggregation of stands with similar biological characteristics into larger homogeneous units called analysis units (AUs). This aggregation provides the mechanism for application of stand-level modeling and reporting. Each forest cover polygon will be assigned an AU, based on the criteria in Table 7.2. Site index and leading species and operability class were the dominant criteria for creating the AUs.

Table 7.2: Analysis Units

AU	Helicopter AU	Leading Species	Inventory Type Group	MHA	
				Conventional	Helicopter
1	51	Fir	1-8	72	72
2	52	Fir	1-8	82	82
3	53	Fir	1-8	90	140
4	54	Cedar/Spruce	9-11, 21-26	72	72
5	55	Cedar/Spruce	9-11, 21-26	100	120
6	56	Hem/Balsam	12-20	63	63
7	57	Hem/Balsam	12-20	72	80
8	58	Hem/Balsam	12-20	100	170
9	NA	Pine	27-32	90	NA
10	NA	Cottonwood	35,36	50	NA

8.0 REGENERATION ASSUMPTIONS

Within the strategic silviculture analysis, there are two levels to regeneration assumptions. The first level is regeneration trends consistent with the TSR II analysis. These assumptions deal with age of regenerating trees, NSR regeneration assumptions, regeneration distributions, site index adjustments etc. The second level, the strategic silviculture level, addresses trajectory options for regenerating stands.

8.1 Yields for Base Case Managed Stands

This section describes the current regeneration regimes for the TSA base case, identifying managed stand conditions for each analysis unit. The operational adjustment factors for all regeneration AUs are 15% for OAF 1 and 5% for OAF 2. All conifer-leading stands are planted. Cottonwood naturally regenerates along a VDYP curve.

Table 8.1: Existing and Future Managed TIPSy Curves - Planted and Spaced

AU #	Helicopter AU	Zone	Regen Delay ^a	MHA	
				Conventional	Helicopter
121 - Fir G	171	Deer	3	82	82
122 - Fir M	172	Deer	3	80	80
123 - Fir P	173	Deer	3	90	200
132 - Fir M	182	Botanical	3	90	90
133 - Fir P	183	Botanical	3	100	100
101 - Fir G	151	Remaining	3	72	72
102 - Fir M	152	Remaining	3	63	72
103 - Fir P	153	Remaining	3	100	100
104 - C/S G/M	154	Remaining	3	72	80
105 - C/S P	155	Remaining	3	117	122
106 - H/Ba G	156	Remaining	3	54	54
107 - H/Ba M	157	Remaining	3	90	90
108 - H/Ba P	158	Remaining	3	100	120
109 - Pine All	NA	Remaining	3	63	NA
110 - Ac All	NA	Remaining	3	50	NA

^a The effective regeneration delay is 0, as two year stock is planted in the spring of the 3rd year after harvest.

8.1.1 Species Conversion

Table 8.2 outlines the regeneration assumptions to be applied for the base case. These values were derived based on historical knowledge of regeneration in the TSA. In instances where species conversion occurs, the area was transferred to the most appropriate analysis unit. For example, if 30% of the H/B-G analysis unit is planted to Douglas-fir then 30% is shifted to Fir-G analysis unit. If applicable, site indices were adjusted for conversion. Species conversion will apply only to the first rotation and will be applied to existing natural stands only. Further rotations will not result in species conversion.

Stands, which require species conversion, will be assigned as per Table 8.2.

Table 8.2: Regeneration Assumptions

	Convert To											
Existing	101	102	103	104	105	106	107	108	109	110	Sum	
1	100										100	
2		100									100	
3			100								100	
4				100							100	
5					100						100	
6	30			50		20					100	
7		30			50		20				100	
8								100			100	
9									100		100	
10										100	100	

The following equation will be used for conversion in H/B stands to fir:

$$SI_{Fdi} = 0.480 + 1.11 * SI_{Hw}$$

8.1.2 Genetic Gain Allowances

As a result of an on-going tree improvement program, a volume increase is expected for stands regenerating from genetically improved stock. The only AUs assumed to have genetic gain in the base case are AU 101 Fir-G (3.0%), 102 Fir-M (2.25%), and 132 Fir-G Botanical (0.75%).

A sensitivity scenario will apply a 4% genetic improvement in Douglas-fir leading stands and a 2% increase in other softwood yield volumes to account for planting of genetically-improved stock. The genetic gain was applied to 75% of the THLB with the lower-site Balsam and hemlock units (25% of the THLB) excluded. In general, poor stands in helicopter logging areas, pine stands, and cottonwood stands were assumed to not be regenerated with genetically-improved seedlings.

8.1.3 Existing Managed Immature

Table 8.3 provides information, by analysis unit and leading species, for the area by age class of planted and spaced second growth immature stands, applied in TSRII.

Table 8.3: Existing Managed Immature by Age Class

Analysis Unit	Area Managed (%)		
	1-10	11-20	21-30
All Douglas-Fir	100	100	100
All H/B	100	100	
All Cedar/Spruce	100		

For the Silviculture Strategies Base Case onward, managed stands were assumed to be those ≤ 40 years in age as well as older stands with a managed history.

8.2 Not Satisfactorily Restocked

In *FSOS*, NSR is modeled using negative ages, which are applied to reflect the NSR restocking schedule.

Table 8.4: Summary of NSR Restocking Strategy

Regenerated to	Current NSR Area ^a (ha) 2001	Backlog NSR Area (ha)	
		2003	2008
101	190	45	87
102	777	23	14
103	513	95	107
104	145	11	59
105	126	21	22
106	36	9	0
107	1,023	64	43
108	908	97	5
121	16	4	0
122	13	60	0
123	5	0	62
151	55	2	0
153	5	8	0
154	0	0	9
157	0	3	4
Total	3,812	468	416

^a Gross area of polygons in the THLB. Further partial net downs may apply to these polygons for a representation of actual net area.

8.3 TASS Curves

The strategic silviculture analysis focuses on determining the optimal timing and treatments given certain forest cover objectives, employment objectives, budgeting, timber flow criteria, timber volumes, costs of treatment, etc. For each AU, the stakeholder group in Workshop #1 identified a series of treatment regimes. The TASS curves were generated for each regime after which the regimes were tested from a forest-level perspective using *FSOS*.

The TASS curves provide a range of treatment regimes for regenerating stands. From these treatment options, a “good” treatment option for each stand based on forest-level objectives can be determined. The treatment regimes are shown in Table 8.5.

Table 8.5: TASS Regeneration Curves

STRATEGIC SILVICULTURE ANALYSIS - SOO TSA													
TREATMENT REGIMES AND RULES										Version Date: August, 2000			
Regime	Spp	MHA	Heli	TASS Values			Treatment Regime				Spacing	Prune	Commercial Thin
#			MHA	SI	Density							1st	2nd
General Rules										Top Height		Add an SI increase	Leave larger well spaced trees as crop trees
					initial density	FTG density					Up to max 40% LCR		min dbh of removal trees 12.5 dbh
SFA1	Fd	83	91	23	2000	2200	Do nothing						
SFA2	Fd	85		23	2000	2200	Space				500 @ 10m		
SFA3	Fd	81		26	2000	2200	Space	Fert			500 @ 10m		+ 3m
SFA4	Fd	108		26	2000	2200	Space	Fert	Ct		650 @ 10 m		+ 3m
SFA5	Fd	118		23	2000	2200	Space	Ct			650 @ 10 m		to 250spha@25 cm dbh
SFA6	Fd	200		23	2000	2200	Space	1st CT	2nd CT		1200 @ 10 m		30% volume removal @ 25 & 50 cm DBH
SFA7	Fd	140		26	2000	2200	Space	1st CT	2nd CT	fert	1200 @ 10 m		+ 3m
SFA8	Fd	129		23	2000	2200	Ct						30% volume removal @ 25 & 50 cm DBH
SFA9	Fd	85	94	23	5000	5500	Do nothing						to 250spha@25 cm dbh
SFA10	Fd	83		23	5000	5500	Space				500 @ 10m		
SFA11	Fd	81		26	5000	5500	Space	Fert			500 @ 10m		+ 3m
SFA12	Fd	108		26	5000	5500	Space	Fert	Ct		650 @ 10 m		+ 3m
SFA13	Fd	117		23	5000	5500	Space	Ct			650 @ 10 m		to 250spha@25 cm dbh
SFA14	Fd	210		23	5000	5500	Space	1st CT	2nd CT		1200 @ 10 m		30% volume removal @ 25 & 50 cm DBH
SFA15	Fd	150		26	5000	5500	Space	1st CT	2nd CT	fert	1200 @ 10 m		+ 3m
SFA16	Fd	135		23	5000	5500	Ct						30% volume removal @ 25 & 50 cm DBH
SFA18	Fd	72	72	29	2000	2200	Do nothing						to 250spha@25 cm dbh
SFA19	Fd	81		29	2000	2200	Space				600 @ 10 m		
SFA20	Fd	72		32	2000	2200	Space	Fert			600 @ 10 m		+ 3m
SFA21	Fd	90		32	2000	2200	Space	Fert	Ct		750 @ 10 m		+ 3m
SFA22	Fd	99		29	2000	2200	Space	Ct			750 @ 10 m		to 250spha@25 cm dbh
SFA23	Fd	117		29	2000	2200	Space	1st CT	2nd CT		1200 @ 10 m		30% volume removal @ 25 & 50 cm DBH
SFA24	Fd	108		32	2000	2200	Space	1st CT	2nd CT	fert	1200 @ 10 m		+ 3m
SFA25	Fd	99		29	2000	2200	Ct						30% volume removal @ 25 & 50 cm DBH
SFA26	Fd	72	72	29	5000	5500	Do nothing						to 250spha@25 cm dbh
SFA27	Fd	81		29	5000	5500	Space				600 @ 10 m		
SFA28	Fd	72		32	5000	5500	Space	Fert			600 @ 10 m		+ 3m
SFA29	Fd	90		32	5000	5500	Space	Fert	Ct		750 @ 10 m		+ 3m
SFA30	Fd	99		29	5000	5500	Space	Ct			750 @ 10 m		to 250spha@25 cm dbh
SFA31	Fd	120		29	5000	5500	Space	1st CT	2nd CT		1200 @ 10 m		30% volume removal @ 25 & 50 cm DBH
SFA32	Fd	108		32	5000	5500	Space	1st CT	2nd CT	fert	1200 @ 10 m		+ 3m
SFA33	Fd	108		29	5000	5500	Ct						30% volume removal @ 25 & 50 cm DBH
SFA35	Fd	72	72	33	2000	2200	Do nothing						to 250spha@25 cm dbh
SFA36	Fd	72		33	2000	2200	Space				600 @ 10 m		

SFA37	Fd	81		33	2000	2200	Space	Prune 2 lifts			500@6m	3.0 m @ 7 m	5.6m @12 m		
SFA38	Fd	72		36	2000	2200	Space	Prune 2 lifts	Fert		500@6m	3.0 m @ 7 m	5.6m @12 m	+ 3m	
SFA39	Fd	72		36	2000	2200	Space	Fert			600 @ 10 m			+ 3m	
SFA40	Fd	81		36	2000	2200	Space	Fert	Ct		800 @ 10 m			+ 3m	to 250spha@25 cm dbh
SFA41	Fd	90		33	2000	2200	Space	Ct			800 @ 10 m				to 250spha@25 cm dbh
SFA42	Fd	108		33	2000	2200	Space	1st CT	2nd CT		1200 @ 10 m				30% volume removal @ 25 & 50 cm DBH
SFA43	Fd	90		33	2000	2200	Ct								to 250spha@25 cm dbh
SFA44	Fd	72	72	33	5000	5500	Do nothing								
SFA45	Fd	72		33	5000	5500	Space				600 @ 10 m				
SFA46	Fd	72		33	5000	5500	Space	Prune 2 lifts			500@6m	3.0 m @ 7 m	5.6m @12 m		
SFA47	Fd	72		36	5000	5500	Space	Prune 2 lifts	Fert		500@6m	3.0 m @ 7 m	5.6m @12 m	+ 3m	
SFA48	Fd	72		36	5000	5500	Space	Fert			600 @ 10 m			+ 3m	
SFA49	Fd	81		36	5000	5500	Space	Fert	Ct		800 @ 10 m			+ 3m	to 250spha@25 cm dbh
SFA50	Fd	90		33	5000	5500	Space	Ct			800 @ 10 m				to 250spha@25 cm dbh
SFA51	Fd	99		33	5000	5500	Space	1st CT	2nd CT		1200 @ 10 m				30% volume removal @ 25 & 50 cm DBH
SFA52	Fd	90		33	5000	5500	Ct								to 250spha@25 cm dbh
SHA1	Hw	99	99	25	3000	3300	Do nothing								
SHA2	Hw	99		25	3000	3300	Space				800 @ 10 m				
SHA3	Hw	135		25	3000	3300	Space	Ct			1000 @ 10 m				to 300spha@25cm dbh
SHA4	Hw	135		25	3000	3300	Ct								to 300spha@25cm dbh
SHA5	Hw	108	108	25	8000	8800	Do nothing								
SHA6	Hw	108		25	8000	8800	Space				800 @ 10 m				
SHA7	Hw	135		25	8000	8800	Space	Ct			1000 @ 10 m				to 300spha@25cm dbh
SHA8	Hw	144		25	8000	8800	Ct								to 300spha@25cm dbh
SHA9	Hw	81	81	30	3000	3300	Do nothing								
SHA10	Hw	81		30	3000	3300	Space				800 @ 10 m				
SHA11	Hw	90		30	3000	3300	Space	Prune 2 lifts			600 @ 6 m	3.0m@6m	5.6m@10m		
SHA12	Hw	99		30	3000	3300	Space	Ct			1000 @ 10 m				to 350spha@25cm dbh
SHA13	Hw	108		30	3000	3300	Ct								to 350spha@25cm dbh
SHA14	Hw	81	81	30	8000	8800	Do nothing								
SHA15	Hw	81		30	8000	8800	Space				800 @ 10 m				
SHA16	Hw	90		30	8000	8800	Space	Prune 2 lifts			600 @ 6 m	3.0m@6m	5.6m@10m		
SHA17	Hw	99		30	8000	8800	Space	Ct			1000 @ 10 m				to 350spha@25cm dbh
SHA18	Hw	108		30	8000	8800	Ct								to 350spha@25cm dbh
SBA1	Ba	99	99	25	4000	4400	Do nothing								
SBA2	Ba	99		25	4000	4400	Space				900 @ 10 m				
SBA3	Ba	90		26	4000	4400	Space	Fert			900 @ 10 m			+ 1m	
SBA4	Ba	108	108	25	8000	8800	Do nothing								
SBA5	Ba	99		25	8000	8800	Space				900 @ 10 m				
SBA6	Ba	99		26	8000	8800	Space	Fert			900 @ 10 m			+ 1m	
SBA7	Ba	81	81	30	4000	4400	Do nothing								
SBA8	Ba	81		30	4000	4400	Space				1000 @ 10 m				
SBA9	Ba	81	81	30	8000	8800	Do nothing								
SBA10	Ba	81		30	8000	8800	Space				1000 @ 10 m				
SCA1	C	117	117	22	3000	3300	Do nothing								

SCA2	C	117		22	3000	3300	Space				800 @ 10 m				
SCA3	C	117	117	22	8000	8800	Do nothing								
SCA4	C	126		22	8000	8800	Space				800 @ 10 m				
SCA5	C	99	99	28	3000	3300	Do nothing								
SCA6	C	99		28	3000	3300	Space				900 @ 10 m				
SCA7	C	117		28	3000	3300	Space	Ct			1000 @ 10 m				to 300 spha @ 35cm dbh
SCA8	C	117		28	3000	3300	Ct								to 300 spha @ 35cm dbh
SCA9	C	99	99	28	8000	8800	Do nothing								
SCA10	C	99		28	8000	8800	Space				900 @ 10 m				
SCA11	C	117		28	8000	8800	Space	Ct			1000 @ 10 m				to 300 spha @ 35cm dbh
SCA12	C	117		28	8000	8800	Ct								to 300 spha @ 35cm dbh
SSA1	S	99	99	22	2000	2200	Do nothing								
SSA2	S	99		22	2000	2200	Space				700 @ 10 m				
SSA3	S	99	99	22	8000	8800	Do nothing								
SSA4	S	99		22	8000	8800	Space				700 @ 10 m				
SSA5	S	81	81	28	2000	2200	Do nothing								
SSA6	S	81		28	2000	2200	Space				700 @ 10 m				
SSA7	S	81	81	28	8000	8800	Do nothing								
SSA8	S	81		28	8000	8800	Space				700 @ 10 m				

Two commercial thins are applied, following spacing, to stands in the Spotted Owl habitat areas to create desirable owl habitat sooner in this zone.

Stands in the heli-logging zone do not receive any treatment, regenerating on the 'do nothing' option.

For each site index, there are two density classes in TASS. These classes represent different levels of yield, i.e., the yield is somewhat dependent on the density. All unmanaged stands and stands without density information were assumed to regenerate to the lower density curve. For managed stands, if the density was known, the appropriate density class was used. If the density was not known, the analysis used the lower density curve. After regeneration, all yields were assumed to follow lower density yield curves. It was assumed that these densities modeled natural ingress adequately.

Under-stocked stands (i.e. in the Pemberton region) follow their own managed curves until harvest, at which point they regenerate to fully-stocked stands with a complete suite of treatment options.

Existing managed stands were determined to be all stands that were 40 years in age or less. Where treatments could be confirmed in the ISIS database or in the FIP database, existing managed stands were placed on the appropriate point on the yield curve based on age and previously applied treatments.

Where information could not be directly linked to ISIS, the forest cover information was used.

Cottonwood regenerated to the same curves as used in TSR II. Pine was regenerated to fir TASS curves.

8.3.1 Minimum Harvest Age Criteria

For TASS yield curves, the following criteria were used to determine the minimum harvest age (MHA). The lowest minimum age at which all the criteria were achieved defined the MHA. The actual harvest age was defined by model scheduling.

Conventional land base:

- merchantable log volume > 350 m³
- 0.9 of MAI
- age ≥ 65

Helicopter logging:

- merchantable log volume > 400 m³
- 0.9 of MAI
- age ≥ 65

Commercially thinned stands (applied in non-heli only):

- merchantable log volume > 350 m³
- 0.9 of MAI

- age ≥ 65
- MHA is at least 10 years later than commercial thinned

8.3.2 Site Index Adjustments

Prior to reassignment of a yield curve, all stands underwent some degree of site index adjustment. Existing mature stands (>140 years) had OGSi adjustments applied, after harvest, according to the *Site Index Adjustments for Old-Growth Stands Based on Veteran Trees* (1998) study. All managed existing stands were adjusted according to Table 8.6. Thrifty stands received the same magnitude adjustment after the first harvest. The SI adjustments in the table are based on local experience and information (Brian Broznitsky, Pers.Comm., 1999).

Table 8.6: Site Index Adjustments

Species	SI Adjustment Elevate FC SI by	SI Adjustment Elevate SIBEC by
Fir – good	4	7
Fir – med	7	4
Fir – poor	7	0
Cedar/Spruce	4	0
Hemlock/Balsam	8	7

8.3.3 ISIS Integration

The linkage from ISIS to the forest cover is not a 1-to-1 relationship. Currently, an opening number is used to link the two databases; however, within each opening, the forest cover may have many forest cover polygons, and the ISS would have several treatment units. The number of sub-components in the opening may or may not be equal between ISS and the forest cover information.

Where a 1-to-1 relationship existed, the FIP database was updated with ISS data based on the leading species within each opening. Where a direct linkage was not achieved, the data was linked based on leading species and a tolerance around reported areas and a “best-fit” was achieved. With this method, a high usability of the ISIS data was achieved.

8.3.4 TASS – Regeneration Delay

The regeneration assumption made in the Timber Supply Review was used for the silviculture strategies analyses; planting would utilize 2-year-old seedlings, and would occur in the spring of Year 3, effectively having the year of logging act as year 0.

8.3.5 TASS Modeling of Balsam

TASS does not model Balsam (*Abies* spp). Western hemlock will be used as a surrogate for balsam for this analysis. There was some concern expressed in Workshop #1 that hemlock does not adequately represent the bole shape, treatment response or value potential of balsam. However, of the species that TASS is capable of modeling (Fdc, HWc, Cwc, Ss, Pli, Swi, Fdi, Hwi), coastal western hemlock is the closest and will be used in this analysis.

9.0 PROTECTION

9.1 Unsalvaged Losses

Unsalvaged losses are losses due to natural events that are non-recoverable and result in a decrease in the productivity of the TSA. These losses focus on the epidemic losses, such as losses due to fire, insects and diseases that are not salvaged, whereby the endemic losses are accounted for through operational adjustments and net down reductions. The analysis uses the values and rationale from the TSR II report. The losses for fire (30,000 m³/year) and insects (4,000 m³/year) total 34,000 m³/year.

Volumes are removed from the modeled harvest levels to represent net available volume.

10.0 Integrated Resource Management

The intent of this section is to provide details on how modeling methodology will integrate non-timber resource values with timber objectives.

10.1 Forest Cover Requirements

Table 10.1 outlines the forest cover objectives for the Soo TSA, by management zone, for maintaining non-timber values. Forest cover objectives are applied to model biodiversity values, hydrological recovery, and visual quality objectives by placing maximum and/or minimum boundaries on specific age distributions, focusing largely on young age and old age forests.

By applying Hugh Hamilton Limited's analysis approach, **FORUM**, forest cover objectives can be viewed as either targets or constraints. In simulation mode, forest cover constraints can be applied that must coincide with harvesting actions. In the optimization approach, targets will be set which will attempt to develop and schedule harvest units to best achieve age class and timber flow objectives. Some trade-offs between objectives may occur.

Table 10.1: Management Zones and Forest Cover Objectives – Base Case Scenario

Resource	Zone	THLB Area (ha)	Prod Area (ha)	Cover Requirement			
				Age 1	Max % < age 1	Age 2 (years)	Min % > Age 3 (1,70,140)
IRM^a		72,963	--	12	33	-	-
Water Supply	23 community watersheds	1,687	6,012	10	10	-	-
Spotted Owl	SRMZ	25,630	53,410	-	-	100	67
Deer Habitat	Migration	2,491	4,041	12	20	-	-
	Rotation	6,154	9,154			50	50
	Selection	58	692			50	50
	Spring	471	798			50	50
Mushrooms		513	836	16	25	80	50
Visual Quality^a	Retention	5,744	16,001	16	5	-	-
	Partial Retention	31,508	69,267	16	15	-	-
	Modification	17,539	36,029	16	25	-	-
BEC Variants^a	AT p ^b	58	3,877	--	--	250	9.7/11.6/13.6
	CWH dm	7,585	14,487	--	--	250	7.3/8.6/10.0
	CWH ds1	34,497	59,322	--	--	250	7.3/8.6/10.0
	CWH ms1	45,541	98,918	--	--	250	7.3/8.6/10.0
	CWH vm1	5,647	8,579	--	--	250	9.7/11.6/13.6
	CWH vm2	13,028	24,339	--	--	250	9.7/11.6/13.6
	ESSF mw	1,093	12,751	--	--	250	7.3/8.6/10.0
	ESSF mwh	1,121	4,105	--	--	250	7.3/8.6/10.0
	IDF ww	8,904	15,576	--	--	250	9.6/11.6/13.6
	MH mm1	5,432	17,911	--	--	250	14.2/17.0/19.9
	MH mm2	4,847	39,482	--	--	250	14.2/17.0/19.9
	MH mm2e	0	485			250	14.2/17.0/19.9

^a Applied by individual landscape unit

^b Areas without biogeoclimatic unit coding on inventory were assigned to AT p. Review of the inventory suggested that these areas are within the CWH zone, consequently, the seral stage requirements for CWH were used for AT p. (MoF, 1999)

10.2 Spotted Owl Special Resource Management Zones (SRMZ)

Spotted owl is managed through SRMZs and candidate areas. TSR II modeled the spotted owl habitat requirements as follows:

- SRMZ – 15.8% of THLB; minimum of 67% of the land base in stands above 100 years of age with a 1.5 % WTP requirement.
- Candidate Areas – 5.5% of the land base; IRM cover constraints with a 5.0% WTP requirement.

This analysis modeled all spotted owl areas with the 67% / 100-year requirement and 5.0% WTP requirement. In addition, only partial harvesting was used in owl areas.

The Spotted Owl Management Plan provides a thorough description of the desired stand structure required for enhancement of the spotted owl population. The primary requirement for the owl is a multilevel stand with a wide diversity of structure. The spotted owl is an interior forest species and, in order to avoid predation by large raptors, generally avoids flying through openings.

Many of the strategies defined in the Spotted Owl Management Plan can only be prescribed and identified at the stand-specific level, and many of the stand categories, such as Recruitment Areas or Replacement Areas have not been included in the inventory database. At the stand level, habitat enhancement can be achieved by employing some form of partial cutting system, ideally some form of shelterwood/retention system. However, shelterwood/retention systems are very difficult to model because the growth and yield model, TASS, cannot provide a growth and yield curve for uneven-aged management. Partial cutting in the spotted owl areas is modeled in this exercise by using commercial thinning as a surrogate treatment

The long-term stand structure objective for spotted owls has two components, suitable and superior habitat. For each category, the definition varies slightly according to the biogeoclimatic subzone, with the coastal subzones requiring slightly larger trees than the transition subzones. The criteria in table 10.3 are the ones that can be identified within this analysis. Others, such as snags, deformed trees or coarse woody debris are stand-level measurements that this analysis cannot represent.

Table 10.3 Stand Structure Objectives for Spotted Owl Habitat

Superior Quality Habitat	Moderate or Suitable Habitat
Wetter Maritime Ecosystems – CWHdm, CWHvm1, CWHvm2, MHmm1 – NDT 1&2	
3 or more multi-species canopy layers	2 or more multi-species canopy layers
Overstory trees >75 cm dbh, 37-185 sph	Overstory trees >50 cm dbh, 247-457 sph
60-80 % canopy closure	60-80 % canopy closure
Dryer Submaritime Ecosystems - CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, IDFww – NDT 2&4	
3 or more multi-species canopy layers	2 or more multi-species canopy layers
Overstory trees >50 cm dbh, 173-247 sph	Overstory trees >30 cm dbh, >247 sph
60 –85 % canopy closure	>50 % canopy closure

To meet these stand structure requirements, a surrogate even-aged management regime was designed so that it can be modeled by TASS. While this treatment regime will not meet the operational requirements, it is meant to approximate the product generation and timing that would be expected if an uneven-aged silviculture system was modeled.

10.2.1 Treatment Regime

The following guidelines were used to generate the TASS curves within the owl habitat areas based on historical data and discussions with operational personnel in the Soo TSA:

- Juvenile spacing at average stand height of 7.0 m (20 years) to 1200 sph.
- Commercial Thinning #1 at an average stand diameter of 25 cm dbh removing 30 % of the stand volume – Douglas-fir stands only.
- Commercial Thinning #2 at an average stand diameter of 50 cm dbh removing 30% of the stand volume – Douglas-fir stands only.
- Minimum harvest age at no less than 140 years, depending on site class.
- No treatments for stands with leading species other than Douglas fir.

The following stand targets have been established:

- 80% of each zone must be taller than 19.4 m
- Block size distribution to average 1.0 ha with maximum size of 3.0 ha. It is noted that the resolution of the dataset may not accommodate all block being within this size range.

TASS models single species stands. Only a single species will be modeled in the analysis. That species will be assumed to be the dominant canopy species; however, in actuality, ingress should introduce enough other species to produce multi-level, multi-species stands. It is assumed that treatments will be applied to enhance species diversity in spotted owl SRMZs.

10.3 Deer Habitat

The deer habitat forest cover requirements outlined in Table 10.1 were applied in the base case analysis.

11.0 TIMBER OBJECTIVES

During Workshop #1, a number of timber value, supply, cost and treatment issues were identified and required additional investigation. The proposed strategies are outlined in this section.

11.1 Timber Values

Timber values used within the analysis are based on a series of piece size groupings - similar to industrial grading - for each species. The analysis is based on average log diameter, taper, and knot size and rings per inch. Logs will be bucked to provide optimal lengths for value.

The product selling prices for the analysis were derived using MoF second growth coastal log survey data with all incidental volumes removed from the database. The data is based on indexed monthly averages for the seven years ending December 15, 1999. The indexing is by the British Columbia consumer price index. The second growth selling prices are summarized in Table 11.1. Figure 11.1 depicts per cubic meter pricing for different grades by incremental top diameter.

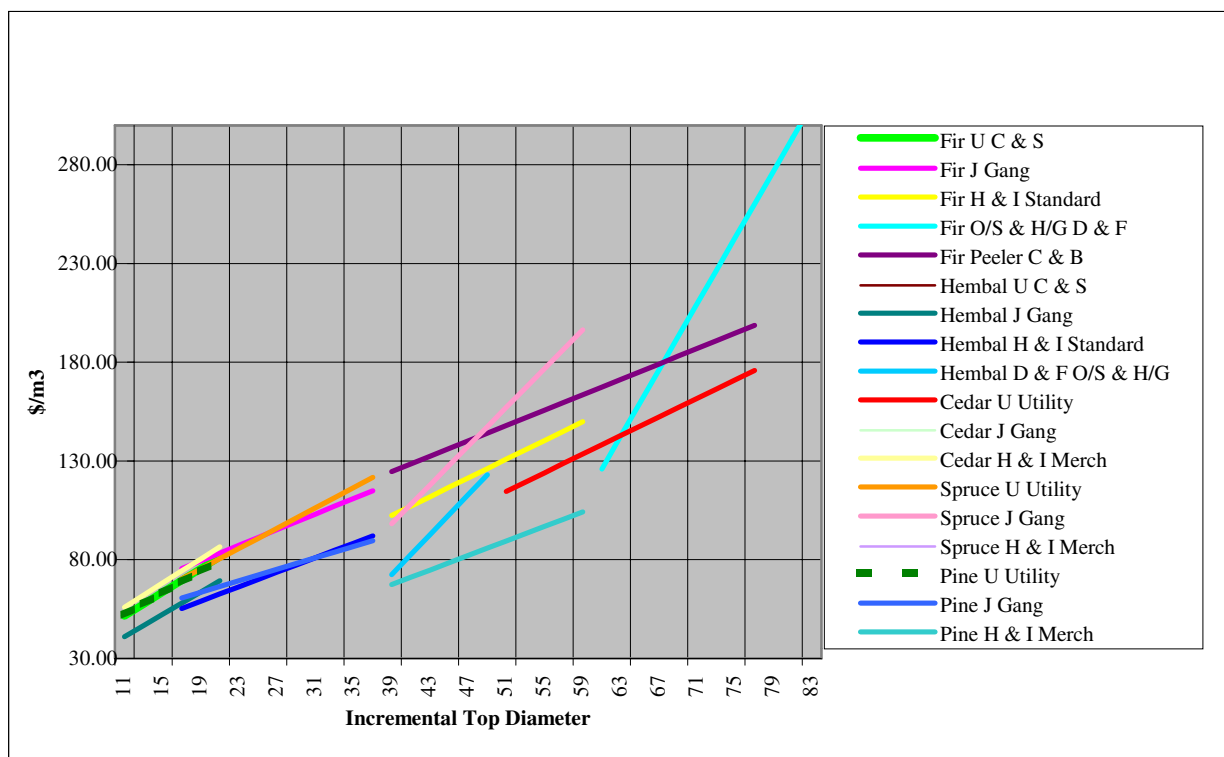


Figure 11.1 – Second Growth Timber Value by Species Grade; Sort at Howe Sound

Table 11.1 Summary of Second Growth Selling Prices by Diameter Class

Species	Statutory Grades	Assumed Industrial Sorts	Average	Max.	Min.	Upper	Lower	Incremental Top Diameters In 2 cm Classes (i.b.)																																										
			Selling Price (\$/m3)	Selling Price (\$/m3)	Selling Price (\$/m3)			Quartile (\$/m3)	Quartile (\$/m3)	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81	83				
Fir	U	C & S	61.85	101.31	41.19	81.58	51.52	51.52	57.53	63.54	69.55	75.57	81.58																																					
Fir	J	Gang	100.55	129.43	50.40	114.99	75.47				75.47	79.43	83.38	87.33	91.28	95.23	99.18	103.13	107.09	111.04	114.99																													
Fir	H & I	Standard	130.21	169.55	74.59	149.88	102.40															102.40	107.15	111.89	116.64	121.39	126.14	130.89	135.64	140.38	145.13	149.88																		
Fir	O/S & H/G	D & F	169.14	451.90	82.77	310.52	125.95																									125.95	142.73	159.51	176.29	193.07	209.85	226.63	243.40	260.18	276.96	293.74	310.52							
Fir	Peeler	C & B	158.33	238.99	90.90	198.66	124.62															124.62	128.51	132.41	136.31	140.20	144.10	148.00	151.90	155.79	159.69	163.59	167.48	171.38	175.28	179.17	183.07	186.97	190.87	194.76	198.66									
Hemba	U	C & S	52.29	86.55	29.85	69.42	41.07	41.07	46.74	52.41	58.08	63.75	69.42																																					
Hemba	J	Gang	69.65	114.43	41.06	92.04	55.36				55.36	59.02	62.69	66.36	70.03	73.70	77.37	81.04	84.70	88.37	92.04																													
Hemba	H & I	Standard	92.71	153.35	52.30	123.03	72.51															72.51	82.61	92.72	102.82	112.92	123.03																							
Hemba	D & F	O/S & H/G	133.79	217.99	95.51	175.89	114.65																					114.65	119.36	124.07	128.78	133.49	138.20	142.91	147.62	152.33	157.05	161.76	166.47	171.18	175.89									
Cedar	U	Utility	67.53	105.65	44.46	86.59	55.99	55.99	62.11	68.23	74.35	80.47	86.59																																					
Cedar	J	Gang	93.22	150.21	47.33	121.72	70.28				70.28	75.42	80.56	85.71	90.85	96.00	101.14	106.28	111.43	116.57	121.72																													
Cedar	H & I	Merch	136.61	256.25	59.95	196.43	98.28															98.28	108.10	117.91	127.73	137.54	147.36	157.17	166.99	176.80	186.62	196.43																		
Spruce	U	Utility	64.87	94.44	39.17	79.66	52.02	52.02	57.55	63.07	68.60	74.13	79.66																																					
Spruce	J	Gang	69.03	110.30	52.38	89.67	60.70				60.70	63.60	66.50	69.39	72.29	75.18	78.08	80.98	83.87	86.77	89.67																													
Spruce	H & I	Merch	83.61	124.87	51.30	104.24	67.45															67.45	71.13	74.81	78.49	82.17	85.85	89.53	93.20	96.88	100.56	104.24																		
Pine	U	Utility	52.30	79.97	29.25	66.14	40.77	40.77	45.85	50.92	55.99	61.07	66.14																																					
Pine	J	Gang	61.23	95.97	35.40	78.60	48.32				48.32	51.35	54.38	57.40	60.43	63.46	66.49	69.52	72.55	75.58	78.60																													
Pine	H & I	Merch	All incidental volumes & pricing.																																															

All timber values are based on domestic pricing, regardless of whether export opportunities for the wood exist.

11.2 Harvesting Costs

Two harvest systems are being proposed for the Soo TSA; a ground-based and cable-based system.

Harvesting costs will be determined by the utilizing both the Coast and Interior Appraisal Manual costing allowances. Harvesting cost estimation is used in conjunction with the log values to provide ranking criteria for various treatment regimes. The costs need to be reasonable, but as they are not being used in any legal context, do not need to be exact. Following criteria were used:

- Must represent marginal increases in piece size gained through treatment;
- Should be based on a single harvesting system for each polygon;
- Should be defensible as to data source and methodology.

The stumpage appraisal system was chosen to provide costing. As it is based on operator survey data, it is defensible to the MoF and stakeholders. The harvesting cost systems will not be accurate for every cut block, because of the operational ability to blend harvesting systems; rather it is a method to allow different regimes to be ranked against each other.

11.2.1 Tree to Truck

The Tree-to-Truck section of the Interior Appraisal Manual was chosen to develop the tree-to-truck costs. This is reasonable, because it is applicable to the Lillooet TSAs as well as the TSAs within the Interior Wet Belt, all of whom experience “coast-like” operating conditions. The Coastal Appraisal Manual was not chosen because all tree-to-truck harvest methods have been blended to provide a single value of \$20.71, applicable to all sizes, locations and blended harvesting methods. A GIS analysis was done on the dataset, which divided the area at the 40% slope grade. Below 40% slope will use the ground-based tree-to-truck costing method, while those polygons greater than 40% will use the cable-based harvest system.

Data from three FERIC studies:

- Partial Cutting in Mountainous Old-Growth Forests in Coastal British Columbia: Harvesting Productivity and Cost, and Residual Stand Impacts; Bennett, December 1997;
- Harvesting Sensitive Sites with a Long Distance Cableway System: Productivity and Costs; Bennett, January 1996;
- Shelterwood Harvesting in Coastal Second Growth Douglas-Fir; Hedin, October 1994;

were reviewed, but did not provide a superior methodology to provide a tree-to-truck cost. The information from the reports was used to validate and modify the Interior Appraisal Manual Methodology.

For Tree-to-Truck harvest cost estimation, the following equations are used:

Ground-based Harvesting Systems

$\text{CONSTANT} + (3.34 * \text{SS\%/100}) + (4.24 * \text{SLOPE\%/100}) - (5.41 * \text{VOLHA/1000}) +$
 $(.7 * \text{VOLHA/VOLTREE/1000}) + (.43 * \text{GVOL}) + (3.61 * \text{BD\%/100}) + (2.85 * \text{DPCUT2}) - (2.76$
 $* \text{PCCUT2/100}) + (.67 * \text{SUPP2/100}) + (1.26 * \text{SUPP3/100})$

Variable	Definition	Assumption or Application
CONSTANT		Set at 17.10
SS%	Sensitive Site	Assumed to be 0
SLOPE	Ground Slope	Set at 20%
VOLHA	Net Volume per ha	Defined as the merch vol/ha on the TASS curves
VOLTREE	Net Volume per tree	Defined as the Merch vol/ha divided by stems/ha in TASS
GVOL	Gross Volume per tree	Defined as Total Vol/ha divided by stems/ha in TASS
BD	Blow Down	Assumed to be 0
DPCUT2	Partial Cut	If commercial thinning = 1, else = 0
PCCUT2	Volume removed	As defined in the commercial thinning schedule
SUPP2	Distance to support	Ignored for this calculation
SUPP3	Distance to support	Ignored for this calculation

The distance to support center has been ignored, because the tree-to-truck costs have been attached to the yield curves and can occur throughout the TSA. A distance to support center cost will be attached to the hauling costs, which are spatially based.

Cable-based Harvesting Systems

$\text{CONSTANT} + (4.58 * \text{SLOPE\%/100}) - (2.01 * \text{VOLHA/VOLTREE/1000}) - (2.12 * \text{GVOL})$
 $+ (.2 * \text{GVOLSQR}) + (2.08 * \text{CDPCUT}) + (.7 * \text{SUPP2/100})$

Variable	Definition	Assumption or Application
CONSTANT		Assumed to be 29.04
SLOPE	Ground Slope	Assumed to be 40%
VOLHA	Net Volume per ha	Defined as the merch vol/ha on the TASS curves
VOLTREE	Net Volume per tree	Defined as the Merch vol/ha divided by stems/ha in TASS
GVOL	Gross Volume per tree	Defined as Total Vol/ha divided by stems/ha in TASS
GVOLSQR	Gross Vol/tree squared	
CDPCUT	Partial Cut	Partial Cut =1 else =0
SUPP2	Distance to support	Ignored for this calculation

The distance to support center has been ignored, because the tree-to-truck costs have been attached to the yield curves and can occur throughout the TSA. A distance to support center cost will be attached to the hauling costs, which are spatially based.

It is assumed that no incremental silviculture treatments will occur on helicopter blocks, therefore, helicopter harvesting costs are not required.

11.2.2 Hauling

The Coast Appraisal Manual will be used to determine hauling cost. In the Interior Appraisal Manual, haul distance is based on cycle time, which cannot be calculated within this analysis. The Coast Appraisal Manual uses haul distance in its calculation and, within the appraisal manual; haul distance is measured from the centre of the cut block(s). For this analysis, we will determine an average haul cost for each landscape unit, a spatial overlay for every polygon. In addition, harvest premiums can be included for individual landscape units to represent local conditions.

The hauling cost will be calculated as $3.092 + 0.1100$ (One way distance). (Coast Appraisal Manual)

11.2.3 Towing

All log prices were assumed to be set at Centre Bay, Gambier Island. The towing price from Squamish to Gambier Island is \$0.94 and from Spring Creek to Pitt Lake \$1.60 (Coast Appraisal Manual).

11.2.4 Dump, Boom, Sort and Scale

A standard cost of \$8.10 is applied (Coast Appraisal Manual).

11.2.5 Road Construction

Because this analysis is only dealing with values achieved from second growth timber, it is assumed that all wood has been roaded. A standard cost of \$5.00 is applied to account for road reconstruction. A standard road maintenance cost of \$1.74 is applied (Interior Appraisal Manual).

11.2.6 Administration

A standard cost of \$20.00 is applied (Coast Appraisal Manual).

11.2.7 Basic Silviculture

A standard cost of \$2.10 is applied (Coast Appraisal Manual).

Table 11.2 Soo TSA – Landscape Unit Attributable Harvest Costs per m³

Landscape Unit	Distance (km)	Measured to	Hauling Cost	Tow	DBSS	Rd Const	Rd Mtce	Admin	Basic Silvi	LU Premium	LU Cost
Rogers	38	Spring Ck	7.27	1.60	8.10	5	4.42	20	2.1	11.34	59.83
Meager	160	Squamish	20.69	.94	8.10	5	4.42	20	2.1	10	71.25
Ryan	112	Squamish	15.41	.94	8.10	5	4.42	20	2.1	8	63.97
L. Squamish	31	Squamish	6.50	.94	8.10	5	4.42	20	2.1	3	50.06
Billygoat	63	Spring Ck	10.02	1.60	8.10	5	4.42	20	2.1	11.34	62.58
Mamquam	20	Squamish	5.29	.94	8.10	5	4.42	20	2.1	4	49.85
Tuwasus	40	Spring Ck	7.49	1.60	8.10	5	4.42	20	2.1	11.34	60.05
E. Howe Sound	16	Squamish	4.85	.94	8.10	5	4.42	20	2.1	5	50.41
Indian	27	Squamish	6.06	.94	8.10	5	4.42	20	2.1	5	51.62
Soo	82	Squamish	12.11	.94	8.10	5	4.42	20	2.1	7	59.67
Whistler	56	Squamish	9.25	.94	8.10	5	4.42	20	2.1	6	55.81
Callaghan	47	Squamish	8.26	.94	8.10	5	4.42	20	2.1	6	54.82
Sloquet	20	Spring Ck	5.29	1.60	8.10	5	4.42	20	2.1	11.34	57.85
U. Lillooet	152	Squamish	19.81	.94	8.10	5	4.42	20	2.1	10	70.37
Railroad	130	Squamish	17.39	.94	8.10	5	4.42	20	2.1	8	65.95
Birkenhead	104	Squamish	14.53	.94	8.10	5	4.42	20	2.1	8	63.09
Gates	118	Squamish	16.07	.94	8.10	5	4.42	20	2.1	8	64.63
Lizzie	114	Squamish	15.63	.94	8.10	5	4.42	20	2.1	8	64.19

11.3 Treatment Costs

Treatment costs for the analysis are based on MoF and industry information obtained at the pre-analysis workshop. Table 11.3 shows the treatment costs used in the analysis.

Table 11.3 Treatment Costs

Treatment	Low	Medium	High	Person Days
Spacing (per ha)	\$800	\$1200	\$1600	4.0
Pruning 1 st lift (per ha)	\$1200	\$1600	\$2000	5.0
Pruning 2 nd lift (per ha)	\$1600	\$2000	\$2400	6.0
Fertilization – Fd/B (per ha)	\$150	\$200	\$250	.1
Commercial Thin (per ha)	\$0	\$0	\$0	2.0
Deciduous Conversion (per ha)	\$2900	\$3600	\$4300	
Fertilization – Hw (per ha)	\$200	\$250	\$300	.1
Brush & Plant (Fill Plant) (per ha)	\$1900	\$2600	\$3300	6.5

11.4 Commercial Thinning

Commercial thinning will provide a significant supply of logs for the Soo TSA in the near future. However, not all second growth stands are economically or operationally viable. The following methodology will be used to determine the viability of a stand. Using a GIS analysis of TRIM data, stands with an average slope under 40% are assumed to be commercially thinned using a ground-based system. For stands with an average slope greater than 40%, it is assumed that commercial thinning will utilize a cable-based system. This analysis will assume that no commercial thinning, or any incremental silviculture will occur on helicopter blocks.

For ground-based blocks, and this does not preclude using a cable-based system, it is assumed that minimal stand requirements are 250 m³/ha, with an average stem dbh of 25 cm.

For cable-based blocks, minimum stand requirement is 300 m³/ha with an average dbh of 25 cm.

11.5 Fertilization

Fertilization, in scenarios 6 and 7, is applied after every 10 years starting at age 20. The last treatment is at 70 years.

11.6 Stand Density Determination

Stand density information was used for existing managed stands where available. In order to estimate the likely regeneration volume of future managed stands, correlation analysis was used in one or more combinations for the following variables: age, crown closure, species, and height or biogeoclimatic zone. However, no significant correlation was found. A frequency distribution for each biogeoclimatic unit showed that the highest probability of density always fell within the lower density class established. Therefore, all future managed stands were assumed to regenerate at the lower density options.

11.7 Value Analysis

In the analysis, all costs and revenues were aggregated at the forest level and brought back to today's dollars using a 4% discount rate. The model was then used to find a solution that would maximize the forest-level difference between costs and revenues over the planning horizon.